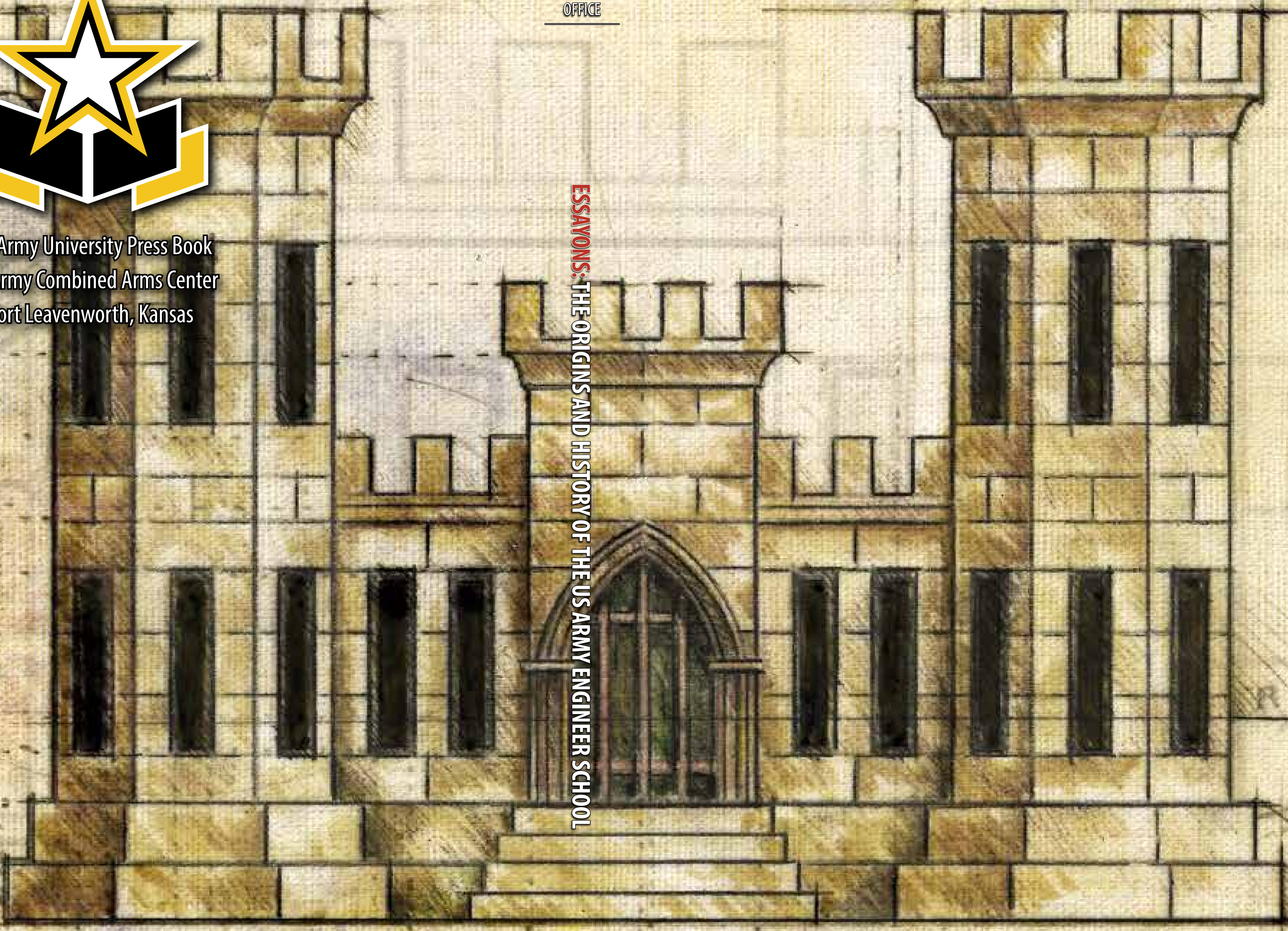

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ESSAYONS: THE ORIGINS AND HISTORY OF THE US ARMY ENGINEER SCHOOL

ARMY UNIVERSITY PRESS

The Origins and History of the US Army Engineer School

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Staff of the US Army Engineer School History Office

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2020

Editors
Diane R. Walker and Amanda M. Hemmingsen

Dedication

This book is dedicated to the men and women who have honorably worn the Engineer castle on their uniforms, the Engineer Regiment Army Civilians, and their families who have sacrificed so much for their loved ones to serve the United States of America.

Contents

Illustrations

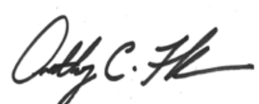
Foreword

I am proud to be a product of the US Army Engineer School. After nearly thirty-five years of active duty service and three separate tours serving the school, the most recent from 2013 to 2015 as its 95th Commandant, I have a tremendous respect and appreciation for how the Engineer School is both a cornerstone and keystone for the Engineer Regiment. In the course of serving the regiment, I have witnessed what is required to train our future engineer leaders and the school's instrumental role in our leaders' development. My memories reinforce the understanding of what it means to be an engineer and what every engineer should aim to be: an innovative problem solver, a steadfast leader, and a technical steward of our profession.

These aspirations form the school's purpose. Our product—a trained and ready soldier and leader (sappers, mappers, builders, firefighters, bridgers, and divers)—who will well and faithfully serve the Army and be prepared to engage in a range of missions around the world. Our engineer graduates have led forces throughout our nation's history into the breach, closed gaps, and created bridges and structures under the most trying conditions. We have taken the lessons learned each time and shared them across the force to ensure we were ready for the next call.

The importance of the educational institution within our Army and the training base throughout history cannot be overemphasized. After the Revolutionary War, President Thomas Jefferson reduced the size of our Army. But realizing the importance of preparing for the future, he established the United States Military Academy, which was the forbearer of our very own Engineer School. After the American Civil War, the Command and General Staff College was formed to capture lessons learned and develop future leaders. The Army War College was created as a solution to military failings uncovered during the Spanish-American War. The colleges would grow to advise the president, devise plans, acquire information, and direct the intellectual exercise of the Army. The Training and Doctrine Command was formed after Vietnam to put combat developments under the purview of the branch schoolhouses. Again and again, it is after great conflicts that the Army reflects and learns. During my tenure as commandant, the Engineer School collected lessons learned from Operation Enduring Freedom and Operation Iraqi Freedom to support the maneuver commander in Unified Land Operations with combat, general, and geospatial engineering.

Today we are preparing for large-scale combat operations (LSCO) and modernizing the Army for the future. We are seeking the best organizational structure, integrating technologies into doctrine, and procuring new equipment to meet requirements. I have tried to reflect on how previous leaders and our Army looked at the challenges that influenced their efforts for success. I found that after major wars and conflicts, institutions like the Engineer School had a great impact on how we restructured and drove training and leader development based on important lessons learned. While these transition points happened at the institutional level, we as a regiment had not captured this rich history in one document. This book is an effort to explore our history, both from the perspective of the school—as the institutional basis of the Engineer Regiment—and the engineer leaders and commandants whose decisions shaped our identity. It is OUR story. I proposed this book during my tenure as the Engineer School Commandant for the regiment to capture the Engineer School's role in developing engineer leaders capable of creative thought and ingenuity and engineering solutions for our nation's toughest challenges today and into the future. Thanks to the team that did all the research and writing for this tremendous project. You leave a great legacy. Essayons!



Anthony C. Funkhouser
Major General, US Army
Deputy Commanding General
Military and International Operations
US Army Corps of Engineers

From the Commandant

In history, a great volume is unrolled for our instruction, drawing the materials of future wisdom from the past errors and infirmities of mankind.

—Edmund Burke

History is the common language that binds us with our predecessors, and history is at the core of our identity. Regardless of the time period, regardless of the threats that faced our Nation, one thing remains—the Spirit of the Engineer. The United States Army Engineer School instilled this intangible spirit of grit and loyalty in our soldiers, making them unique from the rest.

The Engineer School produced soldiers who created the history written within this book. What we have accomplished during our 245 years is nothing short of astounding. Engineers built the Washington Monument, the Panama Canal, the Bonneville Dam, the Pentagon, the Kennedy Space Center, the Border Wall, and alternate care facilities for the COVID-19 pandemic. They may not have known that they were living history at the time, but they were ready when called upon by their Nation. The Engineer School ensured our soldiers' readiness and inculcated the foundational skills of problem solving and critical thinking. Engineers are leaders who are trained and ready to solve our Nation's toughest challenges and prepared to engage in a wide range of missions around the world. It was engineers who breached obstacles on Omaha Beach, who surveyed the West, who fortified Bunker Hill, who repaired ports in Haiti, who enacted fire protection measures to secure Army airstrips; and it is engineers who support and defend the Constitution of the United States against all enemies, foreign and domestic.

Leaders have a responsibility to educate themselves, inspire others, and enhance the engineer legacy. Look within yourself and reflect upon how our school prepared and trained you and how you may have helped train the next generation of engineers. Leverage history to learn your craft and build your team, because our Army's most valuable asset IS our people. Our sappers, mappers, builders, divers, and firefighters have a responsibility to inspire their subordinates, peers, and superiors. They have a duty to cultivate a team of teams comprised of all military occupational specialties (MOSs), all components, and all branches of service united under a common goal of success, because winning matters.

As evident through history, engineers trust in the processes and lean on training at our school to make complex problems simple. Throughout World War I, our Army learned to navigate trench warfare. In Korea, we adapted to conquer the treacherous terrain. In the post 9-11 world, we trained soldiers and fielded equipment to overcome the improvised explosive device (IED) threat. Today, we must prepare for an unknown threat in a multi-domain environment. We must ensure our engineers and our capabilities continually evolve with tomorrow's complex domains and strategic requirements. Harnessing the ability to traverse obstacles, successfully cross wet gaps, and critically think to succeed against a near-peer adversary is a necessity.

Encompassed in this book is the lineage of our Engineer School and our Nation. This book explores the institutional influences of the Engineer School and engineer leaders who have shaped our identity. Writing our history is integral to memorializing our legacy while understanding our history is vital to securing a better future. The themes intertwined within this text are our school's ability to consistently educate, inspire, and enrich our soldiers to ensure a prepared force. Thank you to the Engineer School History Office team who researched and prepared this remarkable testament to our legacy. Similar to the engineers of yesterday and today, we need to guarantee that tomorrow's soldiers are prepared to engineer solutions to our Nation's toughest challenges. *The Origins and History of the United States Army Engineer School* is the story of every engineer. What will you write into our history?

Essayons! We Will Succeed!

Mark C. Quander
Brigadier General, US Army
98th Commandant
US Army Engineer School

Acknowledgements

I wish to acknowledge the many people who made this publication possible and thank them for their hard work and efforts. *ESSAYONS: The Origins and History of the US Army Engineer School* is based on the vision and guidance of then-Brig. Gen. and now-Maj. Gen. (Retired) Anthony C. Funkhouser. As the 95th Commandant of the Engineer School, Major General Funkhouser instructed the Engineer School History Office in 2014 to formulate and execute a plan to produce a history of the Engineer School from its beginnings to the present day. Even though the publication process was much longer than anyone anticipated, Major General Funkhouser continued to stay involved long after his departure from the school.

Numerous individuals have worked on this project on and off over the last six years; I ask forgiveness for any I have failed to include in the list below. The contract to write this publication was initiated by then-Command Historian David C. Chuber and then-Deputy Historian Vincent J. Hodge, who oversaw the team that worked on the first rough draft manuscript. The Engineer School's contract historian, David J. Ulbrich—with the help of Capt. Elizabeth A. Betterbed, Capt. Jessica G. Sweeney, and Chief Warrant Officer 3 (Retired) Jason E. Patrick—produced and submitted a first rough draft manuscript to the Engineer School in late 2016. Following Chuber's retirement in December 2016, the project came to a halt until the Engineer School could select and hire a new command historian; the process was delayed by a six-month government hiring freeze.

In May 2017, I inherited the mission to get Major General's Funkhouser's publication back on track and published as soon as possible. In the summer of 2019, following several administrative road blocks and after being drawn away to several other time-sensitive projects, I was finally able to take a much-needed closer look at the previously submitted work. Chief Historian John C. Lonnquest as well as Matthew T. Pearcy and Bianka J. Adams from the US Army Corps of Engineers Office of History provided detailed, insightful reviews and suggestions regarding the Engineer School first rough draft manuscript. Armed with their input, Engineer School History Office team members began fact and source-checking, editing, and rewriting entire chapters from the first rough draft manuscript. The process of checking every date and source was painstakingly slow, and I couldn't have completed this critical step without the support of Capt. Hugo N. Magana, Capt. Anne T. McEldowney, Capt. Alex Parra, Capt. Christopher S. Sherrill, Capt. Jakob C. Stewart, Ronney Z. Miller, and my deputy historian, Samuel D. Roberts.

I am most thankful for the support received from two civilian volunteers, Margaret R. Hawthorne and Jay C. Shaw. While Hawthorne easily volunteered more than 100 hours of her own time, Shaw took his dedication and support for this book to the next level—volunteering over 350 hours in total. Another valued voice of reason and support was Engineer Museum Director Troy D. Morgan, who always makes himself available to the Engineer School History Office when his advice or expertise is needed. And, of course, we can't forget Larry D. Roberts, the Engineer School's command historian from 1988 until 2011, along with the school's archivist, Janet Fisher, who both spent many years building the Research Collection available today to researchers around the world. Furthermore, US Army Engineer School senior leaders provided exceptional support and guidance to help complete this project. I extend my thanks to the current commandant, Brig. Gen. Mark C. Quander; the former commandant, Maj. Gen. Robert F. Whittle; the deputy commandant, James R. Rowan; the former assistant commandant, Col. Marc F. Hoffmeister; the former chief of staff and current assistant commandant, Col. Brian P. Hallberg; and finally the current chief of staff, Lt. Col. Aaron M. Williams. I also wish to thank Capt. Marshall J. Kobylski, 1st Lt. Danielle A. Nuszkowski, Mary E. (Beth) Rolufs, and Kenneth R. Howard for last-minute support to get this project completed on time. I am greatly indebted to all of you.

I also owe thanks to the staff of Army University Press for supporting the efforts of the US Army Engineer School by publishing this book both in physical as well as digital format. Special thanks to Donald P. Wright, deputy director; Katharine S. Dahlstrand, team chief and historian of the Books and Research Team; Robin D. Kern for graphics; Dale E. Cordes for the cover design; and Diane R. Walker and Amanda M. Hemmingsen for layout and copyediting.

All of the above-named professionals have made this book better, and I am grateful for their support and contributions. Lastly, on a personal note, I offer my heartfelt thanks to my family for always supporting me. My wife, Terra L. Waitl, has been instrumental in getting this book project completed on time. Even though she was activated by the Missouri Air National Guard in support of COVID-19 pandemic operations during this time, she gladly volunteered her time and skills to the Engineer Regiment and this project to check and organize the glossary of acronyms and several of the appendices. As always, I wouldn't be where I am today, without her by my side.

Finally, this finished product is the combined effort of past and present volunteers and employees of the US Army Engineer School History Office. While I did not author the first rough draft manuscript, I alone am responsible for any errors, omissions, or limitations of this work. The doors of the Engineer School History Office are always open for all researchers. I appreciate any feedback or suggestions you might have for follow-on editions. If you find inconsistencies or possess important documents and primary sources that will shed light on the US Army Engineer School's eventful history, please let us know. After all, we are Army engineers and this is OUR HISTORY. History Matters!

Florian L. Waitl
Command Historian
History Office
US Army Engineer School

Introduction
The Hard Right over the Easy Wrong
Florian L. Waitl

History should be read by the officer for the purpose of obtaining information and drawing deductions. He who reads for the story merely, without making application either in his further reading or to his work, might find the historical novel more entertaining, and of equal value.[1]

—Maj. Gen. Lansing H. Beach
Chief of Engineers 1920–24

The proud and long history of the US Army Engineer School is intertwined with the 245-year history of the US Army Corps of Engineers. While the Corps of Engineers history is well illustrated throughout several publications, there has been no previous attempt to record the full history of the US Army Engineer School and its impact on the Engineer Corps throughout the years. An institution which dates back to the American Revolution with its rudimentary, yet effective, School of Application at Valley Forge, Pennsylvania, deserves the utmost attention and dedication of historians attempting to write its official history. A good-enough-for-government-work approach is not sufficient; the engineers and sappers of the past, present, and future deserve much better. This has been the reason this book project took as long as it did to be completed. The following pages must be worth the dedication and sacrifices that Engineer Regiment soldiers made to support and defend the United States of America. The staff of the US Army Engineer School History Office, along with many volunteers from within the US Army Engineer School and beyond, have worked countless hours to turn this book into what it is today. The staff attempted to correct the many mistakes that were made in early writings of this project; unfortunately, it is almost certain that some minor mistakes are still present in today's work.

Driven by the dictates of time, properly documenting even a percentage of the events of the Engineer School's proud history is an impossible task. The number of individual actions and decisions for any of the major events at the Engineer School would fill volumes of paper and take even more precious time to produce. *ESSAYONS* presents a snapshot of certain efforts; by no means does it constitute a traditional administrative or organizational history of the US Army Engineer School. A large amount of important decisions, innovations, and challenges have not been noted in these pages not just due to the time constraints of writing a thorough work but also because documents either do not exist or have not been transferred to the Engineer School's History Office. It is an aspect of human nature that if the same thing happens often enough, it becomes routine and is seen as normal. Reorganization is a normal part of activities in an organization such as the Engineer School. In that sense, a lot of what has happened at the Engineer School throughout the decades was seen as routine and many times wasn't documented to the fullest extend necessary to answer today's many questions regarding why and how. Most documents and primary sources used in the book are straight out of the Engineer School's Research Collection, which the 2019 TRADOC Military History Program Certification Visit rated as "among the best of its kind and an example for other TRADOC field history offices to follow."[2] And yet, the documents used for this research didn't answer all the questions and, in some cases, created more questions than answers. It is apparent that we as humans often fail to identify significant events in our daily routines and notate them appropriately. Army digitization efforts over the last decade also hindered more than helped in preserving the Engineer School's history in a way to make sense of decisions made just a few years ago.

At the end, a comprehensive and analytical examination of the Engineer School's history requires more resources than are available at this point. The doors of the Engineer School's History Office are always open to researchers who would like to conduct their own research on the various topics discussed in this book as well as those that might have not even made the cut or have been temporarily lost to history in the research collection itself. What this book does accomplish is to provide some indication of the breadth, depth, and complexity of the Engineer School's efforts to train engineers to fight and win America's wars.

The history of US Army engineers is a story of continuously adapting to changing technology, environments, and missions. Yet, the essential tasks of engineers have not changed too much after all. Conflict after conflict, engineers are called upon to provide the five basic engineering functions of mobility, countermobility, survivability, general (sustainment) engineering, and topographical (geospatial) engineering. This book addresses the various challenges the Engineer School faced throughout the years and the ways that Engineer School leaders responded to these challenges. Several themes have surfaced and resurfaced throughout the Engineer School's history, including mobilization and training of a large number of engineers in a short time span, curriculum changes prompted by mission requirements, doctrine development, combat development, school re-organization, civil-military relations and their effects on the Army and the school, and budgetary challenges. *ESSAYONS* was not written for history's sake, but it is the first attempt to record the Engineer School's history in a single publication to continuously improve efforts to educate and train tomorrow's engineer leaders. It is my hope that this book will provide some ideas of how to respond when faced with similar challenges. At the same time, focusing only on some of the major events discussed in the book may present a somewhat distorted picture of the level of activity and accomplishments achieved by the countless engineer soldiers of the Engineer School. All are part of the whole, and without each individual's effort, nothing would have been done the way it was done. The Engineer Regiment wouldn't be what it is and always will be—the epitome of the profession of arms. Essayons!

Notes

1. Maj. Gen. Lansing H. Beach, "The Reading of Military History," *The Military Engineer* 14, no. 75 (May–June 1922): 137.

2. Lt. Gen. Theodore D. Martin, "Memorandum for Commandant, U.S. Army Engineer School, Subject: Certification Visit," 6 November 2019, US Army Engineer School Military History Program, 1.

Chapter 1
The Origins of the US Army Engineer School

From 1775 to 1779 during the American Revolutionary War, the chief engineer and the Corps of Engineers gradually became parts of the Continental Army. The development of an embryonic school also occurred during that same period. The engineers achieved many successes in the Revolutionary War because of the effective leadership of foreign-born and French-trained officers. Many insights can be gleaned from examining engineer operations during this conflict, and many traditions are better appreciated in the context of their origins. The Revolutionary War's conclusion in 1783 meant an end of the Engineer Corps and its school when the American military demobilized in dramatic fashion. Yet national security threats from Europe spurred the resurrection of the school and the Corps in 1794. This new iteration incorporated the engineers and the artillerists in a single organization. Even so, this combined corps barely survived the fiscal constraints of the 1790s.

Legacies of Vauban and Engineer Training in France

More than a century before the start of the American Revolution, France emerged as the leader in European military engineering and especially in fortification design and construction.

European castles were traditionally built with high walls and, ideally, on high ground, which gave defenders the advantage of shooting down on enemy forces. Attackers could succeed in capturing castles by only two means: starve the defenders into surrender over time or breach the castle walls. A successful breach could take three different tacks: sending soldiers to scale the walls with ladders or towers, undermining the walls and causing them to collapse, or breaking the walls or gates down with battering rams or by bombardments of heavy stone projectiles. Attackers and defenders vied with each other to find measures and countermeasures to defeat the other's efforts. The process of laying siege to a castle could take much time and many lives, while not affording the attackers any certainty of victory.[1]

In the 1300s, gunpowder and heavy artillery changed everything about fortification designs and tactics in Europe. Suddenly, the castle's high walls became liabilities. A sustained bombardment by cannon could easily bring them down, rendering the castle vulnerable to ground assault. This is most vividly observed in the siege of Constantinople in 1453, where the

Ottoman forces used artillery to breach the Byzantine city's supposedly impregnable walls. The Ottomans employed heavy cannons that hurled projectiles weighing hundreds of pounds in a bombardment lasting fifty-five days. When sections of the walls finally collapsed, Constantinople fell after a very brief, albeit bloody struggle in the city streets. The lesson here was clear for all of Europe, the new and ever-improving siege artillery made the medieval castle obsolete.[2]

The defensive solution to the improved and devastating bombardment required a complete redesign of fortifications. The need for expertise in mathematics, physics, architecture, masonry, and construction heralded the rise of modern military engineering. Starting in sixteenth-century Italy, engineers designed and built the *trace italienne* (a star-shaped bastion or fort). The thick, sloping walls of these new forts offered only low silhouettes that could not be easily targeted by direct enemy fire. The walls were backfilled by soil that dissipated the kinetic force of artillery bombardments; surrounding ditches with landscaped terrain impeded enemy movements and exposed soldiers to defensive fire. Squat ramparts atop the walls offered protected firing positions for defenders. The only major threat to the defenses came from plunging fire from mortars; however, the new forts minimized such damage with deep bunkers and firing positions (called casemates) inside the walls. The new forts also improved medieval castle survivability in two other ways: their star-shaped bastions eliminated dead zones where assault forces could avoid the defenders' fire, and these same bastions created overlapping fields of fire that made the attackers vulnerable from multiple directions.[3]

In the late 1600s, Sébastien Le Prestre de Vauban (1633–1707), a French engineer officer, perfected the original designs of the *trace italienne* and created fortifications on a grand scale in King Louis XIV's France. Vauban added more flanking positions and obstacles that further maximized defensive advantages. In all, he directed the construction of thirty-seven new forts and upgraded 300 others, mostly along France's coastline and eastern border. Other military engineers in Europe and North America imitated Vauban's designs until the late nineteenth and early twentieth centuries when rifled siege artillery and armor-piercing ordnance made Vauban's forts obsolete.[4]

Not only did Vauban master the construction of fortifications capable of withstanding artillery bombardments, but he also developed tactics, techniques, and procedures for successful sieges of enemy fortifications. After all, if he could design forts, then he could find their weaknesses.

Vauban systematized the siege operation so that victory could be achieved by following a step-by-step process.

First, the besieging force surrounded the enemy fort and cut it off from relief or escape. Next, an engineer surveyed the terrain near the fort to identify ideal locations for trenches and the placement of siege artillery. Then soldiers (called sappers) began digging those trenches as part of the "first parallel," which ran parallel to the fort at a distance of approximately 1,000 yards. After being emplaced in the trenches, the siege cannons began bombarding the fort, not to breach the thick walls, but rather to keep the defenders' heads down and destroy their artillery. Meanwhile, the sappers dug zig-zag trenches called "saps" that approached the fort's walls at oblique angles to protect them from enemy fire. In this manner, the sappers inched their way closer to the fort.[5]

When the saps reached a few hundred yards from the fort's walls, the "second parallel" trenches were dug so that more siege artillery could be emplaced. Plunging fire from mortar could also be added. These intensifying bombardments would destroy the defenders' remaining cannons and open breaches in the walls. At this point, the fort's commander had only two courses of action: surrender to the besieging forces and hope for leniency, or attempt to repel the inevitable ground assault and risk having his fort destroyed and his garrison killed. More often than not, the commander chose to surrender. For his part, Vauban became so effective at these operations that he could calculate down to the day how long sieges might last before the defenders surrendered or the fortress succumbed to a ground assault.[6]

Vauban's fortifications and siege operations demonstrate several ideas that would become central to the development of military engineering as both an academic discipline and a professional field. The scale and intricacy of his fortifications demanded competent engineer officers to design and build. The sieges themselves demonstrated the degree to which ground warfare had become remarkably complex in the age of gunpowder, again requiring expertise and experience on the part of combatants. Moreover, Vauban proved that no matter how brilliant a novice commander might be in leadership or tactics, he could not undertake sieges without advice from skilled engineer officers. Finally, Vauban's techniques highlighted the continuing evolution of doctrines relating to the engineering functions of survivability, countermobility, and mobility. He codified his doctrines in the *Treatise on Sieges and the Attack of Fortresses* in 1704 and the *Treatise on the Defense of Fortresses* in 1706. Although neither text was published until almost four decades after his death, they became the seminal textbooks on constructing fortifications and offensive and defensive siege operations for more than 150 years. Thus, Vauban's ideas and lessons about military engineering as a whole helped prepare future generations of engineer officers.[7]

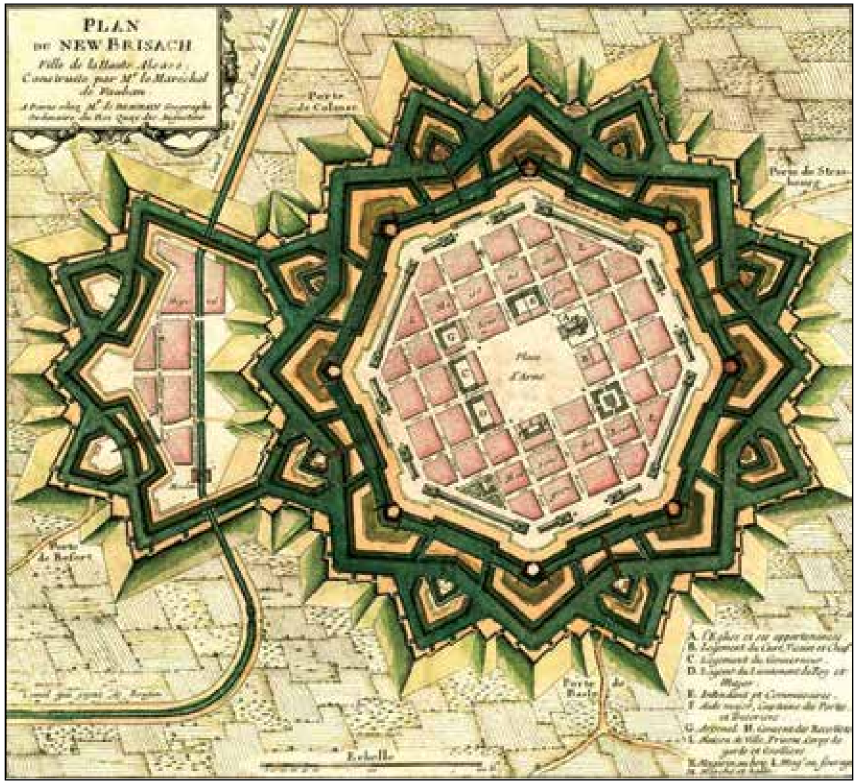


Figure 1.1. Plan of the fortified town of Neuf Brisach built on the orders of Louis XIV after the loss of Breisach on the Rhine. This classic design by Vauban was drawn in 1697. From the public domain.

Among his many legacies on and off the battlefield, Vauban added the "science of war" to the "art of war," and firmly established military engineering as a "profession of arms." He used principles of civil engineering, architecture, topography, physics, and mathematics to train his subordinates in siege warfare. Eventually in 1748, the French Army established the *École royale du génie* (Royal School of Engineers) in Mézières and another school in Metz, both of which used Vauban's writings in their curricula.[8]

Apart from military operations, Vauban and his fellow engineers helped to modernize France's infrastructure by planning and managing the construction of roads, waterways, bridges, and aqueducts. The French officers were guided, in part, by the Enlightenment's assumption that rationality could solve problems. Whether building bridges or besieging fortresses, they believed that both tasks could be accomplished by following standardized steps.[9] Their civil works efforts stood as important predecessors to similar missions undertaken by the US Army Corps of Engineers in the nineteenth century and after.

Writing in 2004, historian Jānis Langins pays tribute to the impacts of Vauban and his nation on subsequent generations of engineers in peace or war:

> French military engineers of the Enlightenment left a significant legacy to military engineers and armies everywhere, as well as to modern engineering and engineering education. Indeed, France is a prime locus and the Enlightenment is a primary period in which to study the emergence of engineering as we know it today. The influence of French military engineering was felt from West Point to St. Petersburg. . . . It is no revelation that engineering is one of the most important professions of our time.[10]

Vauban's ideas spread throughout Europe during his lifetime and thereafter to North America, most notably in the design of Forts Duquesne and Ticonderoga in the modern-day United States, and the fortress towns Louisbourg and Montreal in Canada. Vauban's influence extended still further into the 1800s because his designs affected the development of coastal fortifications in the United States, while his manuals became required reading for cadets at the United States Military Academy at West Point. Vauban is legitimately considered one of history's greatest military engineers.[11]

The American Revolutionary War and the Recruitment of French Engineers

Across the Atlantic, Enlightenment-era French engineering appeared in many battles during the American Revolutionary War. The conflict erupted in 1775 because of increasingly onerous British control of the thirteen colonies along the eastern coast of North America. For their part, the colonists fought to gain independence from their parent country, which possessed the most powerful navy in the world and one of the most formidable armies in Europe. Conversely, the loose coalition of thirteen colonies possessed no professional army or navy. Neither chain of command nor unity of command existed. The colonies did not benefit from a tradition of military education for uniformed personnel, either. When the Revolutionary War began in 1775, the colonies fielded a ragtag assortment of untrained militiamen and a few veterans of the French and Indian War (1754–63). Most men serving in the militias knew very little about infantry tactics, drill, or discipline. Experience and knowledge of military engineering was even rarer.[12]

Fighting the British military with any hope of success required that the colonists—the American Revolutionaries or "Americans"—create and support an army. To this end, on 14 June 1775, the Revolutionary government's Continental Congress voted to organize the Continental Army, raise ten companies, and draft rules and regulations for that Army. This date marked the birth of the US Army and the Infantry branch.

One day later, Congress unanimously chose George Washington to become general and commander in chief of the new Continental Army. He had already led men in combat, constructed fortifications, and endured sieges during the French and Indian War. Moreover, Washington had learned the importance of general and topographical engineering capabilities. He had served with infantry units that cut their way through the wilderness, so he knew the importance of road construction for maneuver warfare and logistical support. Washington had also gained an appreciation of topography from combat operations in the French and Indian War and from surveying his personal lands on Virginia's western frontier.[13]

Washington recognized his new Army lacked any sort of engineering expertise, as demonstrated in 1775 in a letter to the president of Congress: "The war in which we are engaged, requires the Knowledge comprehending the Duties of the Field and Fortifications."[14] With this shortage of engineers in mind, the Continental Congress passed a resolution on 16 June 1775 that would provide a chief engineer for the Continental Army. The senior officer would serve as a subject-matter expert on Washington's staff. This resolution's date now stands as the birthday of the US Army Corps of Engineers.[15]

Washington appointed Col. Richard Gridley to be the first chief engineer in July 1775. Gridley had gained significant engineering experience while serving with the British Army prior to the American Revolution. He had designed batteries and directed construction efforts during two British sieges of the French-held fortress town of Louisbourg in Nova Scotia in 1745 and 1758. During the French and Indian War, he had also commanded a provincial artillery unit that supported the British in the Battle of the Plains of Abraham outside Quebec.

Gridley's first major task during the Revolution was expelling British forces from Boston, Massachusetts in the summer of 1775. He supervised the digging of earthworks on Breed's Hill and saw action in the subsequent Battle of Bunker Hill. The ensuing engagement did nothing to

hurry the British departure, but it did show the value of a fortified position. Although intelligent and experienced, Gridley had limited mobility due to his advanced age of sixty-five, not to mention a wound suffered at Bunker Hill. He was restricted, therefore, to the Boston area and could not accompany Washington and the Continental Army on campaigns in the field. Thus, Gridley was unable to provide Washington, the maneuver commander, with immediate advice on engineering matters. The elderly Gridley stepped down from his post in April 1776.[16]

Col. Rufus Putnam followed Gridley as the nation's second chief engineer in August of the same year. Putnam could not claim formal training in military engineering, but he had learned many valuable skills in the field serving alongside the British in the French and Indian War. Washington wrote that, although Putnam was not "scientific," he did possess "more practical knowledge in the Art of Engineering than any other we have in the camp or Army." Washington likewise praised his chief engineer as "indefatigable."[17] Earlier in the American Revolution, Putnam had supervised the fortification and placement of artillery batteries on Dorchester Heights, which helped drive the British from Boston in March 1776. Thereafter, Putnam had directed the construction of defensive works in New York City and on Long Island. Finally, as chief engineer, Putnam started planning for a formal Corps of Engineers after recognizing the need for knowledgeable engineer soldiers and officers to form effective units in the Continental Army.[18] Writing to Washington in September 1776, Putnam explained his vision for the training of those engineers:

> The first Excersise to be taught them is the use of there arms; the Next is to keep them to there Business. The third kind of Exercise is the Instructing them in the Several forms of Dementions and Properties of Works. Again. All Workmen Imployed in Building of any kind may Serve very well for Works of Fortification. Again: by this means you may have good Miners and Sappers in abundence.[19]

Putnam's desire for well-trained engineers resonated with Washington, who in turn endorsed the idea. When Putnam submitted this plan for a Corps of Engineers to the Continental Congress, however, the delegates refused to accept it, and Putnam resigned his position shortly thereafter. Despite the limited numbers of homegrown engineers to meet the wartime needs of the thirteen colonies, the Continental Congress would not support the creation of a Corps. The delegates lacked sufficient funds to fill many military priorities, of which the expense of engineer officers was just one.[20]

Another great source of experienced engineer officers did exist across the Atlantic Ocean in France. This nation boasted the best engineering resources on the continent. Furthermore, France's loss to Great Britain in the French and Indian War (1754–63), if not centuries of bitter rivalry, had left the French with a deep-seated anger toward their enemy. King Louis XVI actively looked for ways to avenge this defeat. The new United States Continental Congress decided to exploit this enmity by recruiting French officers, including engineers, for service with the Continental Army. Congress sent Silas Deane as a secret representative to France in 1776 to attract support for the fight against the British. Shortly thereafter, Benjamin Franklin also went to France in the official capacity of the American commissioner (ambassador); he hoped to secure the service of engineer officers, acquire financial support from the French, and forge an alliance with France. The labors of Deane and Franklin bore fruit. They obtained loans and material aid from France for the fledgling nation. They likewise received permission from the King to offer contracts to several French officers to serve in the Continental Army. After negotiations, the American contracts were accepted by Louis Lebègue Duportail, Jean-Baptiste Gouvion, Louis de La Radière, and Jean-Baptiste de Laumoy.[21]

Earlier in their careers as Royal French engineers, all four attended the *École royale du génie* in Mézières, arguably the premier engineering school in Europe. The curriculum required its students to spend their first year studying mathematics and physics. Each of the four officers contracted to fight for the new US Army had also taken courses on Vauban's doctrines on fortifications and *stéréotomie* (techniques of cutting solids, such as stone or wood, into particular shapes). Then, in the second year of the program, they surveyed existing fortresses and conducted numerous field exercises. The next two years had seen the newly commissioned second lieutenants serving in field units. These tours expanded the junior officers' understanding of how, for example, artillery and topography were intertwined with military engineering. Finally, they spent two years apprenticing with senior engineer officers.[22] This mixture of classroom preparation and operational experience became the training model followed by every subsequent version of the US Army Engineer School.

Louis Duportail, the Corps of Engineers, and the School of Engineering

Louis Duportail and his three countrymen arrived in the thirteen colonies in the spring of 1777. They brought high levels of professionalism to the Continental Army and, while all four Frenchmen played critical roles in the Revolutionary War, it was Duportail who made the greatest contributions. General Washington appointed Colonel Duportail to be the third chief engineer in July 1777. The two officers developed a close working relationship and personal friendship in which each played confidant to the other. Duportail offered advice to his commander in chief on topics beyond the scope of engineering. He warned Washington to avoid major engagements that might bring decisive defeat, and instead to fight a war of attrition against the British. Later in 1778, Duportail swore allegiance to the new United States and thus claimed American citizenship.[23]

Figure 1.2. Louis Duportail. Courtesy of the US Army Engineer School History Office Archives.

Reaching the rank of major general, Duportail held his post as chief engineer until the end of the American Revolution in 1783. He stood up the first formal School of Engineering, commanded the first formal Corps of Engineers—once it was finally established—and integrated engineer units into the Continental Army's force structure. In short, he institutionalized engineering in the US Army. In addition to these efforts, Duportail directed the construction of fortifications at the American camp at Valley Forge in 1777. He also provided Washington with expert counsel during the Battle of Monmouth Courthouse the next year, the siege of Yorktown in 1781, and several other engagements. Although Louis Duportail was overshadowed in history by other European officers such as Marquis de

Lafayette and Baron Friedrich von Steuben, Duportail is regarded as the "Father of the US Army Corps of Engineers."[24]

Early in the American Revolutionary War, General Washington recognized the Continental Army's desperate need for better reconnaissance and cartographic capabilities. He particularly wanted men to map "Roads, Rivers, Bridges, and Fords over them, the mountains and the passes through them."[25] To fill this need, Washington wanted to create a geographer's department to supplement the work of the army's engineers. Washington had to push the Continental Congress into action, and the delegates finally approved Washington's proposal in July of 1777 for the appointment of a geographer "to take sketches of the country, the seat of war, and to have the procuring, governing, and paying the guides employed under him."[26]

Washington chose Robert Erskine, a mapmaker, inventor, and member of the Royal Society of London. The choice was a good one because Erskine possessed significant skills in terrain analysis and surveying. Together with his assistants, Erskine prepared valuable sketches and maps until his untimely death in October of 1780. Thereafter, his assistant, Simeon Dewitt, worked with Capt. Thomas Hutchins to continue Erskine's mission. That next year, they were named "geographers of the United States." During the decisive Yorktown campaign in the fall of 1781, Dewitt and Hutchins provided accurate maps to the Franco-American armies. Although they performed the function of topographical (geospatial) engineering, the US Army did not establish a Topographical Bureau until 1813.[27]

Washington, Duportail, and other American officers recognized the ongoing problems caused by there being so few qualified officers and enlisted men serving as engineers. From 1775 through 1777, the units performing engineer functions were raised somewhat haphazardly, either by voluntary enlistment or by the transfer of hand-picked soldiers from other units. However, there was limited quality control in the selection process; personnel problems could only be solved by organizing a formal Corps of Engineers with engineer units commanded by the chief engineer. Once established, units in the Corps could then be assigned to missions as needed. Washington and Duportail, both very aware of these issues, urged Congress to pass the appropriate legislation to create this new, necessary entity.[28]

Despite their best efforts, progress toward establishing a formal Corps of Engineers was slow. On 27 May 1778, Congress finally passed a resolution establishing an "Engineer Department" along with rank and pay structures. This new department consisted of three companies of miners and sappers. According to a unit table of organization, seventy-two soldiers

would serve in each company under the command of a captain, with a staff of three lieutenants and four noncommissioned officers.[29] The resolution also established the following criteria for company leadership: "The Commissioned officers to be skilled in the necessary branches of mathematics; and the noncommissioned officers to write a good hand."[30] This amounted to a mandate that individuals in both ranks be literate and exhibit potential within the profession of arms.

The new Engineer Department would maintain operational field units and train new soldiers. This process provided feedback loops between the experienced engineers and the new soldiers. The 27 May resolution also stated:

> These companies are to be instructed in the fabrication of field works, as far as relates to the manual and mechanical part. Their business shall be to instruct the fatigue parties to do their duty with celerity, to repair injuries done to works by the enemy's fire, and to prosecute works in the face of it.[31]

The obvious engineering functions of survivability and mobility can be seen in the first sentence and the last two phrases. Yet, there is another observation to be drawn from this resolution. It implicitly called for instructors to motivate their soldiers in the "fatigue parties" (units assigned to particular, sometimes dangerous missions) to achieve their objectives "with celerity" (rapid and efficient action). Such a sense of urgency pointed to the relevance of engineering functions to military operations.

The resolution of 27 May allowed the Engineer Department to begin recruiting the most qualified officers and men to serve in the new companies. The soldiers received training in a rudimentary "School of Application" directed by Maj. Jean-Baptiste Gouvion, located at Valley Forge, Pennsylvania. The Continental Army's camp at Valley Forge in 1778 provided an ideal environment to learn appropriate and beneficial skills by constructing the camp's field fortifications that might come under attack later. The American defensive works produced from this school, however, were so formidable that the British forces stationed in nearby Philadelphia chose not to attack them.[32]

A few more days elapsed between the 27 May resolution and the next step toward the institutionalization of engineering in the Continental Army. Then on 9 June 1778, the Army Headquarters in Valley Forge issued General Orders that called for volunteers to become engineer officers:

> Three captains and nine lieutenants are wanted to officer the company of sappers. As this corps will be a school of engineers it opens a

prospect to such gentlemen as enter it and will pursue the necessary studies with diligence, of becoming engineers and rising to the important employments attached to that profession as the direction of fortified places, etc. The Qualifications required of the Candidates are that they . . . have a knowledge of the mathematics and drawing, or at least be disposed to apply themselves to those studies.[33]

The 1778 documents not only set minimum requirements for becoming an engineer officer but also hinted on the importance and need of establishing the Corps of Engineers and a School of Application for engineers as part of the Continental Army's force structure. Nevertheless, the formal Corps of Engineers did not become a reality for another nine months.

The last and most significant milestone occurred on 11 March 1779, when Congress passed a resolution stating "That the engineers in the service of the United States shall be formed into a corps, and styled the 'Corps of Engineers,' and shall take rank and enjoy the same rights, honours, and privileges with the other troops on continental establishment."[34] Although the term "Corps of Engineers" was used in an informal sense in the earlier resolution, the words "formed in a corps" and "styled" did not appear in earlier documents. These new words affirmed the Corps as a formal part of the American military's organization. The subsequent phrase—"rights, privileges, and honours"—likewise put the engineers on par with soldiers in other branches.

Later in July and August 1779, Washington issued General Orders relating to the "Regulations for the Corps of Engineers." Not only did he reaffirm the resolution of 11 March, but he also gave additional guidance for the daily operations of engineer units. Washington ceded authority for planning and executing defensive and offensive siege operations to the senior engineer officer "with the approbation of the commanding general."[35] Washington next laid out the expectations for the companies of miners and sappers that entailed several engineering functions: mobility, countermobility, survivability, and sustainment. Lastly, he instituted some permanent policies for training and educating engineers of all ranks:

The Sappers and Miners shall be taught the established manual Exercise and Evolutions on days when they are not employed in the particular duties of their department. . . . The Commandant [Chief Engineer] of the Corps of Engineers shall take the most effectual and expeditious method to have the Sappers and Miners instructed in their duty, and as probably the officers of these companies whose talents and acquirements fit them for the profession, will be appointed Engineers, the Commandant of the Corps of Engineers should form a plan of instructions for the officers . . . [and] shall appoint an Engineer or Engineers whom he shall judge but best qualified, to read lectures on fortifications proper for towns and positions; on the manner of adapting fortifications to different grounds and positions; to regulate their extent according to the number of men intended to be covered; upon attack or defense; upon the use of mines and their construction; upon the manner of forming plans, reconnoitering a country and choosing, laying out and fortifying a camp.[36]

Washington concluded his General Orders by mandating the unit's roles on field operations:

On a march, in the vicinity of an enemy, a detachment of the companies of Sappers and Miners shall be positioned at the head of the column, directly after the vanguard for the purpose of *opening road and mending the roads and removing obstructions*.[37]

The italics added in the last phrase tie together the survivability with the mobility functions of combat engineers. Washington clearly recognized the versatility of engineers. Taken as a whole, his General Orders in July and August 1779 constituted his mandates for the Corps of Engineers, the Engineer School, and the engineer branch that still exist in the twenty-first century. Engineer officers and noncommissioned officers must lead and educate their units, whether in the field or in garrison.

In addition to establishing the Corps, Congress passed a second resolution that appointed Brig. Gen. Louis Duportail to be "Commandant of the Corps of Engineers and companies of miners and sappers."[38] This appointment unified his advisory role as chief engineer with his operational role as a commanding officer. Duportail believed his dual-hatted status was justified, because he wanted to protect the new Corps from being depleted if other senior officers requested the transfer of engineers to their commands and then refused to relinquish control of those units. To his great satisfaction, Duportail exercised direct unit control, retaining the ability to pull these engineer units back or even take to the field himself.[39]

Saratoga and Yorktown

The American Revolutionary War contains many case studies of French-educated engineers applying their skills in the service of the Continental Army. Great insights can be gained from examining the decision-making of Tadeusz Kościuszko in the two Battles of Saratoga in

1777, and of Duportail during the Siege of Yorktown in 1781. Both men excelled in the planning and operational phases by offering advice to senior leaders, and by training and commanding engineer units in the field. These battles also highlight how effective use of engineering functions and doctrines yielded decisive advantages to the Continental Army, thereby contributing to its major battlefield victories.[40]

The first example occurred during the Saratoga campaign, featuring the two battles of Freeman's Farm on 19 September and Bemis Heights on 7 October. By the summer of 1777, the British had driven the Continental Army from New York City into New Jersey. In addition to occupying the city, the British wanted to dominate the Hudson River to the immediate west of Manhattan Island. By doing so, they could then cut New England off from the rest of the colonies. To achieve these goals, the British invented a plan to use three separate forces to capture Albany, New York, some 180 miles up the Hudson. The plan, however, fell apart under the weight of its own complexity. The first of the three British forces marched east from Lake Ontario toward Albany, ran into stiff resistance from the Continental Army, and turned back before reaching its objective. The second British force in New York City never followed the plan because its commander inexplicably chose to attack Philadelphia, rather than advance north up the Hudson. This left the third British force under Lt. Gen. John Burgoyne's command to try to capture Albany alone.

Burgoyne's 7,000 men advanced about sixty miles south of Lake Champlain but lost contact with their supply lines by August 1777. Staying where he was in the wilderness did not make sense, and with his troops running low on food, Burgoyne needed to choose between two equally unappealing courses of action. He could retreat north more than sixty miles where he had come from, or he could drive a few more miles south to reach Albany. Burgoyne chose the second option. As was so often the case, the British general assumed his Redcoats could beat the Americans in a set piece battle despite low supplies. Unfortunately for Burgoyne, Maj. Gen. Horatio Gates and 10,000 soldiers blocked the road to Albany. Most of his men were battle-hardened veterans with leaders like Daniel Morgan and the still-loyal Benedict Arnold. Burgoyne had greatly underestimated his enemy's resolve. The Americans would not turn tail in combat.[41]

Gates needed his forces to be arrayed at the right place to fight the British; thus he turned for expert advice to a talented engineer lieutenant colonel named Tadeusz Kościuszko.

Born in Poland in 1746, Andrzej Tadeusz Bonawentura Kościuszko attended a military academy in his home country and then completed his studies at the *École royale du génie* in Mézières, France. This education gave him professional credentials on par with Duportail and other French engineer officers. After receiving a commission as an engineer lieutenant colonel, Kościuszko supervised the construction of fortifications along the Delaware River. In the spring of 1777, he was transferred to the American-held Fort Ticonderoga on Lake Champlain. Kościuszko's suggestions of ways to improve the defenses were ignored and the British exploited these weaknesses and drove the American garrison out of the fort. During the successful retreat, Kościuszko employed countermobility tactics of setting abatis, damming streams, and destroying bridges to obstruct British movement and therefore allowing a safe withdraw of forces across the Hudson River.[42] By August 1777, Kościuszko put his French schooling to use once more by surveying the area north of Albany and identifying Bemis Heights as the key terrain for a defensive position. The low hills gave Gates control of the Hudson River as well as advantages in elevation and visibility over the surrounding countryside. Looking back 200 years, military historian Richard M. Ketchum confirmed that the heights made a "naturally strong site" that was further "strengthened by Kościuszko's planning and some prodigious labor with axes and shovels."[43] The historian next describes how they secured the area:

> On the brow of the hill, Kościuszko laid out a three-sided or U-shaped breastworks, about three-quarters of a mile in extent, with a battery on each corner and in the center. The open side was safeguarded by a steep ravine behind it.[44]

The position offered force protection in all directions. Ketchum observed that Kościuszko was very much "in his element as Gates's engineer" when performing these duties.[45]

Rather than wait for the British attack, Gates sent his soldiers north one mile to confront the enemy at Freeman's Farm. The day-long fight on 18 September went back and forth, before ending with the British repelling the Continental forces, but at a high cost in casualties. Burgoyne then consolidated his position and ordered his men to establish their own earthen fortifications. Over the next two weeks, he realized no help would come from New York City. The general still could have retreated north, but he dismissed this option as disgraceful. So instead, Burgoyne ordered his debilitated British force to strike at Bemis Heights.

The British attack on 7 October came as no real surprise to Gates, who had expected it to occur sooner rather than later, given the enemy's desperate supply situation. The Americans never allowed the British to get near Bemis Heights. Benefitting from good intelligence, numerical superiority, and the safety of Kościuszko's fortifications, they once again stopped the British about one mile from the heights and eventually threw them into retreat. The Americans next captured some of the enemy's key earthworks, thus threatening the entire British line. The defeated British began withdrawing northward by day's end. After a week-long pursuit, the Americans surrounded the British and, with his troops starving and suffering from wounds, Burgoyne had no choice but to surrender on 19 October. The Americans had won a tactical and a strategic victory. More importantly, Saratoga marked a major turning point in the Revolutionary War because it encouraged France to finally join the fight against Great Britain.[46]

The two Battles of Saratoga have been studied extensively and at length because they yield valuable insights regarding maneuver, initiative, security, and leadership.[47] Moreover, the contributions of Tadeusz Kościuszko cannot be undervalued. It was, after all, he who had chosen Bemis Heights and supervised construction of the defensive works, thus executing the functions of countermobility and survivability taught to every engineer. His shaping actions afforded Maj. Gen. Horatio Gates the luxury of knowing his own base was secure.

Although soundly defeated in the two Battles of Saratoga, the British forces occupied New York City until the end of the Revolutionary War in 1783 and never gave up on the idea of extending control northward up the Hudson River. The ongoing struggle for the waterway set the context for the Battle of Stony Point on 16 July 1779. The engagement yields great insights about planning, leadership, and audacity in engineer operations of the past and present. Stony Point, known as the "little Gibraltar," sat on the western bank of the Hudson River about thirty miles north of New York City. Cannons emplaced atop the 150-foot-tall outcropping of high ground controlled traffic on the river. It provided a potential base for further operations west of the Hudson. Finally, Stony Point lay within striking distance of the Continental Army's stronghold at West Point, just ten miles to the north. These factors motivated the British to capture Stony Point in May of 1779. The British dug earthworks for artillery emplacements, placed abatis made of tree trunks sharpened on one end in those earthworks, and stationed 625 soldiers there. In addition to manmade obstacles, swamps separating Stony Point from the main shoreline would bog down any large

ground assault force. The British also placed a gunboat on the river to guard against water-borne or amphibious attacks.[48]

Because George Washington recognized the serious British threat at Stony Point, he ordered it retaken. A major frontal assault, however, would cost too many casualties because of the formidable British fortifications. Therefore, only a carefully coordinated surprise attack could work. The Continental Army's plan called for a three-pronged assault on Stony Point in a nighttime operation on 15–16 July 1779. One unit made a large, loud diversionary move against the center of the British line, which drew out most of the British defenders. Meanwhile the other two units moved quietly along the shoreline to the northern and southern flanks of that center assault. Soldiers in the lead elements used axes and picks to cut gaps through the British abatis. It is worth noting these soldiers performed the classic engineer missions of leading the way, breaching obstacles, and clearing paths. Once gaps opened, the two flanking battalions engaged the British defenders in bloody hand-to-hand combat. A French-born engineer lieutenant colonel, François-Louis Teissèdre de Fleury, commanded the American infantry battalion striking at the southern flank of Stony Point. He and his men fought their way through the British defenses to Stony Point's summit, where de Fleury personally pulled down the British flag. He exemplified combat leadership from the front. Complete victory was achieved in less than thirty minutes. De Fleury and two other American officers received medals from Congress. The citation for them read in part that they "exhibited a bright example to their brother soldiers, and merit in a particular manner the approbation and acknowledgment of the United States." Lt. Col. François-Louis Teissèdre de Fleury was the only foreign officer to receive such an accolade during the American Revolution.[49]

Four years after Saratoga, the greatest benefits of a Franco-American alliance can be seen in the 1781 siege of Yorktown.[50] This operation began taking shape in 1780 when Lt. Gen. Jean Baptiste Donatien de Vimeur, comte de Rochambeau arrived in North America with his French soldiers. Rochambeau and General Washington initially concentrated their forces in the north, while Washington toyed with the idea of attacking the British in New York City. However, Rochambeau and Brig. Gen. Louis Duportail believed the city to be too well-defended to risk an all-out assault. Instead they convinced Washington to move the combined Franco-American forces south to Virginia in the summer of 1781. It was here that they believed they could defeat the British occupying the village of Yorktown on the York River.

By September, when all the French and American units converged on Yorktown, their numbers swelled to some 18,000 men. They boasted nearly 100 artillery pieces specifically designed for siege operations. Washington and Rochambeau also benefitted from the expert engineering knowledge of Duportail, together with Lt. Col. Jean-Baptiste Gouvion and a young captain, Etienne Rochefontaine.

Arrayed against them was Lt. Gen. Lord Charles Cornwallis commanding 7,000 British troops and Hessian mercenaries based in Yorktown. He did possess sixty-two cannons, though too few were the heavy artillery pieces capable of breaking a determined siege. During the summer of 1781, the British and Hessians had set about fortifying Yorktown. Cornwallis directed his engineers to dig star-shaped earthworks and place gabions (woven wooden cylinders filled with soil and gravel) and fascines (bundled wooden branches or sticks) on top of those works. The British then built redoubts some 300 yards out from Yorktown's field fortifications. These small forts, according to Sébastien de Vauban's defensive doctrines, could disrupt the enemy's work digging their saps and parallels. Time, however, was not an ally for Cornwallis. His troops were running dangerously low on food and ammunition. Making matters worse, Cornwallis could not hope for assistance by sea because the French Navy halted the British Royal Navy's attempts to come to his aid.

The siege of Yorktown began on 28 September 1781. Duportail and his fellow engineer officers made a plan that followed the systematic process of Vauban's siege doctrines. The French and Continental Armies stretched their units along a half-crescent line that started at the York River's shoreline east and west of Yorktown, ran inland several hundred yards, arced around the village, and then met south of it. Along this continuous line, the French took position on the western half of the crescent and the Americans on the right. They then started digging trenches for their first parallel some 600 yards from Yorktown. Once finished, the Americans and French placed their artillery in those trenches. Cornwallis was now trapped.

Finally, on 10 October, the combined weight of ninety-two cannons, mortars, and howitzers began bombarding Yorktown. The intense artillery barrage sent the British scurrying for cover for several days. In his diary, a Hessian captain named Johann Ewald described the barrage's effects inside Yorktown: "The besiegers have fired bombshells incessantly so that the entire assault resembles a bombardment. The greater part of the town lies in ashes, and two batteries of the besieged [British] have already been completely dismantled."[51] Like some 30,000 fellow Hessians from several German states, Ewald fought as a mercenary with the British against the

American Revolutionaries. Although an infantryman, Ewald developed a keen grasp of engineering functions during his career.[52]

Under cover of the ongoing barrage, American and French sappers began digging saps that zigzagged closer and closer to the British defenses. These saps would methodically expand into the trenches of the second parallel some 300 yards closer to Yorktown. The British, of course, had countermeasures to stop these efforts. Soldiers in their redoubts could lay enfilade gunfire on the sappers, disrupting their work on the saps and on the second parallel. This could slow the entire siege process. From the Franco-American perspective, completing the second parallel required the capture of the British redoubts. This especially held true of Redoubts 9 and 10 on the easternmost end of the defenses because they protected level ground on one Franco-American avenue of approach to the British field fortifications.

On 14 October, the French and Americans attacked and captured Redoubts 9 and 10. The American target—Redoubt 10—fell to Lt. Col. Alexander Hamilton's main force of 700 soldiers. As one of the 100 miners and sappers leading the way for Hamilton and the rest of the unit, Sgt. Joseph Plumb Martin described the combat in dramatic fashion:

> We immediately moved silently toward the redoubt, with unloaded muskets. Just as we arrived at the abatis, the enemy discovered us and directly opened a sharp fire upon us. . . . As soon as the firing began, our people began to cry, "The fort's our own!" and it was "run on boys." The Sappers and Miners soon cleared a passage for the Infantry, who entered quickly.[53]

Martin's description remains invaluable more than two centuries later because his published memoir provides a window into the noncommissioned officer's wartime world. After joining the Revolutionary cause in 1775, he rose to the rank of sergeant within six years. He eventually transferred to one of the companies of miners and sappers, thus serving as a noncommissioned officer in the Corps of Engineers at Yorktown.[54]

The two British redoubts were secured after a few minutes of bitter hand-to-hand fighting. Once they were in Franco-American control, the second parallel was safe from enemy fire and the next phase of this textbook siege could begin. Artillery fire from cannons, howitzers, and mortars in the finished second parallel poured into Yorktown, destroying the last of the British cannons and wreaking havoc in their camp. By 15 October, the siege was almost at an end. With no hope of assistance and his troops low on food, Cornwallis made an unsuccessful attempt to evacuate his men across the York River the next day. The outcome now rested on his shoulders. Cornwallis faced a decision point: surrender and hope for leniency, or fight and risk total annihilation. Cornwallis chose the first option and surrendered in the afternoon of 19 October. Although the Revolutionary War lasted another two years in a legal sense, the decisive defeat of the British at Yorktown ended major combat operations. The siege itself stood as the greatest achievement of the French engineers in this conflict. Meanwhile, government negotiations dragged on until a peace treaty was finally signed in 1783.

Figure 1.3. Lord Cornwallis surrendering his British Army at the end of the siege of Yorktown on 19 October 1781. From the public domain.

Looking at Yorktown as an engineer operation, the siege worked precisely as expected. Just as Vauban had compelled enemy fortresses to surrender in a matter of weeks during the 1600s, so too did the Americans and French push the British to capitulate at Yorktown in 1781. The engineer officers and their miners and sappers performed every task required of them, even under duress of enemy fire and combat. For his part, General Washington praised the monumental contributions made by Louis Duportail in the following letter to Congress:

> His judgment in council, and well conducted valor in the field claim the highest applause, and have assured him the esteem and confidence of the army. His plan and conduct of the late attacks in the . . . successful siege of Yorktown . . . afford brilliant proofs of

> his military genius, and set the seal of his reputation; while they entitle him to my warmest thanks.[55]

Washington also praised Gouvion and Rochefontaine for their efforts. Washington even endorsed the promotion of Duportail to major general and advances in rank for the other French engineers.

The Revolutionary War not only secured independence from the British but also highlighted several important insights that were gained from its engineering operations:

- A formal and independent Corps of Engineers needed to be a permanent institution in the US Army.
- A flag officer with sufficient rank and experience was needed to serve as chief engineer.
- Education needed to be available in a structured curriculum and continued during service in the field. Every operation could be leveraged as a training opportunity from which lessons could be collected and then applied in the future.
- A permanent Engineer School was necessary to capture those past lessons and disseminate revised doctrines, tactics, techniques, and procedures in the future.
- There could be no substitute for competent engineer officers. They needed the technical education, innate intelligence, and requisite experience to perform engineering functions.
- Maneuver commanders needed to realize that they could not achieve some objectives without heeding the expert advice from their engineers on staff.
- Combat-effective units of miners and sappers with knowledgeable noncommissioned officers and junior engineer officers could not be stood up, trained, equipped, and fielded in short order.
- The miner and sapper units needed to be maintained continually within the US Army's force structure, and the units required constant training in engineering functions to maintain their operational effectiveness.

The Interlude: The Corps of Artillerists and Engineers, 1783–96

In the last two years of the Revolutionary War, George Washington turned his attention to what the US Army might look like in the post-war era. Many factors weighed heavily on his mind and on the minds of other leaders, military and civilian alike. They needed to determine the best size and role for the nation's armed forces.[56]

First were ideological factors. Many in the Revolutionary generation, known as Anti-Federalists and later Democratic-Republicans led by Thomas Jefferson, saw a large professional Army as a potential threat because it could suppress liberties. This group joined other Americans in the belief that the United States could not afford the costs of fielding a large Army. Regardless, the United States government, as established under the Articles of Confederation in 1781, could not raise its own revenue for an Army, nor could it declare or make peace without approval by the states.

Second were geostrategic realities. The Americans ensured their independence from Great Britain by the narrowest of margins, and then only with timely assistance from France. The American victory in 1783 did not stop the British or other European countries from venturing into American territory in the future. In such crises, the United States could not necessarily look to France for support. At the very least, the US Army needed to construct and maintain fortifications along the coastline, which would become a critical mission for the Corps of Engineers.

Third were considerations about territorial expansion to the west. Hostilities with the British ended in 1783, but not the fighting with their allied Native American tribes. These tribes stood in the way of American settlers moving inland beyond the Appalachian Mountains. The United States needed an Army capable of safeguarding that movement against Native American resistance or retaliation. Concerns also arose because Spain and Great Britain still confined the United States on all sides of North America. Furthermore, American forts, roads, bridges, and new settlements needed to be built and maintained. Again, these would become critical missions for the Corps of Engineers with further potential benefits for continued military readiness and the commercial infrastructure of the growing nation.

Last were concerns about mobilizing the US Army in future conflicts. The institution found itself dependent upon European technical expertise during the American Revolution. George Washington recognized the absolute necessity of developing a homegrown cadre of officers and noncommissioned officers with skills in engineering and other technical branches. As the Corps of Engineers was also a School of Engineering, Washington expected his engineer officers to take the lead in training and developing their own homegrown experts.

Ultimately, there simply was not the political will, the financial resources, or perhaps the strategic sensibility in Congress to support a large Army or Corps of Engineers. Major demobilization occurred in 1783 and 1784. The Army's manpower sat at 49,900 soldiers (including militia) in 1781, but then shrank to 13,400 soldiers (including militia) in 1783, finally dropping dramatically to a mere 600 soldiers (excluding militia) in 1784. Entire units either disbanded or returned to militia service in their home states. In this sweeping demobilization, the Corps of Engineers and its companies of miners and sappers were among those mustered out of service in 1783. The remaining soldiers served in a single infantry regiment and a company of artillery, both stationed at West Point, New York.[57]

While the political debates dragged on and the Army shrank in size, Washington tasked Maj. Gen. Louis Duportail to draft a proposal for a new corps that combined the engineers and the artillerists. The French engineer agreed with his commander-in-chief that this was the best way forward. Duportail reasoned, "The basic knowledge and skills of these two arms are the same. The use of a cannon is essential in attacking and defending fortified places."[58]

In developing his proposal, Duportail drew on a precedent from the French military, wherein the term "artillery engineer" referred to elite officers with mathematical and technical skills, as opposed to mere "cannoneers" who possessed the requisite skills of operating the firing mechanism. Duportail added to this vision by calling for a true military academy that would serve as an apprenticeship school for the new corps. This proposed three-year curriculum would include calculus, chemistry, physics, and drawing. Duportail was hardly alone in making these recommendations. His fellow Frenchmen, Jean-Baptiste de Gouvion and Pierre L'Enfant, shared similar ideas about establishing a Corps of Engineers and Artillerists.[59]

The recommendations by Washington, Duportail, and others fell on deaf ears in Congress. No movement occurred on this front until 1789, when then-Secretary of War Henry Knox submitted a plan to the newly elected President George Washington for "a small corps of well-disciplined and well informed artillerists and engineers."[60] Despite support at these highest levels, it took several more years, and very real military threats, to spur Congress to action. The early 1790s saw chaos erupt in Europe as the French Revolution spun out of control and plunged Europe into twenty-five years of warfare. As an outsider, if not a possible target, the United States desperately needed a larger, more powerful Army. It likewise needed to modernize its old coastal and harbor fortifications and construct new forts. With no engineer officers in the Army, however, these projects could not proceed. President Washington implemented a stopgap measure and temporarily appointed Majors Stephen Rochefontaine and Pierre L'Enfant to supervise the construction of new forts. Both French engineers brought technical expertise and experience as veterans of the American Revolution. However, they made slow progress.[61]

On 9 May 1794, Congress finally passed an act that provided for the raising and organizing of the Corps of Engineers and Artillerists, consisting of one regiment with 992 soldiers. In addition, the legislation called for the secretary of war to supply textbooks and equipment to support the new corps' operations. The engineers and artillerists could finally start work on the top priorities of constructing, arming, and manning the forts along the eastern seaboard of the United States.[62]

The new corps established its home station at West Point, New York, where the small military academy was also organized. Rochefontaine ran the school that taught engineering and artillery cadets over a two-year program of study. Then tragedy in 1796: a fire destroyed the schoolhouse with all the books and equipment therein. Persistent ideological and fiscal constraints in Congress did not allow the academy to be rebuilt, nor did classes resume, until 1802 when the US Military Academy stood up at West Point. These setbacks notwithstanding, those intervening years saw the Corps of Engineers and Artillerists slowly increase its personnel and responsibilities in reaction to growing security threats from European powers, particularly Great Britain and France.[63]

By the end of the 1790s, President John Adams and Alexander Hamilton, then a major general and the highest ranking officer in the Army, started hiring instructors to teach cadets and junior officers in the Corps of Engineers and Artillerists. As members of the Federalist Party, Adams and Hamilton favored a more robust national defense. Additional impetus came from an undeclared war with France (1798–1800) that underscored the US military's lack of preparedness. Adams moved toward a formalized military academy and a strengthened US Army, but he was unable achieve these goals because he lost his reelection bid to Thomas Jefferson in 1800.[64]

Conclusion

French engineer schools sprang up and trained the best engineer officers in Europe. Later, during the American Revolutionary War, men like Louis Duportail joined George Washington's Continental Army to help fight Great Britain. The French-educated engineers also instilled the doctrines of Vauban in the emerging US Army Corps of Engineers and the idea of an Engineer School formed its roots from the experiences gained during the early years of the rudimentary "School of Application" at Valley Forge, Pennsylvania. Although chronically underfunded and undermanned during the war and in the peace that followed, the US Army's engineers, together with the artillerists, worked to protect their nation by constructing coastal and inland fortifications. It would take the arrival of a new president and Congress in 1800 to create a stand-alone Corps of Engineers and establish a permanent Engineer School at the US Military Academy at West Point in 1802.

Notes

1. Toby McLeod, "Fortifications and Siegecraft," in *The Oxford Companion to Military History*, ed. Richard Holmes (Oxford: Oxford University Press, 2001), 308–9.

2. For an exhaustive study, see Marios Philippedes and Walter K. Hanak, *The Siege and Fall on Constantinople in 1453: Historiography, Topography, and Military Studies* (Surrey, UK: Ashgate, 2011).

3. Jānis Langins, *Conserving the Enlightenment: French Military Engineering from Vauban to the Revolution* (Cambridge: MIT Press, 2004), 1–39; John A. Lynn, "The *trace italienne* and the Growth of Armies: The French Case," *Journal of Military History* 55 (1991): 324–28; Geoffrey Parker, *The Military Revolution: Military Innovation and the Rise of the West, 1500–1800*, 2nd ed. (New York: Cambridge University Press, 1996), 13–14, 163–69; and Albert Sidney Britt III et al., *The Dawn of Modern Warfare*, *The West Point Military History Series*, ed. Thomas E. Greiss (Wayne, NJ: Avery, 1984), 15–16.

4. French Army Corps of Engineers, *French Engineers and the American War of Independence*, trans. Sylvia F. Goldfrank (Paris: Corps of Engineers of the French Army, 1975), 4, US Army Engineer School History Office Archives; Parker, 13–14, 42–43; and Burton K. Wright, "Genius for Fortification: Vauban and the Future of Positional Warfare," *The Professional Army Bulletin for Engineers* (April 2000).

5. Britt, *The Dawn of Modern Warfare*, 65–66.

6. Ken Alder, *Engineering the Revolution: Arms and the Enlightenment in France, 1763–1815* (Chicago: University of Chicago Press, 2010), 31–34; Langins, *Conserving the Enlightenment*, 34, 56–79, 122–33; Britt, *The Dawn of Modern Warfare*, 65–66; and McLeod, "Fortifications and Siegecraft," 311.

7. Colin Jones, "The Military Revolution and the Professionalization of the French Army under the *Ancien* Régime," in *The Military Revolution and the State, 1500–1800*, ed. Michael Duffy (Exeter: Exeter Studies in History, 1980), 29–48; and Alder, *Engineering the Revolution*, 28, 56–57.

8. Langins, *Conserving the Enlightenment*, 82–83, 103, 157; Paul K. Walker, ed., *Engineers of Independence: A Documentary History of the Army Engineers in the American Revolution, 1775–1783* (Washington, DC: US Army Corps of Engineers Office of History, 1981), 6–8; and Alder, *Engineering the Revolution*, 63–73.

9. Alder, 58–61.

10. Langins, *Conserving the Enlightenment*, 2–3.

11. Britt, *The Dawn of Modern Warfare*, 65; and Walker, *Engineers of Independence*, 6–7.

12. Robert Middlekauff, *The Glorious Cause: The American Revolution, 1763–1789*, rev. ed. (Oxford: Oxford University Press, 2005), 221–80; Russell F. Weigley, *History of the United States Army* (New York: McMillan, 1967), 31–42; Richard W. Stewart, ed., *American Military History, Volume 1: The United States Army and the Forging of a Nation, 1775–1917* (Washington, DC: US Army Center of Military History, 2005), 30–40, 45–47; and *The U.S. Army Corps of Engineers: A History* (Alexandria, VA: US Army Corps of Engineers Office of History, 2008), 1.

13. Weigley, *History of the United States Army*, 11, 14–16, 28–31; and Stewart, *American Military History*, 50–53.

14. Cited in Walker, *Engineers of Independence,* 1.

15. Weigley, *History of the United States Army*, 70.

16. US Army Corps of Engineers, *History and Traditions of the Corps of Engineers* (Fort Belvoir, VA: US Army, 1953), 1; Walker, *Engineers of Independence*, 2–5; and US Army Corps of Engineers Office of History, *The U.S. Army Corps of Engineers*, 1, 277.

17. Edgar Denton III, "The Formative Years of the United States Military Academy, 1775–1833" (PhD diss., Syracuse University, Syracuse, NY, 1964), 2.

18. Walker, *Engineers of Independence*, 29–33.

19. Cited in Walker, *Engineers of Independence,* 30. Original spelling and grammar.

20. US Army Corps of Engineers, *History and Traditions*, 1–2; US Army Corps of Engineers Office of History, *The U.S. Army Corps of Engineers*, 1, 277; and Denton, "The Formative Years of the United States Military Academy," 3–5. For more detail on the Continental Army's fiscal challenges, see E. Wayne Carp, *To Starve an Army at Pleasure: Continental Army Administration and American Political Culture, 1775–1783* (Chapel Hill, NC: University of North Carolina Press, 1990).

21. Elizabeth S. Kite, *Brigadier-General Louis Lebegue Duportail: Commandant of Engineers in the Continental Army, 1777–1783* (Baltimore: Johns Hopkins Press, 1933), 24, 35–78; Raleigh B. Buzzaird, "Washington's Most Brilliant Engineer," *Military Engineer* 41 (September–October 1949): 358–60; Walker, *Engineers of Independence,* 6–16; and US Army Corps of Engineers, *History and Traditions*, 3–4.

22. Alder, *Engineering the Revolution*, 58–61; Walker, 14; and Pierre Boulesteix, "Ancêtre peu connue de l'Ecole polytechnique, l'Ecole royale du génie de Mézières et sa belle descendance (1748–1794) [Little-known ancestor of the Ecole polytechnique, the Royal School for engineering of Mézières and his beautiful offspring (1748–1794)]," *La Jaune et la Rouge: Revue Mensuelle de l'Association des anceins* élèves *et diplômés de l'École polytechnique* [*Yellow and Red: Monthly Review of the Association of Former Students and Graduates of the Ecole Polytechnique*]" 553 (March 2000), http://www.lajauneetlarouge.com/article/ancetre-peu-connue-de-lecole-polytechnique-lecole-royale-du-genie-de-mezieres-et-sa-belle-de#.VtzIJOQm5Mt.

23. Walker, *Engineers of Independence*, 12–22; and Kite, *Brigadier-General Louis Lebegue Duportail*, 347.

24. Buzzaird, "Washington's Most Brilliant Engineer," 35–60; US Army Corps of Engineers Office of History, *The U.S. Army Corps of Engineers*, 1, 277; and Kite, 343–45.

25. Walker, *Engineers of Independence*, 22.

26. Walker, 23.

27. Frank N. Schubert, *Nation Builders–A Sesquicentennial History of the Corps of Topographical Engineers 1838–1863* (Fort Belvoir, VA: Office of History, US Army Corps of Engineers, 1988), 3; and Walker, 22–27.

28. Buzzaird, "Washington's Most Brilliant Engineer," 360.

29. French Army Corps of Engineers, *French Engineers and the American War of Independence*, 6; and Walker, *Engineers of Independence*, 36;

30. US Army Corps of Engineers, *History and Traditions*, 4.

31. Cited in Walker, *Engineers of Independence*, 36–37.

32. Kite, *Brigadier-General Louis Lebegue Duportail*, 343–45; and Buzzaird, "Washington's Most Brilliant Engineer," 360–61.

33. Cited in Thomas H. Rees, "History of the Engineer Troops in the United States Army, 1775–1901," *Occasional Papers, No. 37* (Washington Barracks, DC: US Army Engineer School of Application, 1910), 2.

34. Cited in Walker, *Engineers of Independence*, 37, 39.

35. Walker, 41.

36. Walker, 41–43.

37. Walker, 43.

38. French Army Corps of Engineers, *French Engineers and the American War of Independence*, 16.

39. French Army Corps of Engineers, 6; and Buzzaird, "Washington's Most Brilliant Engineer," 361.

40. For surveys of the American Revolutionary War, see Weigley, *The History of the United States Army*, 29–73; Stewart, *American Military History*, 45–106; and Middlekauff, *The Glorious Cause*, 250–581.

41. For an overview of the Saratoga campaign, see Richard M. Ketchum, *Saratoga: Turning Point of America's Revolutionary War* (New York: H. Holt, 1997); and Stewart, 81–85. For material on engineering, see James S. Pula, *Thaddeus Kościuszko: The Purest Son of Liberty* (New York: Hippocrene Books, 1998), 79–81; and Walker, *Engineers of Independence,* 111, 203.

42. Alex Storozynski, *The Peasant Prince: Thaddeus Kościuszko and the Age of Revolution* (New York: Thomas Dunne Book, 2009), 25–32; and US Army Corps of Engineers, *The U.S. Army Corps of Engineers*, 3.

43. Ketchum, *Saratoga*, 355.

44. Ketchum, 354.

45. Ketchum, 354.

46. Ketchum, 363–441.

47. "Battle of Saratoga Integration Study," Department of Military Science, Worchester Polytechnic Institute, accessed 6 March 2016, http://www.wpi.edu/academics/military/sarint.html.

48. Henry P. Johnson, *Storming of Stony Point on the Hudson Midnight, July 17, 1779: Its Importance in the Light of Unpublished Documents* (New York: James T. White, 1900).

49. In 1989, the US Army's Engineer Regiment and the Army Engineer Association adopted the de Fleury Medal as an award that demonstrated the values of its namesake. The front of the medal has a Latin inscription meaning: "A memorial and reward for courage and boldness." In the center, the image of a helmeted soldier stands amidst the ruins of a fort, holding in his right hand an unsheathed sword, and in his left the staff of the enemy's flag, which he tramples underfoot. On the reverse side, another Latin phrase translated as "Fortifications, Marshes, Enemies Overcome." In the center, the fortifications at Stony Point are depicted with turrets and a flag flying. At the base of the hill are two shore batteries, one of which is firing at one of six vessels on the Hudson River beneath the fort is the legend: "STONY POINT CARRIED BY STORM, JULY 15, 1779." Presentations of de Fleury Medals to those individuals meeting established criteria started in 1989. Soldiers and civilians, active and retired, of all ranks proudly wear the de Fleury Medal. "The United States Army Engineer Regiment Presents the *de Fleury Medal*," US Army Engineer Association, 12 March 2017, http://www.armyengineer.com/PDF/defleury_3_12_17.pdf.

50. For an overview of the Siege of Yorktown and the French contributions in the conflict, see Jerome A. Greene, *The Guns of Independence: The Siege of Yorktown, 1781* (El Dorado Hills, CA: Savas Beatie, 2005); Lee B. Kennett, *The French Forces in America, 1780–1783* (Westport, CT: Greenwood, 1977); Kite, *Brigadier-General Louis Lebegue Duportail*, 189–213; and Stewart, *American Military History*, 98–103. For material on engineering, see Paul K. Walker, "An Engineering Victory: The Siege of Yorktown," *The Military Engineer* 73 (September–October 1981): 334–37; Walker, *Engineers of Independence*, 293–326; Buzzaird, "Washington's Most Brilliant Engineer," 363–64; and French Army Corps of Engineers, *French Engineers and the American War of Independence,* 8–13.

51. Capt. Johann Ewald, *Diary of the American War: A Hessian Journal: Captain Johann Ewald, Field Jäger Corps*, trans. and ed. Joseph Tustin (New Haven, CT: Yale University Press. 1979), 334.

52. Ewald, xix–xxvi.

53. Joseph Plumb Martin, *A Narrative of a Revolutionary Soldier* (previously published as *Private Yankee Doodle)* (1962; repr., New York: Signet Classics, 2010), 202–3.

54. Martin, vii–xiv.

55. Cited in Walker, *Engineers of Independence*, 324.

56. For overviews of the US military in the post-war period, see Richard H. Kohn, *Eagle and Sword: The Federalists and the Creation of the Military Establishment, 1783–1802* (New York: Free Press, 1975); Weigley, *The History of the United States Army*, 74–103; and Stewart, *American Military History*, 107–20. For material relating to the Corps of Engineers, see Walker, 327–65; and Sidney Forman, "Why the United States Military Academy Was Established in 1802," *Military Affairs* 29 (Spring 1965): 20–23.

57. Weigley, 77–79; Rees, "History of the Engineer Troops," 3–4; and US Army Corps of Engineers Office of History, *The U.S. Army Corps of Engineers*, 4, 7.

58. Cited in French Army Corps of Engineers, *French Engineers and the American War of Independence*, 14.

59. Alder, *Engineering the Revolution*, 63–73; Denton, "The Formative Years of the United States Military Academy," 12–14; and Walker, *Engineers of Independence*, 327–33, 354–63.

60. Cited in US Army Corps of Engineers Office of History, *The U.S. Army Corps of Engineers*, 7.

61. US Army Corps of Engineers Office of History, "Historical Vignette 22: Engineers and Artillerists Formed One Corps in 1794," accessed 7 March 2016, http://www.usace.army.mil/About/History/HistoricalVignettes/GeneralHistory/022EngineersandArtillerists.aspx.

62. Rees, "History of the Engineer Troops," 4; French Army Corps of Engineers, *French Engineers and the American War of Independence,* 14–16.

63. Raleigh B. Buzzaird, "Washington's Last Engineer," *The Military Engineer* 41 (September–October 1949): 119–22; US Army Corps of Engineers, *History and Traditions*, 9–11; Forman, "Why the United States Military Academy Was Established in 1802," 21–22; and French Army Corps of Engineers, 20–21.

64. Brian McAllister Linn, *The Echo of Battle: The Army's Way of War* (Cambridge, MA: Harvard University Press, 2007), 10–12; Stewart, *American Military History*, 120–23; Denton, "The Formative Years of the United States Military Academy," 15–22; and Forman, 22–25.

Chapter 2
The US Military Academy and the Institutionalization of Engineer Training, 1802–48

The new century saw the inauguration of Thomas Jefferson as president of the United States in 1801. With support from Congress, he established the permanent US Army Corps of Engineers and the US Military Academy. Modeled on schools in France, the academy provided engineering educations to future Army officers, whether they entered the Corps of Engineers itself or some other branch. Although the War of 1812 and the Mexican War affected the academy's size and curriculum, the most striking impacts were made by superintendents and faculty members. Of these personalities, Sylvanus Thayer and Dennis Hart Mahan cast the longest shadows over the nineteenth and into the twenty-first centuries. They played the most critical roles in institutionalizing the engineering education at the Military Academy, as well as the subsequent versions of the Engineer School after 1866.

Engineers and the Establishment of West Point

In 1801, President Thomas Jefferson called for a military academy to be established at West Point, New York. He recognized that only a competent, skilled cadre of home-grown officers could help maintain American security. As seen in the previous chapter, the creation of a permanent academy was hardly a new concept. Indeed, for many years, recommendations came from the likes of Maj. Gen. Louis Duportail, Secretary of War Henry Knox, Secretary of the Treasury Alexander Hamilton, President John Adams, Secretary of War Samuel Dexter, and General, later President, George Washington. Most of these men were also Federalists, who favored a strong national government, but Congress did not act on any of these recommendations before 1801.[1]

As the new president, Thomas Jefferson brought his Democratic-Republican values to the Executive Office. He differed with his predecessors—the Federalist Presidents Washington and Adams—over the purpose and power of the national government. Jefferson favored a weaker national government relative to more powerful state governments. Curiously, his support for a new Military Academy might seem inconsistent with his overarching ideology, since future Academy graduates would become officers in the national government's national Army. Competent, well-trained officers would, in turn, mean an effective Army and more power to the national government, which ran counter to Jefferson's Democratic-Republican sensibilities.

Jefferson realized, however, that the new nation's need for a strong defense outweighed ideological factors. His vision was to populate the new Military Academy with cadets who shared his beliefs or, at the very least, would receive instruction from like-minded faculty. They would be citizens and soldiers. Lastly, apart from political considerations, the new president was intellectually predisposed toward supporting centers of higher education. Indeed, he possessed a limitless fascination with innovation, architecture, mathematics, and science, all of which would become integral to the curriculum at his new Military Academy.[2]

Beyond gaining Congressional approval, West Point would need strong leadership before the school's doors could open. It required academic structure in terms of curriculum, pedagogy, faculty, and administration, not to mention literal structure in the form of buildings for classrooms and living space. Jefferson took the first of these steps in identifying Maj. Jonathan Williams as superintendent and naming Lt. Louis de Tousard as an instructor. Williams had served in the Corps of Engineers and Artillerists, and, like Jefferson, felt a keen interest in science. Tousard, on the contrary, brought experience and expertise in artillery, having seen action with the Marquis de Lafayette during the Revolutionary War. Later in 1808, Tousard wrote *The American Artillerist's Companion, or Elements of Artillery*, which was adopted as a text at West Point and thus became the primer for the US Army's artillery officers.

Jefferson next decided that the location for the new Military Academy would be at West Point, New York. There was no debate or hesitation in this logical choice. The long-time Army base possessed several buildings suitable for the new school. It had likewise been the site of previous schools and academies. Lastly, the location still included fortifications that could be used in coursework or practical exercises.[3]

On 16 March 1802, only a year after Jefferson's inauguration, Congress made the academy a reality. Congress first passed the Peace Establishment Act that separated the Corps of Artillerists and Engineers into two new entities—the Corps of Engineers and the Regiment of Artillerists. Then Congress passed an act creating the firm foundation for a Corps of Engineers, a chief engineer, and a Military Academy. This act also stated:

> SEC. 26. That the President of the United States is hereby authorized and empowered, when he shall deem it expedient, to organize and establish a Corps of Engineers, to consist of one engineer, with the pay, rank, and emoluments of a major; two assistant engineers, with the pay, rank, and emoluments of captains; two other assistant engineers, with the pay, rank, and emoluments of first lieutenants; two other assistant engineers, with the pay, rank, and emoluments of second lieutenants; and ten cadets, with the pay of sixteen dollars per month, and two rations per day. . . .
>
> SEC. 27. That the said corps when so organized, shall be stationed at West Point, in the State of New York, and shall constitute a military academy. . . .
>
> SEC. 28. That the principal engineer, and, in his absence the next in rank, shall have the superintendence of the said military academy.[4]

Several observations are needed to clarify the context of the 1802 acts and to show continuity between the past and the twenty-first century.

In Section 26, Congress gave the president direct authority over the Corps of Engineers, including making final decisions regarding promotions. Advances of this kind did not need to be made on the basis of rank or seniority. Instead the president, as commander-in-chief, was urged to promote engineer officers based on merit.

Next, in Section 27, Congress stated that the new Corps of Engineers "shall constitute" a Military Academy. This firmly established the new academy as the Army's original and formal "Engineer School"—and thus directly traces the lineage of the Military Academy to the US Army Engineer School currently based at Fort Leonard Wood, Missouri. There is a second critical component to Section 27: The Corps of Engineers and the academy were placed under the president's direct control. Thus, President Jefferson and his successors could legally deploy the engineers on combat operations, civil works projects, or disaster relief efforts.

Lastly in Section 28, the academy's superintendent and the Corps' principal, the chief engineer, were one and the same. For fourteen of the first sixteen years of the academy's existence, the superintendent and chief engineer was a dual-hatted position. This section also reaffirmed presidential control over the leadership of the Corps and Academy. For purposes of this history, the early superintendents were the equivalent to commandants of the Engineer School.

After years of hard work and many pieces of legislation, the academy opened its doors on 4 July 1802. It was the nation's first and only engineering school for the next two decades of the nineteenth century. Afterward, the academy maintained its place among the leading institutions of mathematics, science, and engineering until 1866, when control of the institution shifted from the Corps of Engineers to the War Department.[5]

In the intervening years between 1802 and 1866, more than 2,000 cadets were educated at the academy. The top ten percent of each graduating class took commissions in the Corps of Engineers, where they plied their skills supervising the design and construction of coastal or inland fortifications. In fact, throughout the early nineteenth century, the focus on fortifications grabbed the lion's share of resources. The engineer officers also directed civil works like building bridges, constructing roads, dredging waterways, surveying territories, making maps, digging canals, and placing lighthouses, to name but a few. Some of the best and brightest engineer officers returned to West Point as instructors and, in the case of Robert E. Lee (class of 1829), even as superintendent.[6] This rotation between field duties and teaching duties has remained a fundamental practice throughout the entire history of the Corps of Engineers, the engineer branch, and the Engineer School.

Establishing the Engineer Curriculum at the Military Academy, 1802–12

During his tenure as first superintendent in 1802–3 and again in 1805–12, Lt. Col. Jonathan Williams needed to build an educational institution from scratch, having only European models on which to base his new academy. He confronted problems of establishing a command structure, creating a coherent curriculum, and acquiring Congressional support for expansion.[7]

The first problem of command structure arose due to conflicts between Williams, in his role as superintendent, and the captain commanding the regular Army artillery company co-located at West Point. This artillery unit was part of the garrison at the post. Theoretically, an artillery captain exerted no control over matters relating to the academy, while Williams could not exercise command of the garrison. The controversy between the two officers came to a head over requisition procedures. If Williams wanted supplies for the academy, then the artillery captain, as garrison commander, could approve or deny the request. As a lieutenant colonel, Williams resented this level of control held by the lower-ranking captain. Williams argued that because West Point was "appropriated" to the Corps of Engineers, the command of the post should fall to the Corps. He appealed to the secretary of war, but nothing was done. Williams resigned his positions as superintendent and chief engineer in protest in 1803. He would later return to both positions in 1805.[8]

In the interim, leadership fell to Maj. Decius Wadsworth, the next highest ranking officer in the Corps of Engineers. During his two years as acting superintendent, the issue of manpower emerged as the biggest challenge facing the academy. Faculty numbered only two full-time instructors and ten cadets. Even so, it is noteworthy that these two captains boasted impressive credentials: one had graduated from Harvard University and tutored at Cambridge University; the other had previously taught at Yale University and authored a textbook on mathematics and physics. Then, a year later, another blow struck the nascent academy when Major Wadsworth resigned because of poor health. This left the entire academy under the command of a mere captain.[9]

Declining morale, stagnating curriculum development, and encouraging supporters brought Jonathan Williams back to serve as superintendent and chief engineer. He took up the reins of the academy and the Corps for the second time in 1805. The next three years saw more positive steps, as fifteen cadets graduated and the number of enrolled cadets expanded from forty-four to 200 by 1808. Williams remained as superintendent and chief engineer until 1812.[10]

Despite the rocky start, Williams and his faculty now began to address the second major problem of curriculum development. They worked to introduce and teach formal courses and create properly formulated examinations. This latter point was especially in need of reform because cadets would only take their examinations when they and their instructors agreed they were ready. It was entirely possible that a cadet might spend only one year in residence at the academy. This lack of standardization in lengths of study hurt the efforts to regulate the curriculum as a whole.

Over time, the curriculum solidified its concentration on mathematics, science, fortifications, drawing, and French with the goal of providing cadets the technical expertise requisite for engineering. Literacy in French was required so that the cadets could read Sébastien Le Prestre de Vauban's classic *Traité de fortifications* and other textbooks in their original language.[11] All these efforts represented the academy's early commitment to inculcating Army officers into the "profession of arms."

The last problem facing the Military Academy came in part from the lack of support from Congress and the executive branch. During the majority of Williams's years as superintendent, the best he could hope for was benign neglect from the federal government. Adding faculty or improving facilities proved difficult in a political environment dominated by the cost-conscious Democratic-Republicans. In larger social and military contexts, the academy slowly lost visibility with the American people. The Corps of Engineers' more pressing peacetime mission of constructing fortifications required many of the already tiny officer cadre, thereby reducing the pool of potential instructors available to teach at West Point. In fact, beginning in 1808, Colonel Williams himself spent much of his time away from the academy supervising the construction of harbor defenses in New York City.[12]

Making matters still worse, Williams inadvertently undermined the academy's stability by advocating its move from remote West Point to the nation's capital in Washington, DC. His priorities were thus divided spatially because of his frequent absences, and politically because of his desire to move the academy. Thus, Williams did not make much progress in adding new buildings and faculty members. Despite the lack of significant progress on these fronts, the faculty dutifully plodded away teaching their courses, working with inferior equipment, and preparing future officers with engineering skills. These realities caused the institution to flounder, especially between 1808 and 1812. Classes at the US Military Academy were suspended between 1812 and 1813 because officers and cadets were deployed to serve in the War of 1812.[13]

War of 1812: Engineer Operations and Insights Gained

The War of 1812 erupted between the United States and Great Britain for many reasons: disputes over westward expansion by American settlers, ongoing tensions with Native American tribes on the western frontier, anger at British support for those tribes, resentment of British violations of American maritime rights, and an American desire to end British influence in Canada. When the United States declared war on Great Britain in June 1812, the US Army was woefully unprepared for the coming fight. The British outgunned and outnumbered the Americans many times over. This resulted in several American debacles: failure to conquer Canada, defeat in several battles, and the embarrassment of losing Washington, DC, to British control. However, the US Army—augmented by state militia units—did win enough victories, especially at the Battles of the Thames and New Orleans, to survive. As much as anything else, the British grew weary of fighting the United States and in late 1814 agreed to end the conflict.[14]

Although limited in numbers, the engineer officers enjoyed many successes during the War of 1812. They effectively performed four out of five engineering functions: survivability, countermobility, mobility, and sustainment (general engineering). Junior engineer officers, including Sylvanus Thayer, Joseph Totten, Charles Gratiot, Eleazer Wood, and William

McRee, put their West Point educations and subsequent career experiences to effective use during many operations. A company of miners, sappers, and bombardiers assisted the officers. Superintendents Jonathan Williams and Joseph Swift took leave from the academy in order to supervise the expansion of New York City's defenses, which proved so formidable that the British decided against attacking the city altogether. In fact, every officer in the Corps worked on fortifications at some point during the War of 1812.[15] Two examples stand out as particularly pivotal: the famous defense of Baltimore by Fort McHenry against a British seaborne attack, and the less well-known defense of Fort Meigs in northwestern Ohio against two British sieges.

The star-shaped Fort McHenry was built between 1798 and 1800 under the supervision of French engineer and artillerist John Jacob Rivardi. It became part of the system of American coastal defenses that proved so effective during the War of 1812. No better example can be found than the evening of 13–14 September 1813, when the British Royal Navy attempted to destroy Fort McHenry as a prelude to capturing Baltimore. Loss of this important seaport to British control would have been more detrimental than losing the nation's capital. However, the fort's masonry

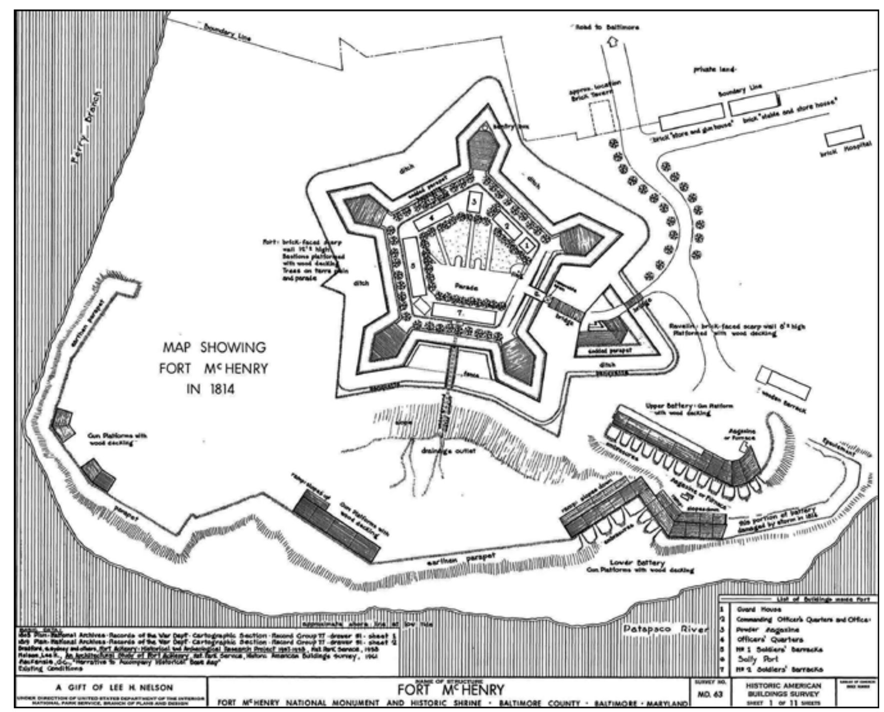


Figure 2.1. Plan of Fort McHenry in 1814. Courtesy of the National Park Service.

and earthen walls withstood the Royal Navy's 25-hour bombardment of some 1,500 projectiles. After a night of the intense barrage, the sight of the large American flag still waving defiantly over the American fort at dawn inspired American observer Francis Scott Key to pen the words for "The Star-Spangled Banner." Fort McHenry's classic design offered protection and survivability to the garrison. In addition to withstanding the naval bombardment, the American fort's accurate cannon fire prevented the British from landing troops nearby to make a ground assault. Consequently, neither Fort McHenry nor Baltimore fell into British hands. The successful defense of this fort testifies to the wisdom of its design and placement by John Rivardi more than a decade earlier.[16]

Earlier in 1813, another example involving engineers and field fortifications occurred nearly 500 miles away in northwest Ohio, where the American Fort Meigs sat on a bluff overlooking the Maumee River. Lying about ten miles upstream from Toledo, Ohio, on Lake Erie, this fort was a key point along supply lines in the region. Its design characteristics demonstrated the influences of the Military Academy's curriculum on two former cadets—Charles Gratiot and Eleazer Wood—both home-grown engineers who had graduated in 1806. Following the principles of Vauban, Captain Gratiot designed the fort with survivability in mind. His plan integrated timber and earthen walls with star-shaped blockhouses at each corner and with outcropped blockhouses along the lengths of the walls. These created overlapping fields of fire for the American defenders.[17] After falling ill in early 1813, Gratiot left the supervision of the building phase to Captain Wood during the severe winter months of February and March. In his personal journal, Wood remarked that the fort "and the appearance of the camp, in every direction, was such as to inspire confidence." He further declared that, "Our intrenchments now, in a manner, formed a complete citadel, which could have been defended to great advantage, and would have been found extremely difficult to force" by the enemy "without sustaining an immense loss."[18] Wood's statement proved correct when Fort Meigs endured two separate sieges by the British, thereby proving its survivability against repeated artillery barrages and ground assaults.

Apart from building fortifications, academy-educated engineers provided their maneuver commanders with advantages of effective mobility, countermobility, and sustainment (general engineering). During the Niagara campaign in the summer of 1814, for example, engineers Maj. William McRee and Maj. Eleazer Wood provided Brig. Gen. Jacob Brown's combat units with greater mobility by supervising repairs to an abandoned road running along the Niagara River. Brigadier General Brown moved

north along those roads from Fort Erie to engage and defeat the British at the Battle of Chippawa in early July. Major Wood helped make this victory possible by giving Brown valuable information from his reconnaissance of the British troop dispositions. Scouting and reconnaissance represented two tasks that fell to engineers because of their knowledge of topography and fortifications.

Next Brown attempted to outmaneuver the British, but he eventually lost the bloody Battle of Lundy's Lane in late July. This defeat compelled Brown's weakened force to retreat south along that same road toward Fort Meigs. Wood and McRee executed countermobility functions by ordering bridges along the evacuation route destroyed to slow the British pursuit. Even so, the British chased the Americans to Fort Erie and laid siege. In September of the same year, the recently breveted Lt. Col. Eleazer Wood died from wounds while leading an attack against the same British besiegers. In doing so, he proved that West Point-educated engineers could step up and lead combat units. Despite his death, Wood's unit succeeded in breaking up the British siege. He was hardly alone among engineers who distinguished themselves in combat. Joseph Totten, for example, saw action at the Battle of Plattsburgh in September 1814. In this engagement, American forces led by another engineer, Brig. Gen. Alexander Macomb, stopped a British attempt to invade the northern United States. Both Totten and Macomb would later serve as chief engineers.[19]

The engineers made critical contributions to the outcome of the War of 1812. In his seminal study of the Jefferson and Madison presidencies published in the late nineteenth century, historian Henry Adams made this observation: "Perhaps without exaggeration, the West Point Academy might be said to have decided, next to the Navy, the result of the war."[20] This is no small praise coming from a descendent of John Adams and John Quincy Adams. Indeed, the insights gained during the War of 1812 either capitalized on examples from the American Revolutionary War or pointed to the need for future changes:

- The contributions of engineers affirmed the value of the Military Academy's technical curriculum and the cadets' subsequent active duty assignments. These provided the officers with expertise in engineering functions. Combat operations were not the right time for on-the-job learning.

- The successful placement, construction, maintenance, and defense of American coastal fortifications validated the resources committed by the US government to this mission of the Corps of Engineers.

• Engineer officers proved their versatility by facilitating the success of several operations, and by mitigating defeats in other operations.

• Experiences in the War of 1812 left indelible marks on several future faculty and superintendents of the US Military Academy, and on future chief engineers.

• Because engineer officers might take command of combat units, they needed to be knowledgeable about infantry, cavalry, and artillery capabilities and tactics.

• The lack of specialized engineer soldiers, let alone entire units, underscored the need to re-establish permanent units in the US Army.

Consolidation of the Engineering Curriculum at the Military Academy, 1812–17

In addition to war with Great Britain, the year of 1812 was marked by several important events at the Military Academy and in the Corps of Engineers. Both institutions received support in April from President James Madison and Congress in "An Act Making Further Provisions for the Corps of Engineers." This act codified the school's subjects and created the respective faculty positions within the departments. Among these were new slots for professors and assistant professors of mathematics, a professor for the art of engineering, and a professor of national and experimental philosophy (science). The Act created the Corps of Cadets as an administrative structure for cadets, setting its manpower at 250. In addition to these curricular, personnel, and administrative additions, the Act appropriated $25,000 for new buildings and updated educational materials at West Point.[21]

As noted previously, when the War of 1812 started in June of that year, the officers and cadets went on active duty in the field as the US Army mobilized. Classes at the academy were suspended and did not resume until 1813. In the interim, Col. Jonathan Williams resigned from both his posts as superintendent and chief engineer, in part because of disagreements with then-Secretary of War William Eustis. Williams particularly resented Eustis's efforts to rewrite some of the academy's policies and his uneven support for the institution. The last straw for Williams may have been Eustis's decision to send officers and cadets away from West Point to serve at Army posts in 1812 and 1813, leaving the institution dormant.

In July 1812, President James Madison immediately promoted Joseph Swift to colonel and appointed him to replace Williams as chief engineer and superintendent of the US Military Academy. Swift was also an alumnus, being the first graduate of West Point in 1802. He had spent the previous decade putting his engineering skills to use supervising harbor defense construction and teaching at the academy. Previously, Swift had served as Williams's second-in-command and was therefore fully aware of the academy's strengths and weaknesses. Swift served as superintendent until 1814 and as chief engineer until 1818.

In those years, Swift brought several prestigious professors to the faculty, including a former Army officer named Andrew Ellicott who became a professor of mathematics. Eventually, Ellicott made his name as the foremost surveyor in the United States. For instance, he was involved in the planning of Washington, DC, two decades earlier. West Point historian Theodore Crackel praised Ellicot because he "brought a measure of national acclaim to the faculty" and "his precise astronomical observations and careful calculation had elevated American surveying and cartography to a new level of precision." This appointment thus increased the expertise in topographical engineering, thereby filling one of the functional voids visible during the War of 1812.[22]

Beyond adding new faculty, Swift expanded the curriculum to ensure, as Crackel asserts, that the cadets would "be more than narrowly trained military technicians. [Swift's] own experience convinced him that officers had to work closely with civil authorities—national, state, and local—and that these officials generally represented the best-educated and most socially influential segments of the population."[23] It was Swift's intention that new courses in geography, ethics, and history would make the cadets better able to interact with civilian communities later in their careers in the Corps of Engineers. Swift even incorporated fencing into the curriculum. The result was more holistically educated cadets, who still acquired knowledge of technical subjects.[24] Such diverse skill sets are still evident in the twenty-first century among officers serving in the Corps of Engineers, particularly when they work with communities, businesses, and governments in a variety of contexts.[25]

By 1815, the Military Academy achieved relative stability again, due in no small part to the long-term effects of the Act of 1812 and the efforts of Superintendent Joseph Swift. By 1815, leadership had again changed hands from Swift to Capt. Alden Partridge, who served as acting superintendent. An 1806 graduate of West Point, Partridge had remained on the faculty first as an assistant professor of mathematics and then as a professor of engineering. When Colonels Williams or Swift left for duties elsewhere, Partridge took temporary command of the academy.[26]

Partridge did not, however, become chief engineer because Swift retained that post until 1818. This division of authority between the two men caused unity of command problems that were magnified by Partridge's personality and his agenda for change. First, Partridge tried to limit the chief engineer's authority at West Point and within the Corps of Engineers itself. This put him directly at odds with Swift. For example, Partridge eschewed Swift's emphasis on a holistic curriculum in favor of a more narrowly focused curriculum grounded in military and technical subjects. Moreover, Partridge presumed to make these changes without faculty support, which did not make him allies inside the academy, or in the Corps at large. Complaints piled up against him. According to the faculty, he substituted a drill and maneuver curriculum for the more broad-based curriculum initiated by Swift. The faculty went so far as to present their complaints in person to President James Monroe in June 1817. A furious Monroe ordered that Partridge be removed from his post, court-martialed, and replaced as superintendent by Sylvanus Thayer the next month. Despite his actions being criticized by contemporaries and historians alike, Alden Partridge did initiate some beneficial reforms at West Point. He enforced a new, stricter code of discipline to govern cadet behavior. Also, on Partridge's watch, the cadets started wearing gray uniforms and began the tradition of the "Long Gray Line" because of a cost-cutting measure. As it turned out, the gray uniforms were less expensive than blue ones. Later, after resigning from the Army in 1817 rather than being dismissed, Partridge went on in 1819 to found his own military academy. It is the nation's oldest private military college and has been known as Norwich University since 1934. Partridge's curriculum blended liberal arts subjects with military science and engineering studies. He believed that graduates from schools such as his were necessary to educate common men, as opposed to what he perceived as education of the elites at West Point.[27]

Between 1817 and 1861, the Military Academy was dominated first by Sylvanus Thayer, and later by Dennis Hart Mahan. These giant personalities did more than any others to ingrain the engineering curriculum and foster professional development in the school. Several other officers, including Joseph G. Totten, Robert E. Lee, George Washington Cullum, and Richard Delafield, also played supporting roles in further crafting the curriculum and increasing professionalism at the academy.

Sylvanus Thayer: Father of the US Military Academy, 1817–33

Capt. Sylvanus Thayer served on active duty as a staff engineer during the War of 1812. Then from 1815 to 1817, Thayer spent two years touring

Europe with the goal of understanding how the European military academies functioned. He sat in on classes, visited facilities, interacted with faculty, and examined the curricula. Not surprisingly, Thayer spent most of his time at France's prestigious *École polytechnique*, where he not only studied engineering topics but also analyzed the curriculum and pedagogy. His travels also allowed him to collect maps, books, and various instruments, using a US government line of credit. In all, Thayer purchased more than 1,000 books for the academy's library. His professional development and continuing education greatly benefitted himself and the US Military Academy during his subsequent tenure as superintendent.[28]

Figure 2.2. Sketch of Sylvanus Thayer by Theodore R. Davis. From History.com.

On his return to the United States in 1817, Col. Sylvanus Thayer became superintendent. The sixteen years he held that position set the academy on a firm curricular and organizational foundation that carried the institution through the American Civil War. Drawing on experiences from his tour, Thayer wanted to replicate European engineering, especially the learning and teaching methods at the prestigious *École polytechnique*, which ranked among the most outstanding engineering and military academies on the continent. Thayer enjoyed support from then-Secretary of

War John C. Calhoun, who from 1817 until 1825 stressed improvement of bureaucratic and organizational processes that paralleled and complemented Thayer's reforms at the Military Academy.[29]

Thayer set up a four-year curriculum that emphasized the technical fields, yet also integrated the liberal arts. Each year, science, mathematics, and engineering components grew increasingly rigorous. Mathematics, for instance, required 780 hours of the newly arrived cadets' four-class year. In total, the engineering-preparatory and engineering-centric coursework amounted to more than seventy-one percent of classroom hours over the newly standard four years at the Military Academy.[30]

Yet this was not all. Thayer also believed in a broader-based curriculum similar to what Joseph Swift favored. Thayer thus helped to reverse the policies that Alden Partridge had initiated between 1815 and 1817. English grammar and composition appeared in fourth-class studies, along with French, which proved necessary for cadets to read many of the library's books on military engineering and tactics that Thayer brought back from Europe. The first-class studies involved a broad range of non-technical fields, including history, ethics, Greek, and Latin.

The classes appropriately were not filled with faculty lecturing endlessly while cadets took notes. Instead, Thayer embraced a different pedagogy and had his advanced cadets run recitation sessions among their junior classmates. The classrooms had blackboards on three walls and instructors' desks were on raised platforms facing the doors. After the cadet section reported for duty, everyone took their seats. Then the instructor answered initial questions and the recitations started. For example, historian Brian R. McEnany describes the process in Albert Church's mathematics courses:

> [Each] cadet was asked to "demonstrate" the problem assigned. The cadet picked up the pointer, faced the section, and proceeded to recite what he was required to prove, the assumptions, the facts, and then the solution to his problem. The process was repeated until all cadets had recited. Some sat down after telling the instructor they did not understand the problem or its solution and received a failing grade (a "cold fess" in cadet slang) for the day.[31]

The recitation concept derives from the French word *répétiteur*, meaning "one who repeats." This fostered shared learning, whereby cadets learned from and taught one another under the watchful eyes of faculty. Thayer borrowed this pedagogical approach from the *École polytechnique* in France.[32]

Thayer initiated other reforms to help maintain quality control in classroom instruction. He required faculty members to create lesson plans that justified their time spent on various activities down to the minute. He also expected them to keep journals that outlined and assessed their own teaching methods. In this way, Thayer instilled accountability among his faculty. If a professor or instructor was lacking, then a paper trail would exist. In the interest of maintaining quality education, Thayer added to the administrative structure of West Point and included the establishment of a Board of Visitors, which would be comprised of several members appointed by the president of the United States. The members would examine the cadets. The chair of this board would be the chief engineer, who in turn served as the inspector general of the Military Academy. These new entities gave means of holding the superintendent and the faculty accountable.[33]

Figure 2.3. Theodore R. Davis sketch of examination by board visitors in the nineteenth century. From *The U.S. Army Corps of Engineers: A History* (Alexandria, VA: US Army Corps of Engineers Office of History, 2008), 17.

Restructuring the academy's curriculum would not have been feasible without supportive faculty members like Claudius Crozet. A former French military engineer with combat experience in Napoleon's forces in Russia and at Waterloo, Crozet also graduated from the *École polytechnique*. He came to West Point as professor of engineering in 1816, and readily embraced Superintendent Thayer's new learning environment. Crozet wrote his own textbook on geometry, and translated many other books from French into English.

Crozet's influence on the new curriculum belies the fact that he taught only six years at West Point before returning to civilian life as a successful construction engineer. Later, he helped found the Virginia Military Institute, and Crozet joined dozens of other former cadets and faculty who used their West Point educations to help populate the faculty of new engineering schools and drive the western expansion of American infrastructure, such as railroads, bridges, canals, and tunnels. Their efforts proliferated across the nation the professionalism instilled at the Military Academy and in the Corps of Engineers. In fact, West Point-educated engineers deserve credit for helping to manage the largest organizations of their day—the railroad companies. The complexities and scale of building, staffing, managing, and maintaining the rail lines and trains required abilities that until the mid-nineteenth century were only possessed by Military Academy graduates.[34]

Another major innovation during Thayer's early years as superintendent was the creation of an Academic Board, which would, according to historian Edgar Denton III, "fix and improve the system of studies and instruction" and "detail the duties of the several instructors."[35] Membership included the superintendent and all the full professors in each department. The Academic Board helped to establish examination and ranking processes, arrange the subject-matter coursework for each year of study, and evaluate the department and faculty positions therein. The Board likewise was involved in the cadets' appointment and commissioning process. It remained intact and influential as a watchdog organization at the academy until the Civil War.[36]

During his last few years as superintendent, Thayer ran afoul of President Andrew Jackson, who was not one to tolerate adversaries to his political vision. The Democratic president saw West Point as an exclusive bastion for sons from wealthy and elite families and believed that it had little in common with the American public. Congressman David Crockett and former faculty member Alden Partridge joined Jackson in his democratic crusade against the academy. Thayer survived Jackson's first term. When Jackson won reelection in 1832, however, Thayer preempted a possible forced removal and resigned as the superintendent in 1833.[37] His sixteen years as superintendent had helped mold the academy into an educational institution that produced officers with valuable engineering expertise, even if the officers did not serve in the Corps of Engineers. Thayer is justifiably given the title "Father of the Military Academy." The so-called "Thayer System" cast a long shadow as the dominant educational paradigm for several decades thereafter.[38]

Dennis H. Mahan: Father of the Engineering Curriculum

The most influential Military Academy professor in the antebellum period was one of the academy's own alumni—Dennis Hart Mahan. He graduated from the academy in 1824 at the top of his class and had already

served as an acting assistant professor of mathematics before his graduation. He received his commission and remained on the faculty at the academy until 1826. For the next four years, he took advanced courses at the *École d'application de l'artillerie et du génie* (School of Application for Engineers and Artillerists) in Metz, France. He also conducted detailed inspections of France's roads, bridges, locks, canals, and other public works that relied on engineering experts for both design and build. He paid special attention to the new construction substance called concrete.[39]

Mahan returned to the Military Academy faculty in 1830. He resigned his commission and eventually became the professor of Civil and Military Engineering, which amounted to becoming the head of that department. He became an institutional figure at the academy, teaching from 1830 until shortly before his death in 1871. During these four decades, Mahan educated thousands of cadets who later fought in the Mexican War, the Civil War, the Indian Wars, and the Spanish-American War.[40]

In addition to his classroom teaching, Mahan was a prolific author. Drawing on his studies in France, for example, he wrote two textbooks: *A Complete Treatise on Field Fortifications* (1836) and *An Elementary Course of Civil Engineering* (1837). For several decades, the texts remained seminal works in military and civilian engineering instruction. Like Vauban had done two centuries earlier, Mahan conceived of engineering as both an art and a science.

Mahan's book, *Field Fortifications*, began with several chapters exploring two key engineer functions—survivability and countermobility. He investigated such practical matters as the "estimate of daily labor of a man working on an intrenchment," the "distribution of working parties," the "precautions to be taken in stony soils," and the "drainage of the terra-plain." Engineer officers needed to know about these nitty gritty details of the fortification process as much as they needed to understand the doctrine governing the art and science of fortifications. Later in the textbook, Mahan dealt with reconnaissance and bridging: how to ascertain enemy unit dispositions and provide mobility to the maneuver commander, even when faced with geographical obstacles.[41]

In his other major textbook, *Civil Engineering*, Mahan started with detailed classifications of stone, lime, cement, mortar, concrete, and timber, then turned to the categorizing of paint and metal. He discussed the strength, durability, and composition of these materials. Later chapters dealt with masonry, which could be found in so many coastal and harbor fortifications constructed between the War of 1812 and the Civil War.

Finally, Mahan examined applications of civil engineering in transportation, making *Civil Engineering* the handbook for Army engineer officers directing the construction of the nation's infrastructure—roads, bridges, railroads, canals, and rivers—throughout the nineteenth century.[42] For example, cadets Robert E. Lee and Montgomery Meigs applied Mahan's principles as Army officers while performing these civil works missions. Lee directed the dredging of steamboat channels on the Mississippi River in the 1830s, while Meigs managed the construction of the Washington Aqueduct in the 1850s.

Dennis Hart Mahan did not limit himself to teaching civil and military engineering. He also wrote about strategy and tactics in what he termed the "art of war." Cadets would become Army officers and, presumably, serve in wartime; thus they needed to understand the principles of warfare. Mahan wrote and taught about the concentration of forces, speed in operations, mobility on the battlefield, and calculated risk in decision-making. He applied the ostensibly engineering skills of topography to conducting terrain reconnaissance, which in turn gave the maneuver commander better knowledge of geographical features in the area of operations. History, and especially the Napoleonic Wars, become his workshop to extract lessons and insights. Many of Mahan's concepts can be seen in *An Elementary Treatise on Advanced-Guard, Outpost, and Detachment Service of Troops, with Essential Principles of Strategy and Grand Tactics* that he published during the Mexican War in 1847. Cadets Ulysses S. Grant, George McClellan, Thomas J. Jackson, Braxton Bragg, William Tecumseh Sherman, and a host of others would employ Mahan's ideas as junior officers during the Mexican War and then as senior leaders in the Civil War. Mahan's influence on those and later conflicts cannot be overstated.[43]

As brilliant as his publications were, Mahan's teaching also measured up to his reputation for excellence. Written in 1951, retired Army Col. R. Ernest Dupuy noted:

> Cadets venerated [Mahan] for his rare but always welcome praise of work well done, and for his eminent fairness. They respected him also for the lucidity with which his soft-spoken voice cleared up knotty problems in their study of military history, resolving [according to one graduate] "what appeared to be a complex jumble of chance events into a striking illustration of the true principle of tactics and strategy."[44]

In this case, the word "venerated" might not be the most descriptive choice. Perhaps, better descriptors for cadet attitudes of Mahan might be fear or awe.

As part of his concern for quality instruction, Mahan expanded on Sylvanus Thayer's earlier efforts to institute the new pedagogy—recitation by cadets. In addition to the educational benefits mentioned above, this helped to stimulate communication, leadership, and critical thinking skills among the cadets. As a pedagogical tool, recitation still remains a hallmark of the Military Academy, the later iterations of the US Army Engineer School, and much of the Army's professional military education system in the twenty-first century.

Dennis Hart Mahan dedicated his adult life to the Military Academy. He remained on the faculty for nearly fifty years, until 1871, when he received word that he was recommended—really forced—to retire. Distraught by the decision, he took his own life in September of that same year. Nevertheless, Mahan left permanent marks on the academy and the Army's officer corps that still echo in the twenty-first century. He is thus arguably the father of US Army engineering training.

Establishing the Corps of Topographical Engineers in 1838

Topography has remained an integral component of military engineering operations since the Revolutionary War. Formally trained in this field, George Washington even surveyed and mapped his own property years before the Revolution. He understood the operational imperative of having accurate maps that showed terrain features that could enhance his own or obstruct his enemy's mobility. Moreover, Washington appreciated the benefits of effective terrain reconnaissance, as seen in the successful siege of Yorktown and many other combat operations during the Revolutionary War.

Without accurate maps and knowledge of terrain, maneuver commanders are blind. Worse still, they find themselves at the mercy of the environment and the enemy's exploitation of that environment. The War of 1812 contains many examples of what maneuver commanders could accomplish when properly briefed on terrain in their area of operations. Academy-trained engineer officers like Capt. Joseph G. Totten and others made accurate maps and conducted terrain reconnaissance of numerous areas for varying operations.[45]

Topographical engineers had been formally, albeit haphazardly, organized and established by the Army since 1813, when Congress recognized the need for this function and authorized eight topographical engineer officers and eight assistants. There were, however, too few qualified personnel to fill all the US Army's topographical needs. Despite this reality, these specialized engineers—sometimes called "topogs"—were discharged after the War of 1812 ended.

By 1818, Army and civilian leaders alike recognized that the loss of the topogs' skills needed to be rectified. The War Department established the Topographical Bureau but did not give its officers autonomy. Instead, they fell under the authority of the chief engineer of the Corps of Engineers. Thereafter, the topogs spent most of the post-war decades surveying and exploring new territories, as well as assisting other government agencies in the construction of canals, roads, bridges, lighthouses, and harbors.[46]

The topogs' duties extended to military operations. The two Seminole Wars (1816–19 and 1835–42) affirmed commander requirements to have officers on staff with terrain reconnaissance and mapmaking skills. These conflicts occurred in the Florida Everglades, where the bogs and sways made accurate geographical and terrain analyses that much more difficult yet still very necessary.[47] During military operations, the Army regulations stated that the topogs:

> [M]ake such surveys and exhibit such delineations as the commanding generals shall direct; to make plans of all military positions which the army may occupy and of their respective vicinities, indicating the various roads, rivers, creeks, ravines, hills, woods, and villages to be found therein; to accompany all reconnoitering parties sent out to obtain intelligence of the movements of the enemy or of his positions; to make sketches of their routes, accompanied by written notices of everything worthy of observation therein; to keep a journal of every day's movement when the army is in march, noticing the variety of ground, of buildings, of culture, and distances, and state of roads between common points throughout the march of the day; and lastly, to exhibit the positions of contending armies on the fields of battle, and the dispositions made, either for attack or defense.[48]

The topographical engineers remained subsumed within the Corps of Engineers. Yet their skills and accomplishments drew much greater attention than the number of topog officers actually on duty. In fact, service in the Corps of Engineers remained the favored choice among the top graduates of the Military Academy throughout the antebellum period. This elite

branch was followed by service in the Corps of Topographic Engineers. According to John Tidball of the class of 1848:

> [The cadets] were taught that with every breath we drew at West Point the utmost reverence for this [order of merit] scale; it becomes a kind of fixture in our minds that the engineers were a species of gods, next to which came the "topogs"—only a grade below the first, but still a grade—they were but demigods. . . The line was simply the line, whether of horse, foot, or dragoons.[49]

After much urging by several engineer officers and support from Congress, the topogs split off from the Corps of Engineers in 1838 to form an independent organization called the Corps of Topographical Engineers. Col. John J. Abert served as chief from 1838 until his retirement in 1861. This entity remained in existence until 1863, in the middle of the Civil War. On Abert's watch, the topogs expanded their efforts in surveying the Great Lakes and other rivers, harbors, and coastlines. Notable officers included John C. Frémont, William H. Emory, and Andrew A. Humphreys.[50] Of the Army's seventy-two topographers serving in the new Corps, the overwhelming majority—sixty-four—received their educations at the US Military Academy. Like their fellow graduates, they studied mathematics, science, civil engineering, geography, drawing, surveying, field fortifications, and construction.

The Mexican War: Engineering Operations, Force Structure Changes, and Lessons

In April 1846, the United States ostensibly went to war with Mexico in retaliation for a Mexican attack on American soldiers along the border between the two nations. Several longer-term causes involving territorial expansion, however, helped precipitate the conflict. American settlers had long been pushing the frontier westward across the great plains toward the Rocky Mountains and beyond to the west coast. This western migration put the United States on a collision course with Mexico, especially as Americans moved into modern-day California and Texas. These so-called "Texians" chafed against Mexican control and rebelled in 1836. After a brief conflict, the defeated Mexican government gave independence to Texas and, in 1845, the Republic of Texas joined the United States as its twenty-eighth state. However, there was no agreement between Mexico, Texas, or the United States regarding the border. This merely fueled existing tensions. The initial skirmishes along the border in the spring of 1846 quickly escalated into an armed conflict in May of that same year. The two-year-long Mexican War included several theaters of operations in what would become the southwestern United States, northern Mexico, and the vicinity near Mexico City. Amphibious assaults and landings also occurred in several places.[51]

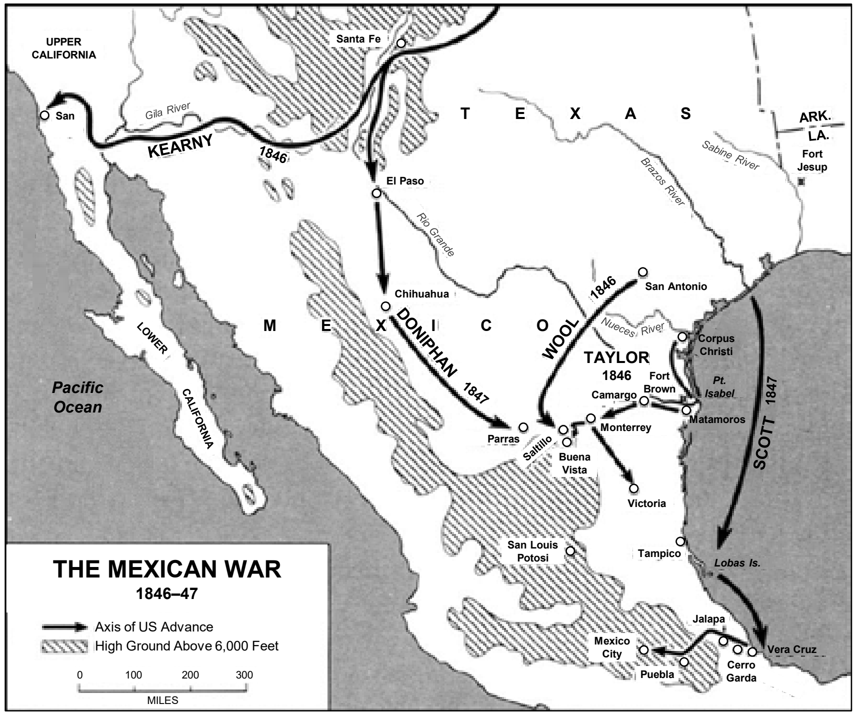


Figure 2.4. Map of the Mexican War. From *American Military History* (Washington, DC: US Army Center of Military History, 1989), Map 20.

Looking at the map, one cannot help but be struck by the incredible distances covered by US Army units. They marched hundreds of miles over rough, mostly unmapped terrain and then fought battles far from supply lines. In such inhospitable environments, all five engineering functions were needed for success at all levels of war: tactical, operational, and strategic.[52]

The eventual American victory against Mexico in early 1848 would have been costlier and slower, if not less probable, without roles effectively played by such engineer officers as Capt. Robert E. Lee or Lt. Ulysses S. Grant, who were educated at the US Military Academy. But the battlefield successes of these officers alone did not account for all such contributions. They needed specialized engineer units; but, with exception of a brief time in the War of 1812, these had not existed in the Army since the end of the American Revolution in 1783. Congress rectified this deficiency by authorizing the enlistment of a company of engineer soldiers on 15 May 1846,

just two days after declaring war against Mexico. The unit was organized on 11 August 1846 as Company A, Corps of Engineers. Capt. Alexander J. Swift served as its first commanding officer. He boasted an impressive background, which included graduating at the top of his West Point class of 1830 and pursuing post-graduate training at the School of Application for the Artillery and Engineer in Metz, France.[53]

Based at West Point, New York, Captain Swift immediately set about raising 100 soldiers to serve as engineers. However, recruiting, training, and equipping his company progressed slowly for two key reasons: Swift was one of only three officers in the unit, which lacked the necessary engineering equipment and tools. Swift was assisted in Company A by the capable 2nd Lieutenants Gustavus W. Smith and George McClellan. Together, the three officers improvised engineer tools and equipment to be used for the unit. They trained their men in combat engineering functions until summer's end in 1846.[54] The enlisted personnel of Company A developed into competent "pioneers"—a nineteenth century term equating to "enlisted engineer soldiers" in the twentieth and twenty-first centuries.

The engineers of Company A sailed from New York and arrived in Texas in September 1846. They then moved overland to the Rio Grande River, where the US Army made its base. While there, the soldiers received more training in engineering functions; and some with the greatest potential received promotions to become noncommissioned officers. Their comrades in Infantry units mocked the engineers as the "pick and shovel brigade."[55] In an article published in 1932, Maj. William Robinson Jr. explained how their officers "told the men not to mind the jibes of the infantry, for when it came to real work in the face of the enemy, it would be the infantry digging under the direction of the engineer soldiers. That when the time came for close fighting, the engineers would be in the thick of it."[56] Robinson's observation proved correct: no one could laugh at the engineers during combat operations.

Nevertheless, many ongoing hardships faced Company A, such as yellow fever and dysentery that left as much as one-third of the unit on sick call. In fact, Captain Swift himself spent time in a hospital before returning still sick to command his soldiers during the landing at Vera Cruz in March 1847. He died in New Orleans, Louisiana, just days later after he was evacuated following the successful landing. At that time, Lt. Gustavus W. Smith took the reins of the engineer company.[57]

Engineer officers in several units and those engineers in Company A participated in all battles in the Mexican War, including Vera Cruz, Cerro Gordo Pass, Contreras, Churubusco, and Chapultepec. These examples illustrate the variety of contributions toward victories made by the engineers during the Mexico City Campaign, running from March through September 1847. The American forces under Maj. Gen. Winfield Scott's command planned to seize the Mexican port city of Vera Cruz and then fight their way west several hundred miles over rough terrain to Mexico City. Capturing Mexico's capital would, it was hoped, yield an American victory in the war.[58]

On 9 March, Scott's army landed near the port city of Vera Cruz on the coast of the Gulf of Mexico. He then executed a classic siege operation against the city. The Engineer Company "was engaged in the most severe and trying duties, in opening paths and roads to facilitate the investment, in covering reconnaissance, and in the unceasing toil and hardship of the trenches," reported Chief Engineer and the siege's planner, Col. Joseph G. Totten. "The total force of the company was so small, and the demands for its aid so incessant, that every man may be said to have been constantly on duty, with scarcely a moment for rest or refreshment."[59] Although not part of the company, Capt. Robert E. Lee assisted Gustavus Smith and 1st Lt. George McClellan in identifying the best locations for gun emplacements. The engineers then dug protective positions and mounted the cannons. A relentless bombardment of Vera Cruz began on 22 March 1847; then one week later, the wearied and broken Mexican defenders surrendered their city.[60]

Two weeks after the surrender at Vera Cruz, Scott's army and its tiny contingent of engineers started their march inland along the National Highway toward Mexico City. Blocking their way was a 12,000-man Mexican force dug into strong defensive positions in a canyon of Cerro Gordo. The Mexicans had placed cannons and infantry units in these positions, layered in a defense in depth. They also enjoyed excellent fields of fire along the road. On the face of it, their formidable position would cause many casualties should the American troop make a frontal assault. As maneuver commander, General Scott needed another course of action, so he turned to his engineers for help.

It was here that Engineer Capt. Robert E. Lee made one of the greatest engineering contributions in the entire conflict. Throughout 15 April, he and one other soldier personally conducted a terrain reconnaissance to find an alternative path to attack the Mexicans on their flank. After struggling over the rough terrain and avoiding Mexican patrols, Lee returned to report good news to General Scott.[61]

A narrow path existed where the US Army could bypass the Mexican defenses. That path needed improvements as General Ulysses S. Grant recalled in his memoir several decades later:

> Under the supervision of the engineers, roadways had been opened over chasms to the right where the walls were so steep that men could barely climb them. Animals could not. These had been opened under cover of night, without attracting the notice of the enemy. The engineers, who had directed the opening, led the way and the troops followed. Artillery was let down the steep slopes by hand, the men engaged attaching a strong rope to the rear axle and letting the guns down, a piece at a time, while the men at the ropes kept their ground on top, paying out gradually, while a few at the front directed the course of the piece. In like manner the guns were drawn by hand up the opposite slope.[62]

The young Lieutenant Grant would not forget the engineers' 1847 road construction capabilities when he assumed command of Union forces some fifteen years later in the Civil War.

In the ensuing Battle of Cerro Gordo on 18 April, General Scott ordered a multi-pronged attack. Some units feigned a head-on assault against the Mexican position to keep the enemy occupied. Meanwhile, the more critical flanking attack used the path discovered by Lee and improved by the engineers. The Americans successfully surprised the Mexicans and decisively defeated them. This battle demonstrated how effective terrain reconnaissance and road improvement could improve maneuverability and enable surprise attacks. It is also worth noting that the Engineer Company A saw combat as a lead element.[63]

Victory at Cerro Gordo opened the way to Mexico City. In mid-August at the Battle on Contreras on the outskirts of the Mexican capital, Lee duplicated his earlier feat by scouting and building a path through a supposedly impassable lava field. During the fighting, Scott's American forces executed another surprise attack and routed the 5,000-man Mexican force. Once again, the Engineer Company fought with the infantry. First Lt. Gustavus Smith praised his noncommissioned officers as "men of intelligence, education, and character . . . repeatedly distinguished for gallant and high soldierly conduct in battle."[64]

As the Americans moved closer to Mexico City, they fought the remaining Battles of Churubusco in August and then Molino Del Rey and Chapultepec in September 1847. The engineers continued to reconnoiter enemy positions and provide invaluable analysis to their commanding officers. All three battles ended in American victories, severe losses for the Mexican Army, and the fall of Mexico City to American control. Although negotiations lasted for several months, major combat operations ceased with this victory. Later in December 1847, Maj. Gen. Winfield Scott paid high praise to the West Pointers; he claimed that without officer education at the Military Academy, "this Army, multiplied by four, could not have entered the capital of Mexico."[65]

Robert E. Lee, Gustavus Smith, George McClellan, and the soldiers of Company A were not alone in making significant contributions to the American victory of the Mexican War. Some twenty-five officers in the Corps of Topographical Engineers also served during that conflict. They had all attended the US Military Academy at West Point, where they had taken courses from the likes of Dennis Hart Mahan. For many, their Army careers leading up to the Mexican War had included tours doing civil works, constructing coastal fortification, and performing other peacetime projects. During the conflict, topographical engineer officers such as George Meade, Andrew A. Humphreys, and Joseph E. Johnston cut their teeth in the widespread campaigns in Mexico and California. They conducted their own terrain analysis, sometimes under fire, as in the case of Meade at the Battle of Monterey in September 1846. While serving on staffs, the topogs poured over existing maps and drew up new ones. In the latter case, this often required the officers to scout enemy positions to get precise locations of their troops and artillery.[66] In his "Report of the Chief, Topographical Engineers in 1848," Col. John J. Albert explained the significance of efforts made by his topogs:

> Accurate geographical and topographical knowledge of a country are particularly essential to military operations. They are the eyes of the commanding general. With these he can see the country and can know how to direct and combine all the movements or marches, whether offensive or defense, and without them he is literally groping in the dark, incapable of devising plans for his own operations, or anticipating those of the enemy. With this knowledge, war becomes a science, in which intellect will ever predominate over numbers.[67]

If ever there was a mission statement for topographical engineers or their successors—the geospatial engineers—this report makes that statement.

After the end of the Mexican War, the engineers of Company A stayed in Mexico as part of the American occupation force and continued to train

under their officers. The experience of the Mexican War instilled within them both unit and branch esprit de corps. In late spring of 1848, Company A returned to its home station at West Point, remaining intact as an active unit until the start of the Civil War in 1861. The unit had proved its value in the Mexican War, and its ongoing existence bore witness to the need for permanent engineer units in the Army's force structure. All the engineer officers received praise from their unit commander. Most moved back to civil works or fortification projects, although some like George McClellan returned to the Military Academy to teach the upcoming generations of officers.[68]

The engineers took away several lessons from the Mexican War. Some experiences were repetitions of earlier conflicts, others validated the lessons learned from earlier conflicts, and new lessons emerged as future needs for action:

• The success during the Mexican War and the post-war survival of Company A demonstrated that lessons taken from the War of 1812 were well-learned. If anything, the number of engineer units needed to be increased.

• A trained cadre of topographical engineers together with engineers, educated in mapmaking and terrain reconnaissance, was indispensable to operational success. Without their skill and knowledge, maneuver commanders found themselves not only at the mercy of the terrain, but also at the mercy of the enemy leveraging that terrain to their advantage.

• Several of the engineer officers joined the faculty or administration of the US Military Academy in the years following the Mexican War. In a feedback loop, they brought their first-hand experiences of engineer operations in the field back to the classroom. The faculty modified the curriculum to better prepare the cadets for future missions based on their contemporary, practical knowledge.

• Many officers, of all branches, made valiant contributions to America's victory in the Mexican War, and so convinced the American public and Congress to continue to support the Military Academy.

• Dozens of junior engineer officers gained their first combat experience that would further help shape their performance in the Civil War.

Conclusion

From its inauspicious beginning in 1802 to the triumph of its graduates in the Mexican War, the US Military Academy grew over time to become an accepted fixture in the American military establishment. The curriculum inculcated in every cadet, regardless of branch, the knowledge of science, mathematics, and engineering. This, in turn, meant that future officers could leverage those skills in public works projects or combat operations. The institutionalization of engineering education at the academy occurred thanks to many individuals' efforts. Standing above all others were Sylvanus Thayer as superintendent and Dennis Hart Mahan as longtime professor of Civil and Military Engineering. As the lineal forerunner to the Engineer School of the twenty-first century, the Military Academy of the early nineteenth century established traditions and expectations of excellence for both the engineer branch and the Corps of Engineers.

Notes

1. Col. S. E. Tillman, "Academic History of the Military Academy, 1802–1902," in *The Centennial of the United States Military Academy at West Point, New York, 1802–1902*, vol. 1 (Washington, DC: Government Printing Office, 1904), 218–22; Theodore J. Crackel, *West Point: A Bicentennial History* (Lawrence, KS: University Press of Kansas, 2002), 37–42; George S. Pappas, *To the Point: The United States Military Academy, 1802–1902* (Westport, CT: Praeger, 1993), 13–17; and Sidney Forman, "Why the United States Military Academy Was Established in 1802," *Military Affairs* 29 (Spring 1965): 20–25.

2. Russell F. Weigley, *History of the United States Army* (New York: McMillan, 1967), 103–8; and Crackel, 43–51. For the best overview of this period of American military history, see Richard H. Kohn, *Eagle and Sword: The Federalists and the Creation of the Military Establishment, 1783–1802* (New York: Free Press, 1975).

3. Crackel, 49–59; and Forman, "Why the United States Military Academy Was Established in 1802," 25–26.

4. Cited in Forman, 26.

5. A. J. Angelo, "The Polytechnic Comes to America: How French Approaches to Science Instruction Influenced Mid-Nineteenth Century American Higher Education," *History of Science* 1 (2012): 316–18; and Lawrence P. Grayson, "A Brief History of Engineering Education in the United States," *Engineering Education* (December 1977): 246–48.

6. R. Ernest Dupuy, *Men of West Point–The First 150 Years of the United States Military Academy* (New York: William Sloane Associates, 1951), 25–46; and Todd Shallat, "Science and the Grand Design: Origins of the US Army Corps of Engineers," *Construction History* 10 (1994): 17–25.

7. For an overview of Williams's superintendency, see Stephen E. Ambrose, *Duty, Honor, Country* (Baltimore: Johns Hopkins University Press, 1999), 24–40; Pappas, *To the Point*, 27–59; Crackel, *West Point*, 55–71; and Edgar Denton, III, "The Formative Years of the United States Military Academy, 1775–1833" (PhD diss., Syracuse University, Syracuse, NY, 1964), 27–88.

8. Denton, 28.

9. Pappas, *To the Point*, 29–30.

10. Pappas, 54.

11. Sidney Forman, "The First School of Engineering," *The Military Engineer* 44, no. 298 (March–April 1952): 109–10.

12. Ambrose, *Duty, Honor, Country*, 21–22.

13. Ambrose, 36.

14. For overviews, see Donald R. Hickey, *The War of 1812: A Forgotten Conflict, Bicentennial Edition*, rev. ed. (Urbana, IL: University of Illinois Press, 2012); and Richard W. Stewart, ed., *American Military History, Volume 1: The United States Army and the Forging of a Nation, 1775–1917* (Washington, DC: US Army Center of Military History, 2005), 131–56.

15. William Shunk, “Services of Graduates in the War of 1812 and in the Mexican War,” in *The Centennial of the United States Military Academy at West Point, New York, 1802–1902*, 586–90; and Charles Emerson Walker, “The Other Good Guys: Army Engineers in the War of 1812,” *The Military Engineer* 70 (May–June 1978): 180–82.

16. Mark A. Smith, *Engineering Security: The Corps of Engineers and Third Defense System Policy, 1815–1861* (Tuscaloosa, AL: University of Alabama Press, 2009), 8–24; and Weigley, *History of the United States Army*, 97–99.

17. Eleazar D. Wood, “Journal of the Northwestern Campaign of 1812–1813 under Major-General William H. Harrison,” 16–21, Archival Collection, Fort Meigs, Ohio Historical Society, Perrysburg, Ohio, 1975; and Walker, “The Other Good Guys,” 182.

18. Wood, 21.

19. Shunk, “Services of the Graduates,” 590–601; and Walker, “The Other Good Guys,” 180–83;

20. Cited in Walker, 180. See also *The U.S. Army Corps of Engineers—A History* (Alexandria, VA: US Army Corps of Engineers Office of History, 2008), 11–13.

21. Denton, “The Formative Years of the United States Military Academy,” 81.

22. Crackel, *West Point*, 72.

23. Crackel, 72.

24. Denton, “The Formative Years of the United States Military Academy,” 31–32.

25. Crackel, *West Point*, 73.

26. Crackel, 76.

27. Crackel, 76–80.

28. Denton, “The Formative Years of the United States Military Academy,” 110.

29. William B. Skelton, “West Point and Officer Professionalism,” in *West Point: Two Centuries and Beyond*, ed. Col. Lance Betros (Abilene, TX: McWhiney Foundation Press, 2004), 22–30; Charles F. O’Connell, “The Corps of Engineers and the Rise of Modern Management,” in *Military Enterprise and Technological Change: Perspectives on the American Experience*, ed. Merritt Roe Smith (Cambridge, MA: MIT Press, 1985), 90–93.

30. John C. Waugh, *The Class of 1846: From West Point to Appomattox: Stonewall Jackson, George McClellan, and their Brothers* (New York: Ballantine Books, 1994), 25–63; Allen H. Mesch, *Teacher of Civil War Generals: Major General Charles Ferguson Smith, Soldier and West Point Commandant* (Jefferson, NC: McFarland, 2015), 9–14; and Tillman, “Academic History of the Military Academy,” 276.

31. Brian R. McEnany, *For Brotherhood and Duty: The Civil War History of the West Point Class of 1862* (Lexington, KY: University Press of Kentucky, 2015), 37. See also Tillman, 251–58; and Waugh, 29–30.

32. Shallat, “Science and the Grand Design,” 17–19; French Army Corps of Engineers, *French Engineers and the American War of Independence*, trans. Sylvia F. Goldfrank (Paris: Corps of Engineers of the French Army, 1975), 15–16; Angelo, “The Polytechnic Comes to America,” 318–20; and Grayson, “Brief History of Engineering Education,” 248.

33. Denton, “The Formative Years of the United States Military Academy,” 182–86; and Ambrose, *Duty, Honor, Country*, 67–72.

34. Forman, “The First School of Engineering,” 110–11; Pappas, *To the Point*, 103–4, 155; and O’Connell, “The Corps of Engineers and Modern Management,” 88–110.

35. Denton, “The Formative Years of the United States Military Academy,” 184.

36. Crackel, *West Point*, 81–84; James L. Morrison Jr., *“The Best School–West Point, 1833–1866* (Kent, OH: The Kent State University Press, 1986), 4, 25, 43–47; and Pappas, *To the Point*, 111.

37. Col. T. J. Cram, “Recollections as a Cadet and Officer” (unpublished manuscript, n.d., c. 1865, US Army Engineer School), 21–27, US Army Engineer School History Office Archives; Denton, “The Formative Years of the United States Military Academy,” 240–80; Crackel, 101–2; and Pappas, 185–206.

38. Lt. Gen. (Retired) John M. Schofield, “Address” (1902), in *The Centennial of the United States Military Academy at West Point, New York, 1802–1902*, vol. 1 (Washington, DC: Government Printing Office, 2016), 57–62; Pappas, 154–55; and Crackel, 103–5.

39. For a biographical sketch, see Henry L. Abbot, “Memoir of Dennis Hart Mahan, 1802–1871” (reading before the National Academy, 7 November 1878), 31–37, US Army Engineer School History Office Archives. For perspectives from a contemporary on staff, see Mesch, *Teacher of Civil War Generals*, 17–39.

40. Brian McAllister Linn, *The Echo of Battle: The Army’s Way of War* (Cambridge, MA: Harvard University Press, 2007); and Forman, “The First School of Engineering,” 111–12.

41. Tillman, “Academic History of the Military Academy,” 282–84.

42. Tillman, 279–82.

43. Edward Hagerman, “From Jomini to Dennis Hart Mahan: The Evolution of Trench Warfare and the American Civil War,” *Civil War History* 13, no. 3 (1967): 200–5; and Dupuy, *Men of West Point*, 20–24.

44. Dupuy, 17.

45. Walker, “The Other Good Guys,” 181–82.

46. Gustav Person, “Past in Review: Topogs: Topographical Engineers in Peace and War,” *Engineer–The Magazine for Army Engineers* 38 (July–December 2008): 68–72; and Frank N. Schubert, *Nation Builders–A Sesquicentennial History of the Corps of Topographical Engineers 1838–1863* (Fort Belvoir, VA: US Army Corps of Engineers Office of History, 1988), 6–18.

47. Schubert, 19.

48. Cited in "A History of the U.S. Topographical Engineers, 1818–1863," accessed 12 March 2016, http://www.topogs.org/History.htm.

49. James L. Morrison Jr., "Educating the Civil War Generals: West Point, 1833–1861," *Military Affairs* 38, no. 3 (October 1974): 108.

50. Maj. William M. Robinson Jr., "The Corps of Topographical Engineers," *The Military Engineer* 23 (July–August 1931): 303–6; Person, "Past in Review," 70–71; and Schubert, *Nation Builders*, 23–27.

51. For overviews, see K. Jack Bauer, *The Mexican War, 1846–1848* (New York: McMillan, 1974); Shunk, "The Services of Graduates," 601–31; Mesch, *Teacher of Civil War Generals*, 54–85; and Waugh, *The Class of 1846*, 73–130.

52. Maj. William M. Robinson Jr., "The Engineer Soldiers in the Mexican War," *The Military Engineer* 24 (January–February 1932): 1–5.

53. Robinson, 2–3.

54. Gustavus W. Smith, *Company A, Corps of Engineers, U.S.A., in the Mexican War, 1846–1948*, ed. Leonne M. Hudson (Kent, OH: The Kent State University Press, 2001), 66–68; and Robinson, "The Engineer Soldiers in the Mexican War," 2–3.

55. Smith, 68.

56. Robinson, "The Engineer Soldiers in the Mexican War," 3.

57. Robinson, 5.

58. For an overview, see Timothy D. Johnson, *A Gallant Little Army: The Mexico City Campaign* (Lawrence, KS: University Press of Kansas, 2007).

59. Cited in George B. McClellan, *The Mexican War Diary and Correspondence of George B. McClellan*, ed. Thomas W. Cutrer (Baton Rouge, LA: Louisiana State University Press, 2009), 78.

60. Smith, "Company A," 76–81; McClellan, 79–96; and Kenneth J. Deacon, "Combat Engineers 34: Siege of Vera Cruz, 1847," *The Military Engineer* 57 (July–August 1965): 258.

61. Kenneth J. Deacon, "Combat Engineers 25: Cerro Gordo, 1847," *The Military Engineer* 56 (January–February 1964): 46.

62. Ulysses S. Grant, *Personal Memoirs of U. S. Grant* (New York: Webster, 1885), 132–33, 187.

63. Robinson, "The Engineer Soldiers in the Mexican War," 5–6.

64. Cited in Robinson, 7–8.

65. Skelton, "West Point and Officer Professionalism, 1817–1877," cited in Lance Betros, *West Point, Two Centuries and Beyond* (Abilene, TX: McWhinney Foundation Press, McMurry University, 2004), 22.

66. Adrian George Traas, *From the Golden Gate to Mexico City–The U.S. Army Topographical Engineers in the Mexican War, 1846–1848* (Washington, DC: US Army Corps of Engineers Office of History and US Army Center of Military History, 1993), 4–9, 63–201; Person, "Topogs," 7; and Robinson, "The Corps of Topographical Engineers," 305–6.

67. Cited in Traas, 320.

68. Robinson, "The Engineer Soldiers in the Mexican War," 8.

Chapter 3
The Civil War: The US Military Academy and the Engineers Respond to Challenges, 1848–66

The US Army's engineers emerged from the Mexican War with invaluable operational experience. The graduates of the US Military Academy who had served in that conflict gained notoriety in the American public's eyes. Veteran officers continued to rise through the ranks, some as far as the lofty heights of the superintendent, as in the case of Robert E. Lee. Meanwhile, West Point entered a period of reform during which some officers returning to the faculty or administration initiated what they believed to be important changes in the curriculum until tensions erupted into the Civil War in 1861.

The US Military Academy and Engineer Education between Wars, 1848–60

At the end of the Mexican War in 1848, the Corps of Engineers resumed its peacetime roles of constructing public works and coastal fortifications. The US Military Academy continued to educate cadets for Army careers. While some West Point graduates left the Army altogether, other veterans like Capt. George McClellan joined the faculty at the academy and brought their wartime lessons to the classroom. Many other officers in the US Army's Corps of Topographical Engineers moved westward across the continent, just as the American frontier advanced westward from the Appalachian Mountains, to the Mississippi River Valley, then on to the Rocky Mountains and finally ending on the west coast. This area encompassed more than two-thirds of the continental United States. During these expeditions, some forty topographical engineer officers ("topogs") mapped the terrain, collected geological data, identified natural resources, and surveyed several possible routes for roads and later railroads. The possible routes ran a thousand miles or more over rugged terrain. Completed later in 1869, the first transcontinental railroad line followed one of the above-mentioned routes, stretching from Omaha, Nebraska to Sacramento, California. By 1900, three other routes also became railroad lines. The resulting maps also helped settlers move west and sped up the nation's growing infrastructure. Arguably the greatest cartographical feat was made by topographical engineer and 2nd Lt. Gouverneur K. Warren. During the 1850s, he spent countless hours compiling and drafting the first comprehensive map of the American western states and territories. It proved to be remarkably accurate, remaining the seminal map for many years.

Many other examples of topog activities during these years should be noted. John C. Frémont led exploration parties along the Oregon Trail over the Rockies during the 1840s. Capt. Howard Stansbury and Lt. John W. Gunnison explored the valley of the Great Salt Lake in Utah in 1849–50. Capt. John Pope explored the region between Fort Snelling in the Minneapolis Territory and the Red River of the North in 1849. Then the next year he reconnoitered the Santa Fe Trail running from St. Louis into New Mexico, which recently became an American territory after the Mexican War. During the 1850s, Capt. George Meade and Maj. James Graham completed a decades-long geodetic survey of the Great Lakes.[1]

Meanwhile, the territorial gains from the American victory sparked a chain of events that would slowly plunge the nation into the Civil War a little more than a decade later. In the fall of 1849, the Military Academy's incoming Fourth Class (first year cadets) numbered more than fifty new cadets, out of the total student population of 218. They embarked upon a program of study that had changed very little in the fifteen years since Sylvanus Thayer resigned his post as superintendent in 1833. The so-called Thayer System remained firmly entrenched with its emphasis on sciences, engineering, and mathematics, not least thanks to the efforts of West Point's Academic Board. In what amounted to an executive council, the board's membership included long-time civilian faculty members like Dennis Hart Mahan as professor of Civil and Military Engineering, William H. C. Bartlett as professor of Natural and Experimental Philosophy (physics), Albert E. Church as professor of Mathematics, and Jacob W. Bailey as professor of Chemistry. Of the four, Mahan's influence would be the most profound; his course on Military and Civil Engineering and Science of War, taught in the First Class (fourth year cadets), continued to be the capstone of the academy's entire program.[2]

Looking back more than 150 years, historian William Skelton described the conservative nature of the curriculum and noted that when they were challenged to include more liberal arts or tactics courses:

> West Point authorities remained committed to the technical curriculum, however, and they countered their critics by stressing the need of both the Army and the nation at large for trained engineers. They also developed the arguments that mathematics and engineering honed the reasoning powers of cadets, resulting in tough-minded, mentally disciplined officers capable of cutting through ambiguity and making coldly logical decisions under pressure. Thus West Point benefitted all of its graduates, regardless of their future branch of service.[3]

The term "West Point authorities" refers to Mahan and the members of the Academic Board. Skelton next acknowledges that the Military Academy prepared cadets going into the scientific branches, such as the engineers, topographical engineers, and ordnance. He nevertheless offers the criticism that, "In terms of content . . . the formal course work at West Point probably proved of little direct value to the great majority of line officers" in the combat arms who saw action in the early Mexican War or later in the Civil War.[4] In fact, the liberal arts and tactics courses on infantry, artillery, and cavalry were downgraded to less than one-third of the entire four-year program by 1850. Practical Military Engineering courses did not appear in the curriculum at all, despite having at least one engineer officer on faculty, such as Captains George McClellan and George Cullum, every year since 1844.[5]

As the Military Academy moved into the 1850s, it underwent two reforms expected to increase the coursework on applied engineering, liberal arts, and tactics. The first reform added a Practical Military Engineering course to the curriculum in 1851. This new course, strongly supported by Chief Engineer Col. Joseph Totten, was partially based on lessons from the Mexican War. The second reform, implemented in 1854, incorporated additional liberal arts and tactics courses into the curriculum through the introduction of an expanded five-year program of study. Both changes lasted only until the beginning of the Civil War in 1861.

Throughout the 1840s, the Department of Practical Engineering existed on paper, but did not include any courses. Then, in the 1851–52 academic year, Capt. George Cullum introduced the new Practical Military Engineering course to the cadets. He embraced a real-world approach to training, rather than the more theoretical focus of Dennis Hart Mahan. In the first years of this course being offered, cadets observed the Army's sole engineer company, which was still stationed at West Point, going through various drills in building bridges, digging trenches, and repairing roads. Then the cadets conducted their own exercises in these everyday engineering tasks.[6] The Practical Military Engineering course remained a fixture of the First Year curriculum until 1862. It included practical instruction in "fabricating" the following content:

- Fascines (bundles of sticks used in earthworks).
- Sap fagots (wood to fill crevices between gabions).
- Gabions (the nineteenth century's version of the HESCO Barrier).
- Hurdles (obstacles to impede enemy tactical maneuver).

• Sap rollers (movable gabions to protect soldiers digging trenches).

• Laying out and constructing gun and mortar batteries, field fortifications, and works of siege.

• Forming of stockades, abatis, and other military obstacles.

• Throwing and dismantling pontoon bridges.[7]

In twenty-first century terms, the content comprised the engineer combat functions of countermobility, survivability, and mobility. Indeed, Practical Military Engineering looked a lot like components of the 2016 Engineer Basic Officer Leadership Course. There may have been different vocabularies, but the content and approach were directed toward the same goals.

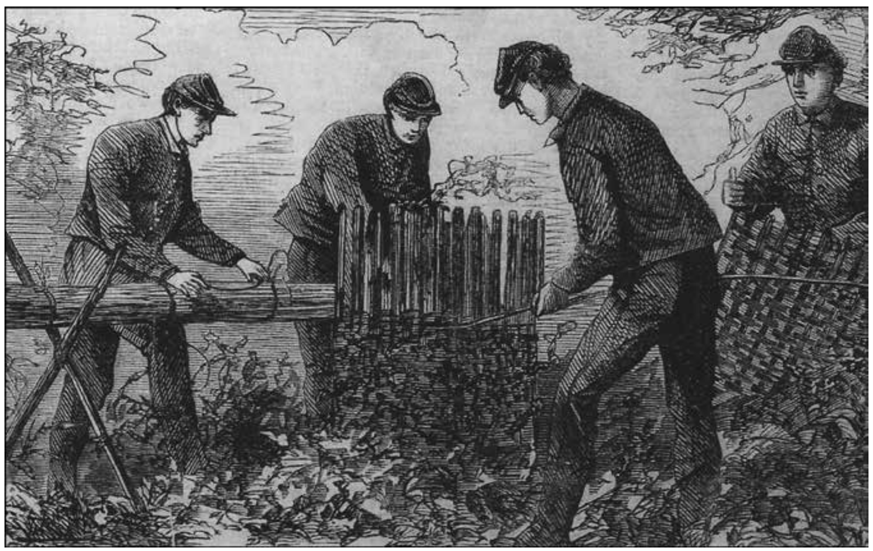


Figure 3.1. Cadets building gabions as part of their Practical Military Engineering coursework. Courtesy of US Army Corps of Engineers Office of History Archives.

The second reform occurred in 1854 when the Military Academy shifted from a four-year to a five-year program. The Academic Board bowed to criticisms from Boards of Visitors, Chief Engineer Joseph Totten, and Superintendent Robert E. Lee about its perceived deficiencies in liberal arts and tactics coursework. In short, they wanted more time allotted for these subjects. Such an expansion had been suggested back in 1846 but gained no traction because the Mexican War drew so many cadets and officers away from West Point. Yet by 1854, several internal and external factors were motivating the academy to change. First of all, adding more time for liberal arts would help expand the number of cadets who could attend the academy. Until that year, the entrance examinations had stressed liberal

arts, yet many prospective cadets failed these sections. Thus, the expanded liberal arts coursework would give otherwise academically qualified cadets the opportunity to learn this material at West Point, rather than being prohibited outright from attending. The impetus for increasing coursework on tactics came in part from the combat lessons of the Mexican War.[8]

In 1854, adding these extras into the already crowded four-year program at the academy was impossible, so the Academic Board recommended expanding it to a five-year program. Mahan and his fellow board members assumed that this recommendation would not be supported by Secretary of War Jefferson Davis, so they offered this as a default option. They believed this would block other changes. Their assumption, however, proved to be incorrect because Totten concurred with the recommendation, which in turn garnered more support from Davis. In the face of this mandate by Davis, the Academic Board grudgingly agreed to the new five-year program. Totten added the stipulation that the 25 percent increase in classroom contact hours could not include any additional technical coursework. In effect, this addendum represented a compromise as the new curriculum added professional military engineering, liberal arts, and tactics components, while still maintaining its overall focus on science, mathematics, and engineering.[9]

Under the new five-year program, cadets studied history, moral science, law, and Spanish, thus rounding out the academy's liberal arts program. Meanwhile, cavalry, artillery, and infantry tactics also received much more time within the now five-year regimen, as opposed to the 1840s when only First Year cadets formally studied these topics. Cadets started with individual tactics and later studied maneuver warfare at the platoon, company, battalion, and then brigade level. They also participated in field-training exercises where, among many other tasks, they deployed as skirmishers and engaged in counter-battery fire. Together, the liberal arts and tactics courses provided the foundation for the fifth and final year of study wherein First Class cadets learned about the science of war from Dennis Hart Mahan. This course examined topics like the composition of armies, strategy, grand tactics, campaigns, and *petite guerre* (small wars).[10]

By the late 1850s, Mahan had slightly expanded the number of lessons he taught in the new program, using some extra classroom time to present lectures on the science of war to his cadets. This appeared to be a departure from the time-honored recitation concept institutionalized by Sylvanus Thayer decades earlier. In an interesting twist, however, Mahan justified his lectures by conceding that there might be weakness in relying too much on cadet recitation, versus blending lectures with recitations. In an 1854 letter to the superintendent and his former student, Col. Robert E. Lee, Mahan wrote:

> This plan is one which I have long thought a *desideratum* [something that is needed] at the academy where so much is taught by textbook and blackboard recitations, by which men lose to a degree that habit of attention to oral instruction which is no small accomplishment in the practical pursuits of life, and I would long since have carried into practice in my own department, could I have any available opening for it in the crowded course of studies.[11]

Mahan pointed to the skill sets of listening to and absorbing material as means to enrich cadet learning during course recitations. It is also plausible that the cadets needed the context provided by Mahan's lectures, so that they could be more effective in their subsequent recitations.

Despite changes in and challenges to the Military Academy's curriculum, the rigor of its studies, a hallmark of the "Thayer System," remained largely intact throughout the 1850s. Some 25 percent of cadets entering the academy's four-year program between 1833 and 1854 received discharges because they failed one or more of their courses. Other cadets resigned due to the intense academic pressure. Once implemented, the five-year program did not help retention as had been intended: more than half of the cadets failed courses or received dismissals between 1854 and 1861. It should come as no surprise, for example, that the rigorous mathematics courses continued to cause the most failures or dismissals during this time.[12]

In 1855, Robert E. Lee transferred to the Cavalry branch in search of a promotion that could only come if he left the Corps of Engineers and stepped down as superintendent of the Military Academy. Then, after Capt. John G. Barnard's brief tenure in 1856, Maj. Richard Delafield returned as superintendent until 1861. Delafield revived the Military Academy's reputation for strict discipline because he believed that Lee and Barnard had been lax in this area. Delafield's experiences observing the Europeans fighting in the Crimean War also made him much more intent on ensuring that cadets were prepared for command positions after graduation. This notwithstanding, Delafield made no significant reforms to the new five-year program.[13]

The Military Academy on the Eve of the Civil War

In the twelve years following the American victory in the Mexican War, sectional differences widened among the cadets hailing from states north and south of the Mason-Dixon Line. They felt the reverberations of civil strife in "Bleeding Kansas" (1854–61), angst over the Supreme Court's Dred Scott v. Sandford decision (1857), and alarm over John Brown's raid on the armory at Harper's Ferry (1858).[14] Occasional verbal clashes erupted between cadets with abolitionist leanings and those with slave-holding sympathies. Two cadets even fought a duel in which Emory Upton of New York squared off against Hampton Gibbes of South Carolina. Neither was killed, but Upton did receive a scar on his face. Superintendent Delafield, along with the Academic Board, did what they could to reduce tensions by encouraging camaraderie among the cadets. Although there were some straw votes for president and some heated rhetoric, these efforts to keep relative peace succeeded for the most part, with no major incidents occurring at West Point in late 1860 or early 1861. The increasing divisions along regional lines blurred the cadets' loyalties to nation, state, family, and fellow. The United States as a whole seemed doomed to a slide toward seemingly inevitable upheaval.[15]

In the final year of pre-war peace in 1860, the Military Academy curriculum looked the same as it had in 1854. The first class in the five-year program had just graduated in 1859, and the second was working its way through its final year of study. The blending of practical engineering, liberal arts, and tactics into the existing technical curriculum seemed to be working well.

The election of Abraham Lincoln as president in November 1860 soured the already poor relations between the citizens of slave and free states. Lincoln and the Republican-controlled Congress would never allow slavery to expand beyond the borders of the fifteen existing slave states. Adding more free states, however, made it only a matter of time before the Republicans pushed legislation ending slavery altogether. The government of South Carolina reacted to the election by seceding from the United States in December 1860. The states of the Deep South—Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas—followed suit by February 1861. Tensions rose between the new Confederate States of America (Confederacy) and the United States (Union) until 12 April 1861, when Confederate cannons bombarded the Union-held Fort Sumter in Charleston harbor in South Carolina. Thereafter, both sides began to call up volunteers and mobilize armies. After refusing to support the Union effort, the states of Virginia, Tennessee, Arkansas, and North Carolina seceded by May and sided with the Confederacy.[16]

By June of 1861, the lines were drawn between the Confederacy and the Union. Just as thousands of soldiers flocked to their respective flags, so too did the officers in the regular US Army and the cadets and faculty members of the Military Academy. The First and Second Classes graduated in May and June 1861, respectively, so as to hasten the commissioning process and the cadets' transitions into active duty in the Army. A year's coursework for Second Class was condensed into a few weeks to make their early graduation possible. The academy would never again have a five-year program.

Within the First Class, only five cadets left the academy before graduation. Despite being fast-tracked for graduation, however, the Second Class slipped from fifty-seven cadets in June 1860 to only thirty-five cadets in May 1861; of this attrition, fourteen hailed from recently seceded states. The decision to leave West Point and not serve in the US Army often involved great soul-searching among the cadets. Not only would Southern cadets have to leave the Union, but they would also sever the bonds of camaraderie they had formed at West Point.[17]

Meanwhile, the conflict forced the faculty to choose sides as well. The academy's official register listed twenty-eight uniformed instructors in June 1861. Of these, one third—nine officers—were relieved or reassigned in the weeks leading up to the graduations in May and June. The newly appointed superintendent, Capt. P. G. T. Beauregard of Louisiana, found himself among this group. He stayed in this post less than a week (January 1861) before being forced to resign when his home of Louisiana seceded. Beauregard thus joined another former superintendent, Robert E. Lee, in choosing loyalty to his home state over his oath of loyalty to the United States.[18]

During the first academic year of the Civil War, 1861–62, the Military Academy experienced great turnover in uniformed faculty. Only three of the twenty officers on faculty in June 1861 continued their teaching duties through June 1862. The vacant faculty positions were filled by eleven officers and ten high-scoring cadets listed as "acting assistant professors." Never before had so many cadets served in faculty positions. Further, the academy was ramping up its enrollment numbers in order to support the mobilizing Union Army, and the inexperienced faculty had their hands full with the large incoming Fourth Year class of eighty-eight cadets. Fortunately for institutional stability, Dennis Hart Mahan and six other civilian faculty serving as professors in various departments did not leave their posts. Their presence provided a critical level of continuity to the wartime institution.[19]

Wartime Curriculum and Wartime Demands

In addition to the near complete turnover of uniformed faculty by June 1862, the curriculum also began evolving to fit wartime circumstances. The principal changes occurred in shrinking the five-year program back to four years. The coursework in mathematics, chemistry, drawing, French, law and literature, mineralogy and geology, natural and experimental philosophy, and military and civil engineering remained in the curriculum for the 1861–62 academic year; some contact hours, however, shifted from one year's study to another, or were split between two years. The courses in branch tactics, practical military engineering, small arms, and gunnery and ordnance likewise survived the initial cuts.

Other material and courses were dropped from the curriculum by the end of the 1862 academic year. Two examples stand out in the course synopsis: the Spanish language course was deleted, and the history textbook was removed from the reading list for the English Studies and Literature course. These time-saving cuts helped trim purportedly non-essential courses and course materials from the pre-war five-year program to make room for the new wartime, four-year program.

In the engineering curriculum, the 1860 version of Dennis Hart Mahan's Military Engineering and the Science of War changed its name to Military and Civil Engineering in 1862. The revised course replaced Jomini's *Art of War* and "Extracts from McClellan's Military Commission to Europe" with Mahan's own textbook, *[Elementary] Course on Civil Engineering* and Moseley's *Mechanics of Engineering*. These changes in readings moved Mahan's First Year course in a more engineer-centric direction, thus giving cadets more technical and theoretical knowledge and skill, even at the expense of operational knowledge and skill. The graduates, it was believed, could learn about operations in the field with the Union Army.[20]

Perhaps the biggest change in the engineering components in the academy's curriculum occurred during the 1862–63 academic year. Most conspicuously, the Practical Military Engineering course was deleted from the First Year coursework. At face value, this decision deprived cadets of the basic knowledge and skills required in combat engineering functions—ironically, as the Civil War was moving into a phase when fortifications and siege warfare would become more prominent. The faculty reasoned, once again, that the graduated cadets could learn these functions in the field through on-the-job training. Therefore, Academy time could be better spent on other, more theory-based subjects like mathematics.[21]

The curriculum for the 1863–64 academic year remained almost identical to the previous year. The only changes relevant to engineering education occurred in the Drawing course in the Second and Third Classes. For many years, this course taught cadets to draw the human figure and topography. The first component was deleted from the content, however, leaving only Topography, which was listed specifically for the Third Class. In the next year of study, Topography and Pencils and Colors augmented the longstanding landscape component of the Second Class.[22] These changes likely resulted from the Union Army's need for more and better skills in mapmaking and map-reading for officers in combat units.

As the war went on, wounded officers returned to teach at the Military Academy. One such faculty member was Tully McCrea of the class of 1862. After receiving his commission in the field artillery, he served with the Army of the Potomac until 1863 and saw action at the bloody Battles of Antietam, Fredericksburg, Chancellorsville, and Gettysburg, where he witnessed such historic actions as the artillery barrage during Pickett's Charge. He then transferred to the Union's Department of the South, but was wounded in the legs at the Battle of Olustee in Florida in 1864. McCrea was brevetted three times for gallantry, reaching the temporary rank of major.

After several weeks of recovery, McCrea was assigned back to West Point in mid-1864. He taught Geography, History, and Ethics during that first year and then transferred to the Department of Mathematics for the following academic year. Aside from remaining in the Army, McCrea could pass along lessons and insights to the cadets based on his two years at the front. He thus personified a feedback loop between combat units and the schoolhouse.[23]

Changes in the Engineering Force Structure and the Corps of Engineers

When the Civil War began in April 1861, the Union Army contained only one understrength engineer unit—Company A—based at West Point, New York. It was the same unit that had enjoyed such successful service in the Mexican War in 1848. The lessons from the Mexican and Crimean Wars had revealed a need for many more engineer units in the Army to keep pace with the massive mobilization of hundreds of thousands of soldiers. In August 1861, Congress took its only step in this era to expand the present engineer force, passing an act that added three more engineer companies to the Union Army's Corps of Engineers. Each company would contain 150 soldiers, commanded by trained engineer officers, and considered equal to other branches in pay and privileges. It took months to recruit enough men to raise these units to full strength. During this process, the companies were stationed in Washington, DC. It was not until 1863 that they finally reached a full complement of 600 soldiers, and that only because of new special regulations that allowed individuals to transfer from volunteer units into the engineer companies.[24]

During the intervening months between activation in 1861 and achieving full strength in 1863, Capt. James Duane commanded the companies that formed the Engineer Battalion, also called the Battalion of Regular Engineers. Duane, together with his officers and veteran noncommissioned officers worked to prepare the soldiers new to this unit for engineer-specific tasks. One such veteran "old hand" noncommissioned officer was the first sergeant of Company A, Frederick W. Gerber. Gerber enjoyed a remarkable career that spanned more than three decades which would prepare him to mold the new volunteer recruits into effective engineer soldiers during the early years of the Civil War. Born in Dresden, Germany, he immigrated to the United States in the 1830s and joined the US Army as an infantryman in 1839 but returned to civilian life in 1844. With the 1846 authorization to form Company A, Battalion of Engineers during the Mexican War, Gerber reenlisted in the army and stayed in the Corps of Engineers for the rest of his life. During the Mexican War, Gerber won numerous accolades and is credited with saving the life of then-Lt. George B. McClellan, a battalion officer who would later become general-in-chief of the Union Army.[25] Gerber's recruits of 1861 looked up to him with a reverential feeling because this "old soldier" had seen combat in Mexico. Gerber possessed expert knowledge of all areas of military life by acting as quartermaster, drill master, butcher, blacksmith, or boatman, as needed. His versatility, leadership, and expertise stand as hallmarks of every effective noncommissioned officer. Gerber had been offered a commission several times throughout his career but declined each offer. Gerber "considered that to be the ranking noncommissioned officer in the Army was a greater honor than to hold a commission."[26] In June 1864, Gerber became the first sergeant major in the battalion of engineers and on 21 February 1867, Gerber was named the permanent sergeant major, making him the corps' top enlisted man and battalion adjutant. Congress recognized his service in 1871 with a Medal of Honor, citing him for "distinguished gallantry in many actions and in recognition of long, faithful, and meritorious services covering a period of thirty-two years;" Gerber was the first engineer to receive the Medal of Honor.[27]

Writing decades later, one engineer soldier recalled, "To Captain Duane may be given the credit of the opportune development of what afterwards became known as the American military bridge equipage, which, with some slight modifications, proved to be the best ever used."[28] Duane was a logical choice: an 1848 graduate of the Military Academy, third ranked graduate in his class, and a commissioned officer in the Corps of Engineers. After spending time on duty in the field, he returned in 1852 to serve in Company A and to teach Practical Military Engineering at West Point. Duane also published his *Manual for Engineer Troops* in 1861. Reprinted during the Civil War, this book outlined all current engineering functions and gave guidance on running a "school of the sap" to train engineer soldiers in the field. After the end of the Civil War, Duane was the commander of Willets Point, New York, from 1866 to 1868 and later served as the Army's chief engineer from 1886 to his retirement in 1888. Duane epitomized the competent engineer officer-scholar-instructor-veteran.[29]

During 1861 and into early 1862, the Engineer companies helped construct Union fortifications around Washington, DC. The First Battle of Bull Run occurred only a few miles from the capital, and northern Virginia constituted a major area of operations for Union and Confederate forces. By early 1863, the four companies fell under the official designation, "Battalion of Sappers, Miners, and Pontoniers." Although incredibly active in most battles and campaigns throughout the eastern theater of operations, the Engineer Battalion never expanded beyond four companies and some 600 men.[30]

The major source for mobilizing engineer units came from volunteers. Like so many of the combat arms regiments, officers recruited individuals from local communities to serve voluntarily in the engineer regiments. This process drew on the citizen-soldier and militia tradition in American military history. Each regiment contained approximately 1,000 men and often fewer, depending on casualties or diseases. Eventually, some 25,000 soldiers served in the 1st Regiment Michigan Volunteer Engineers and Mechanics, the 1st Regiment Missouri Volunteer Engineers, Bissell's Engineer Regiment of the West, and the 1st, 2nd, 15th, and 50th New York Volunteer Engineer regiments. Of these units, the 15th and 50th New Yorkers were mustered into the Army as infantry units in 1861 and subsequently designated as engineer regiments by year's end. These two later merged into the Volunteer Engineer Brigade in the Army of the Potomac in 1862. The regiments were assets at echelons above division, as opposed to being assigned as organic units in brigades or divisions. In addition to the larger

units, several independent engineer companies from Kentucky and Missouri joined the Union Army. All received training by their officers in such tasks as building pontoon bridges and constructing field fortifications.[31]

Taken as a whole, the Union's volunteer regiments and companies shared several characteristics. They tended to be led by officers who, although not Military Academy graduates and often not veterans, boasted expertise in technical fields and relevant experience that qualified them as "professionals." The Army made concerted efforts to attract enlisted men with backgrounds in relevant occupations.[32]

The 1st Regiment Michigan Volunteer Engineers and Mechanics provides an example of what a typical unit looked like. On 13 September 1861, the secretary of war and Michigan's governor authorized the raising of a regiment with William Innes as its commander at the rank of colonel. Innes boasted strong credentials, having spent twenty years working his way up from construction laborer to civil engineer, and finally to project manager for railroad companies. His background provided him with an understanding of complex operations of building and maintenance.[33] Innes started this process by choosing his four company commanders, none of whom were academy graduates. Yet, as historian Mark Hoffman observed in his book on the regiment:

> What the Michigan Engineers' officers lacked in military experience, however, they made up for in engineering and mechanical experience. In fact, the prewar experience of most of the officers made this regiment better prepared for its contemplated war assignment than most infantry or cavalry regiments being raised on either side.[34]

Colonel Innes and his officers next started recruiting individuals to serve in the regiment, specifically looking for those with skills in or knowledge of the railroad or construction fields. After their soldiers adapted to Army discipline, structure, and operations, Innes and his competent officers led them in executing the missions assigned to them.[35]

Unlike the Union Army, shortages of competent engineer officers and viable units plagued the Confederate Army throughout the conflict. The agricultural economy in the Southern states made matters worse because no civilian pool of technical engineering experts existed. Ultimately, this hurt the Confederacy's capability to maneuver through rough terrain or traverse rivers, not only because of manpower limitations, but also due to shortages of such equipment as pontoons for bridges. Early in the conflict, routine functions like bridge building or road repair were often handled in ad hoc ways and not always under an engineer officer's supervision. In 1863, the Confederate Army made an important change by assigning an engineer company to every division. These 100-man units were formed from existing ranks based on individual soldiers' construction or mining backgrounds. By 1865, there were some 4,000 soldiers serving in these companies. Indeed, the Confederate Army harnessed sufficient expertise to design and construct formidable field fortifications, most notably at Vicksburg, Mississippi, and Petersburg, Virginia.[36]

For the most part, the Confederacy needed to rely much more on self-taught or amateur engineer officers and soldiers than did the Union. Perhaps the best example was Jedediah Hotchkiss. A native New Yorker, Hotchkiss visited Virginia as a young man and settled in the Shenandoah Valley in western Virginia in the 1850s. After teaching for several years, Hotchkiss established his own secondary school. Meanwhile, he studied engineering and science on his own time; and while on walking tours, he developed into an accomplished topographer. When Virginia seceded in 1861, Hotchkiss joined the Confederate Army, where his skills in reconnaissance and accurate mapmaking garnered the attention of Maj. Gen. Thomas J. "Stonewall" Jackson.[37] In March 1862, the general famously told Hotchkiss: "I want you to make me a map of the Valley, from Harper's Ferry to Lexington, showing all the points of offense and defense in those places."[38] Jackson made Hotchkiss his chief topographical engineer, a role in which Hotchkiss provided his general with advice on leveraging terrain during combat operations. After Jackson's unexpected death in May 1863, Hotchkiss continued to make maps used by Generals Richard Ewell, Jubal Early, and Robert E. Lee throughout the remainder of the Civil War.

The Civil War: Engineering Operations and Insights

Following the start of the Civil War in April 1861, military and civilian leaders on both sides were supremely confident of a quick victory. The bloody Battle of Bull Run in July replaced those naive assumptions with the grim realities of modern warfare. Between the summers of 1861 and 1863, the Confederate forces won almost every major battle in the Eastern Theater, which was comprised of Virginia, western Maryland, and south-central Pennsylvania. Superior operational commanders like West Point graduates Generals Robert E. Lee and Thomas J. "Stonewall" Jackson outmaneuvered and defeated the often-superior Union forces. Their success lasted until their decisive defeat at Gettysburg in July 1863.

Meanwhile in the Western and Trans-Mississippi theaters, the Union forces scored several hard-fought victories culminating in the capture of the key city of Vicksburg on the Mississippi River in July 1863. This loss handicapped the Confederate supply system. The Union's building momentum paralleled the rise of two other West Point products, Generals Ulysses S. Grant and William Tecumseh Sherman, both of whom possessed brilliant strategic minds and were tenacious leaders. In March 1864, Grant took command of the entire Union Army and began directing operations in Virginia, where he tried to capture the Confederate capital of Richmond. Lee thwarted Grant in late June 1864. The opposing armies then settled into a ten-month siege at nearby Petersburg, a conflict that included intricate field fortifications and siege operations that foreshadowed the First World War's trench warfare.

In the Western Theater in 1864, Sherman replaced Grant as senior commander and started a grinding campaign to deprive the Confederacy of its moral will and material capability to continue fighting. In September, he captured Atlanta before cutting a swath of destruction to the coastal city of Savannah by year's end. He then advanced into the Carolinas, laying waste to everything in his path. By the next spring, General Robert E. Lee had no more viable options for continued fighting. He surrendered his beleaguered Confederate forces in April 1865.[39]

The Civil War saw engineering functions performed in every theater, campaign, and battle. Of these, the construction, repair, and maintenance of roads and railroads remained such constant activities that they became commonplace. Every maneuver commander required mobility for his combat units and the wagon trains that supplied them. One of the many examples occurred in late April 1862 following the Union victory at the Battle of Shiloh in Tennessee. After a two-week respite, the Union soldiers marched along eighteen miles of narrow dirt roads toward Corinth, Mississippi, where the defeated Confederates had withdrawn after Shiloh.[40] One officer in the 1st Michigan Volunteer Engineer Regiment described his unit's activities:

> We have been constantly in detail for opening roads for the army to advance . . . much of the way through swamps and low lands full of brooks which had to be bridged . . . you will form the idea of the amount of labor to be performed to open these routes through the wilderness.[41]

Thus, it fell to the engineers to enable Union mobility. In addition to such difficult terrain, the engineers contended with ambushes by enemy units, as well as shortages of potable water and diseases like mosquito-borne malaria. The Union commander, Maj. Gen. George Halleck, slowed his advance further because he insisted on fortifying his camps every night. Despite the engineers' best efforts, these factors set a pace of one mile per day. Halleck did eventually lay siege to and capture Corinth by the end of May 1862.[42]

Several additional Civil War battles can be used as case studies to highlight other engineering contributions to operations. All the following examples illustrate one or more of the core functions of mobility, countermobility, survivability, topographical (geospatial) engineering, and general (sustainment) engineering. Each battle in turn demonstrates how engineering efforts can maximize or minimize the successful application of the principles of war.

Just as road work offered mobility and sustainment benefits to maneuver commanders, so did bridges enable similar advantages. Union and, to a lesser degree, Confederate engineers built bridges over hundreds of rivers and streams. They traversed gaps from a few yards wide to, as will be seen during the Petersburg campaign, thousands of feet of water. What was rarer in the Civil War, however, was bridging under fire. The conflict's prime example occurred at the Battle of Fredericksburg.[43]

As 1862 drew to a close, the Union's Maj. Gen. Ambrose Burnside hoped to end the war by crossing the Rappahannock River at Fredericksburg, a town sitting on the river's southern bank in Virginia. Then Burnside's forces could drive sixty miles due south to capture the Confederate capital of Richmond. Speed and mobility were essential to his plan because he hoped to confuse the highly mobile Confederate General Robert E. Lee. Otherwise, once conscious of Burnside's objective, Lee would react quickly to protect Richmond. The Union had to achieve the first objective of moving some 114,000 soldiers across the Rappahannock River, which in turn required the Union's engineer units to construct pontoon bridges. Burnside concentrated this sizable force on the river's northern bank opposite Fredericksburg in mid-November in hopes of making his quick crossing.

The transit of the pontoons to the Rappahannock, however, took much more time than expected because of bureaucratic and logistical problems such as a shortage of nearly 300 horses necessary to pull the wagons laden with bridging equipment. A sufficient number of pontoons did not arrive until the end of November. By then, Lee had discerned Burnside's objective and moved to Fredericksburg to stop him. By month's end, Lee's

72,000 Confederate soldiers had dug stout earthworks on the high ground just west of the town. He also deployed some 1,600 sharpshooters to occupy the town's buildings and cover the river's crossing.

After interminable delays, soldiers of the 50th New York Volunteer Engineer Regiment began on 11 December 1862 to construct six pontoon bridges across the 400-foot-wide Rappahannock. The engineers extended the bridges about 200 feet across this gap while morning fog covered their activities. On some of the bridges, they did not experience serious opposition. A massive Union artillery bombardment of Fredericksburg tried to suppress the sharpshooters there. The commander of the 50th, Col. Wesley Brainerd, recalled in his memoir:

> Men sprang to their work as if their lives depended on their efforts. The time passed rapidly by and I heard the Town bell strike *Two* and my bridge . . . was fast assuming shape. Our squads were so thoroughly drilled and so well did each man understand his duty, that it was scarcely necessary to give words of command.[44]

The professionalism of Brainerd's engineers in this situation was in large part a result of the time he, his officers, and his noncommissioned officers had invested in training the unit so thoroughly that their activities had become second nature.

Nevertheless, when the fog lifted in the early afternoon, the pontoon bridge near the center, opposite of Fredericksburg, came under direct rifle fire from Confederate sharpshooters ensconced in the buildings. Once again, Brainerd explained what it was like to be standing on the pontoon with his men:

> The bullets from the enemy *rained* upon my bridge. They went whizzing and spitting by and around me, pattering the bridge, splashing into the water, and thugging through the boats. Where were my men? They did not require any command to fall back in good order. . . . Some fell into the boats, dead. Some fell into the stream and some onto the bridge, dead. Some, wounded, crawled along on their hands and knees.[45]

In fact, Brainerd was wounded himself. Try as they might, the soldiers of the 50th could not complete the bridge under such withering fire. It was necessary for Union infantrymen to row some pontoons to the far bank, disembark, and silence the Confederate sharpshooters in bitter house-to-house fighting. Once the buildings were cleared of the enemy, the 50th New York Engineers completed the pontoon bridges in short order. In the few days thereafter, Maj. Gen. Ambrose Burnside's massive force used them to cross the Rappahannock and then fight the Battle of Fredericksburg.[46]

Throughout the Civil War, topographical engineering played critical, though rarely conspicuous, roles at all levels of war from tactics to strategy. Accurate maps of terrain features and troop dispositions offered significant benefits to maneuver commanders of any rank, whereas ignorance usually doomed them to defeat. One outstanding example of topographical engineering can be seen in the Battle of Chancellorsville in Virginia, not far from Fredericksburg. On 1–4 May 1863, General Robert E. Lee's 60,000 soldiers squared up against two numerically superior, albeit separated, Union forces commanded by Maj. Gen. Joseph Hooker. Thanks to accurate maps and knowledge of terrain, Lee won his greatest victory there.[47]

As of 1 May, some 73,000 Union soldiers were camped near the village of Chancellorsville and another 40,000 sat several miles to the east in Fredericksburg. Over the next two days, Lee executed a daring plan to divide his own Confederate forces into three contingents. The first two small contingents, 11,000 and 17,000 soldiers, fought holding actions to lock Hooker's two much larger forces in place at Chancellorsville and Fredericksburg, respectively. Lee did not want them combining. Meanwhile over the night of 1 May, Lee sent his best subordinate, Lt. Gen. Thomas J. "Stonewall" Jackson, with the third Confederate contingent of 28,000 soldiers on a night-long twelve-mile march around the western flank of Hooker's larger force near Chancellorsville village. The next day, 2 May, the undetected Jackson launched a surprise attack on Hooker's far right flank. This master stroke caught Hooker unaware, allowing Jackson to roll up the Union flank and give Lee the best chance to defeat Hooker in the subsequent fighting.

Jackson's decisive march at night along country roads would never have been possible without assistance from his chief topographer, Jedediah Hotchkiss. In late April 1863, just days before the battle, Jackson ordered Hotchkiss to draw eight maps of the area of operations. The self-taught mapmaker's accurate terrain reconnaissance and analysis allowed him to present Jackson and Lee with a realistic understanding of the area's geographical features. After tracing grids onto a piece of cloth, Hotchkiss used colored pencils and watercolors to delineate rivers, elevations, roads, and trees. He also tracked troop and artillery positions and movements on his maps. His finished products were reliable, as well as artistic. On 1 May, Hotchkiss also worked with local residents to scout the road ahead of Jackson's march, and distributed his operational maps to Jackson's division commanders.[48] This high degree of situational awareness gave the Confederate general decisive advantages over his enemy.

Compelling examples of mobility, countermobility, and survivability can be observed in the last major operations in Virginia, pitting Ulysses S. Grant against Robert E. Lee. The two generals fought several running battles in the Overland Campaign in May and June 1864. Despite grievous casualties, the Union slowly ground the Confederates down through attrition and exhaustion. Grant hoped to capture Petersburg, Virginia, a fortified commercial and transportation hub that protected Richmond. Lee tried to keep pace and prevent his enemy from reaching his objectives. Their opposing forces raced each other from Fredericksburg, Virginia, south toward Petersburg. Every few days, they clashed in bloody engagements.[49]

For Grant to achieve the element of surprise at Petersburg, he needed greater mobility than Lee—no small feat with the Union force of more than 100,000 men, which was double the size of Lee's Confederate force. The challenge was compounded by the several rivers that lay in the eighty miles between Fredericksburg and Petersburg and whose crossings would slow Union efforts even further. Grant looked to the 15th and 50th New York Volunteer Engineer regiments to provide maneuver support to his forces. In May and June 1864, these units erected thirty-nine bridges totaling more than 8,700 feet in length. This staggering figure does not include the time spent constructing abutments to anchor the bridges to shorelines and corduroy roads to approach them.[50]

Of the bridges erected during the Overland Campaign, the most impressive crossed the James River from Weyanoke Point to Windmill Point. After the bridging equipment arrived on 14 June, senior noncommissioned officers supervised four engineer companies—two on each side—as they built the pontoon bridge out from each bank toward the middle. They applied doctrine from Maj. James Duane's *Manual of Engineer Troops* published in 1862. The engineers spent less than eight hours before the two groups met in the middle of the river. The Union Navy provided steam-powered schooners to brace the structure because the river's current would have otherwise swept the pontoons away downstream.

With the eleven-foot-wide bridge in place, soldiers of the Union's Army of the Potomac started across the James River. Eventually, 45,000 men with 30,000 horses, cannons, wagons, and other materials crossed the newly erected bridge. A herd of 3,000 cattle then crossed the bridge. The entire train totaled fifty miles in length. Consequently, the Union Army did steal the march on Lee's Confederates, arriving at Petersburg days ahead of them.

This pontoon bridge stands as one of the best examples of engineering functions providing combat units with mobility and maneuver support.[51]

Writing in his diary, Engineer Sgt. John H. Westervelt gives this first-hand account of 15–16 June on the pontoon bridge:

> This is the first time that I have seen anything like an army cross a pontoon bridge and I can tell you it is worth seeing. From sunrise until 12M it was one steady stream of tramp, tramp . . . tramp, tramp across the bridge. Went on shore this morning for a tramp myself. Landed on the south side and walked toward Petersburg. . . . I walked three miles and on either side as far as I could see there was nothing but men, horses, and wagons. . . . This is probably the longest bridge that has ever been thrown across a river, and the greatest number of men, horses, cattle, and wagons that ever crossed on.[52]

At 2,170 feet in length and supported by 101 pontoons, the James River bridge was indeed one of the longest bridges built by American engineers during the Civil War.

Figure 3.2. Pontoon bridge across the James River. From the US Sanitary Commission Records, 1861–72, at the New York Public Library.

Grant's strategic surprise worked in June 1864. Lee was nowhere near Petersburg, and only a few thousand Confederate soldiers defended the city. After crossing the James River, the Union forces moved quickly to attack the fortifications. By 18 June, the Union had captured the first line of entrenchments, but then stalled when Lee's 50,000 soldiers arrived and repelled their attack. Grant ordered his men to dig siege trenches paralleling the Confederate field fortifications.[53]

As one Union engineer officer observed, "From the moment the Federal troops appeared before Petersburg, the duties of the Engineer Corps were very exacting. Every man engaged in superintending and assisting in the construction of the technical part of the siege-works."[54] Between mid-June and the end of the July, their labors resulted in the placement of some 1,200 fascines and 10,000 gabions along less than four miles of trenches. That latter figure amounted to one gabion for every two feet of the Union line.[55]

Figure 3.3. Fascine Trench Breastworks in Petersburg, Virginia, circa 1860–65. From the National Archives and Records Administration, 524792.

For their parts, Lee and the Confederates were hardly idle while the Union entrenchments took shape. They strengthened the field fortifications that protected the eastern, southern, and western approaches to Petersburg. When attacked, they repelled the Union before they could exploit their gains. Lee proved to be a crafty defender in a stalemate that lasted from

June 1864 to March 1865. The only fortifications that could compare with Petersburg were those at Vicksburg. However, even they could not stop starvation during a six-week siege followed by the Confederate surrender in July 1863. Looking ahead, those repeated fruitless assaults against impregnable field fortifications on both sides presaged trench warfare in the First World War.

When confronted with any obstacle, an engineer has three possible courses of action in breaching it: go over it, go through it, or go under it. Lee's stout defenses made going over the top of his trenches too costly in Union lives. The trenches themselves were backfilled by too much earth and contained too many gabions, fascines, palisades, and the like to be breached by an artillery bombardment. So for the stalled Union forces, the third course of action was the only viable one. Beginning in late June 1864, some Union soldiers from Pennsylvania coal country began work on a 511-foot mine that extended westward from their own lines. According to Union Maj. Gen. Ambrose Burnside's plan, the tunnel would reach the Confederate lines. Then it would be filled with 8,000 pounds of black powder and detonated. The resulting explosion would collapse a large portion of the Confederate fortifications, leaving a breach that could be assaulted. If enough Union soldiers could break through the gap and expand behind the Confederate line, they might drive on into Petersburg and achieve a war-winning victory. Meanwhile, when the Confederates realized the Union's intentions, they also dug two countermines in hopes of collapsing the Union mine, but to no avail. The Pennsylvanian coal miners-turned-soldiers completed their tunnel by the end of July and filled it with gunpowder.[56]

At 0440 on the moonless morning of 30 July, the exploding gunpowder left a giant crater some 125 feet long, fifty feet wide, and thirty feet deep. It displaced 100,000 cubic yards of "clayish dirt," equal to approximately 100,000 tons. The dirt and debris leaped 200 feet into the air. Not only did this explosion kill 300 Confederate soldiers; it also left hundreds of others dazed from the shock.[57] A newspaper correspondent captured the dramatic scene:

> The earth was rent along the entire course of the excavation, heaving slowly and majestically to the surface, and folding sideways to exhibit a deep and yawning chasm. . . . Clods of earth weighing at least a ton, and cannon, and human forms, and gun-carriages, and small arms were all distinctly seen shooting upward in that fountain of horror.[58]

The undermining operation achieved exactly what had been planned. Thus, in terms of breaching an obstacle and providing mobility to the infantry, this detonation constituted an unqualified engineering success.

Nevertheless, the subsequent assault and expansion stages of the Battle of the Crater failed to meet the plan's objectives. The lead Union elements advanced into the crater, but soon bogged down in the debris and halted in the face of enemy fire. Then Ambrose ordered several thousand reinforcements—including the 43rd US Colored Regiment—into the crater to scale its lips or protect the flanks. Nothing worked for the Union as command, control, and communications broke down very quickly. Union reinforcements pressing ahead became intermingled with their comrades already in the crater's cramped space. Commanding officers could neither maintain unit cohesion nor direct troop movements. Making matters worse, the Confederates reacted quickly with a counterattack and bolstered their units with additional manpower. Their defenses proved to be survivable against the Union assault. With enemy fire coming from three directions, the bloodbath in the crater cost some 3,800 Union casualties in less than eight hours, while the Confederates suffered only 1,500 casualties. In sum, despite its engineering success in breaching the Confederate line, the Union lost the Battle of the Crater due to failure to execute the follow-on combat operation.[59]

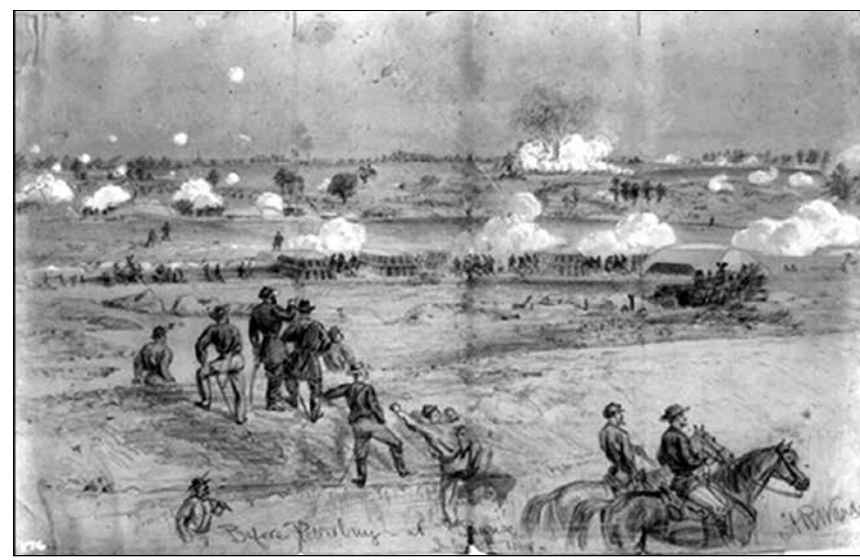


Figure 3.4. Explosion of the mine under the Confederate works at Petersburg which resulted in the Battle of the Crater, Alfred Rudolph Waud, 1829–91. From the Library of Congress, Prints & Photographs Division, LC-USZ62-176.

The siege of Petersburg would last another eight long months. The Union repeatedly attempted to break through the Confederate lines or outflank their defensive positions, but the Union never did repeat the undermining effort. Attrition slowly debilitated the Confederate defenders. At last, by March 1865, General Robert E. Lee's remaining 30,000 men faced starvation, while General Ulysses S. Grant's force had swelled to some 200,000 well-fed, well-equipped soldiers. The following month, Lee made a vain attempt to escape west from Petersburg. Grant gave chase and forced Lee to surrender on 7 April 1865.

The engineering lessons learned during the Civil War remain as relevant 150 years later as they were during the nineteenth century: they underscored the ongoing need to increase the number of units in the regular US Army from a single battalion resourced at the echelon above division; they reinforced the fact that properly trained engineer units possess value at all levels of war and in all principles of war; they highlighted the importance of the engineers' maneuver support roles (sustainment, mobility, and countermobility); they proved that the US Military Academy's education provided many engineers and topographical engineers with the skills to be effective leaders, whether they served in engineering-specific billets or in combat units; they validated that Dennis Hart Mahan's doctrine/instruction on fortifications, together with the Practical Military Engineering courses, prepared engineer officers to design and direct the construction of survivable field fortifications; and they coordinated engineering functions of mobility and countermobility within combat operations (present-day term is combat arms operations).

West Point, 1864–66: The End of the Civil War and of an Era

As the Civil War dragged on into the fall of 1864, then-Brevet Brig. Gen. George Washington Cullum returned to the Military Academy to be the new superintendent. During the first three years of the conflict, he had served as chief engineer in the Department of Missouri and then the Department of the Mississippi, both commanded by Maj. Gen. George Halleck. In the later role, Cullum provided expert engineering advice to Halleck during the siege of Corinth, Mississippi, in the spring of 1862. Later that year, he accompanied Halleck to Washington, DC, where Halleck replaced George McClellan as the general-in-chief of the Union Army. This billet provided Cullum with first-hand experience as an engineer in field operations and as a member of staff.

During his time under Halleck, Cullum was not idle in his own professional development. In 1863, he published a book titled *Systems of Military Bridges in Use by the United States*. The extended subtitle gives more detail about the book's content: *Those Adopted by the Great European Power and such as are Employed in British India with Directions for Preservation, Devastation, and Re-Establishment of Bridges*. Cullum continued to serve as chief engineer under Halleck until September 1864 when he returned to West Point and assumed the post of superintendent.

From 1864 through 1866, Cullum reinserted Practical Military Engineering into the First Year coursework. He argued that without combat operations to serve as teaching opportunities, the cadets needed these everyday skill sets. This in turn indicated that skills in mobility, countermobility, and survivability were essential to successful military operations. The course survived in the curriculum until 1867, one year after Cullum's departure and the end of the Corps of Engineers' direct connection with West Point. Aside from the Practical Military Engineering course, Cullum did not initiate any major curricular changes.[60] The graduation of wartime cadets and the matriculation of incoming cadets during the post-war era absorbed most of his tenure as superintendent.

The end of the Civil War in April 1865, which also marked the middle of Cullum's two-year superintendency, ushered in a massive demobilization of the Union (US) military. The total for the US Army quickly shrank from two million soldiers during wartime to 57,000 in 1867; by the late 1870s, this number had decreased even further to 25,000 soldiers. These post-war soldiers served in what historians have dubbed the "The Frontier Army," in which they spent most of their careers garrisoning forts or fighting Native American tribes in the American West.

With an act of Congress in the fall of 1866, the supervision of the US Military Academy passed to the War Department. New provisions allowed for officers from any branch to serve as superintendent, thus ending the Corps of Engineers' monopoly on control of the Army's Engineer School. The Academy's Board of Visitors pushed this new policy as early as 1865, asserting:

> The institution having ceased to be only, or mainly, a school for engineers, as at first established, and having been the one great national military and polytechnic institute of our country, the reason for such exclusiveness no longer exists, and it is recommended that the appointment [of superintendents] be free hereafter to every arm of the service.[61]

In the interim, the Army's senior generals, William T. Sherman, George Meade, and George Thomas, concurred with the Board of Visitors on removing the requirement for an engineer officer to be superintendent. They believed this would broaden the pool of potential officers to serve in that role. These allies exerted overwhelming pressure on the academy.[62]

Not everyone supported the separation of the academy from the Corps of Engineers. The venerable Sylvanus Thayer opposed this move because he believed the technical focus should remain the academy's primary focus. The elderly Dennis Hart Mahan joined Thayer in resisting the change, but their arguments were largely ignored as the changing tide of the post-war era swept their pre-war ideals aside.[63]

Several historians lament the decision to make the Military Academy independent of the Corps of Engineers. Writing in 1966, historian Stephen Ambrose states in no uncertain terms that "almost immediately after the war [the Military Academy] lost its scientific and engineering pre-eminence, both because of the rise of specialized civilian institutions and because of the increase of technical knowledge that was not reflected in the curriculum of the academy."[64] During this period, Congress passed the two Morrill Acts of 1862 and of 1890 that established dozens of land grants to agricultural and mechanical colleges across the United States. New opportunities arose for students to study science, mathematics, and engineering at schools not associated with the academy, such as Kansas State University, Texas A&M University, Auburn University, Michigan State University, and Virginia Polytechnic and State University. Several of these schools later attained world-class reputations in technical fields. Thus, no longer could the academy claim to be the best, let alone the only, engineering school in the United States.[65] Ambrose lamented that the post-war "cadets spent less time on chemistry and engineering than did the students in the specialized civilian schools, which became superior to it. Academy cadets had proved their excellence on the battlefield" and, consequently, "the academy was able to disregard the mood of the age . . . because no one very much cared."[66]

In his book commemorating the 200th anniversary of the founding of the Military Academy, Theodore Crackel describes the negative effects of the first non-engineer branch officer to take the Military Academy's reins in 1866. The new superintendent was Thomas Gamble Pitcher, a mediocre 1845 graduate of West Point, who had failed to distinguish himself in the subsequent two decades of his Army career. Crackel does not mince words in passing judgment on Pitcher's term as superintendent, calling him "ineffectual" and a failure in "administrative control." Not only was the engineer-centric curriculum lost, but the hazing among cadets during the Civil War steadily increased under his inadequate leadership.[67]

Like Ambrose, Theodore Crackel contends that the academy coasted on its reputation from wartime exploits for several decades.[68] Writing elsewhere, historian William Skelton picks up on the same idea, observing that the post-Civil War cadets lost some of the professionalism exhibited by earlier generations.[69] For his part, Stephen Ambrose used the title "Stagnation" for his chapter on the academy's late nineteenth century period.[70]

Conclusion

The US Military Academy proved its worth in educating more than fifty of the general officers who served on both sides in the Civil War. The engineering curriculum likewise paid great dividends in producing Army officers who grasped the value of the five engineering functions, regardless of branch or rank. Nevertheless, the Military Academy did not survive the post-war era without significant changes. Congress, together with some very senior Union generals, decided to strip control of West Point away from the Corps of Engineers. This departure from the corps did not help the academy grow or evolve for many years. Indeed, it rested on the glory and success of the Civil War for too long. Meanwhile, the Corps of Engineers looked to Willets Point, New York, where the Engineer School could be preserved and eventually rejuvenated.

Notes

1. Gustav Person, "Past in Review: Topogs: Topographical Engineers in Peace and War," *Engineer–The Magazine for Army Engineers* 38 (July–December 2008): 70–71; Frank N. Schubert, *Nation Builders–A Sesquicentennial History of the Corps of Topographical Engineers 1838–1863* (Fort Belvoir, VA: US Army Corps of Engineers Office of History, 1988), 28–63; and US Army Corps of Engineers Office of History, "Historical Vignette 119," https://www.usace.army.mil/About/History/Historical-Vignettes/Parks-and-Monuments/119-Warrens-Map/.

2. R. Ernest Dupuy, *Men of West Point–The First 150 Years of the United States Military Academy* (New York: William Sloane Associates, 1951), 15–20; Russell F. Weigley, *The History of the United States Army* (New York: McMillan, 1967), 146–47; James L. Morrison Jr., *The Best School–West Point, 1833–1866* (Kent, OH: The Kent State University Press, 1986), 25–26, 93–94; Theodore J. Crackel, *West Point: A Bicentennial History* (Lawrence, KS, University Press of Kansas, 2002), 124–27; William B. Skelton, "West Point and Officer Professionalism," in *West Point: Two Centuries and Beyond*, ed. Col. Lance Betros (Abilene, TX: McWhiney Foundation Press, 2004), 26–27; and Brian McAllister Linn, *The Echo of Battle: The Army's Way of War* (Cambridge, MA: Harvard University Press, 2007), 19–20.

3. Skelton, "West Point and Officer Professionalism," 27.

4. Skelton, 28.

5. Morrison, *The Best School*, 115–16; and Crackel, *West Point*, 126–29.

6. Earl J. Hess, *Field Armies and Fortifications in the Civil War: The Eastern Campaigns, 1861–1864* (Chapel Hill, NC: University of North Carolina Press, 2005), 1–2; Morrison, *The Best School*, 97–98; Skelton, "West Point and Officer Professionalism," 26–27; and Weigley, *The History of the United States Army*, 150–51.

7. "Cpt. George Washington Cullum Letter to Lt. J. C. Ives, 18 August 1860," George Washington Cullum Papers, US Army Engineer School History Office. See also David C. Chuber, "Field Fortifications during the American Civil War: A Tactical Problem" (MMAS thesis, US Army Command and General Staff College, Fort Leavenworth, KS, 1996), 41–43.

8. Morrison, "*The Best School*," 115–20; Stephen E. Ambrose, *Duty, Honor, Country* (Baltimore: Johns Hopkins University Press, 1999), 141; *The U.S. Army Corps of Engineers: A History* (Alexandria, VA: US Army Corps of Engineers Office of History, 2008), 19; George S. Pappas, *To the Point: The United States Military Academy, 1802–1902* (Westport, CT: Praeger, 1993), 294–96; and Brian R. McEnany, *For Brotherhood and Duty: The Civil War History of the West Point Class of 1862* (Lexington, KY: University Press of Kentucky, 2015), 21–23.

9. Pappas, 297–303; Morrison, 115–20; and Crackel, *West Point*, 128–29.

10. Wayne Wei-Siang Hsieh, *West Pointers and the Civil War: The Old Army in War and Peace* (Chapel Hill, NC: University of North Carolina Press, 2009), 87–89; Linn, *The Echo of Battle*, 23, 40; Weigley, *The History of the United States Army*, 150–51; and Morrison, 118–21.

11. Cited in Morrison, 117.

12. Morrison, 101, 120, 150–52; and Crackel, *West Point*, 26, 28–29.

13. Morrison, 50, 151; and Crackel, 129–30.

14. For overviews of the 1850s, see David M. Potter, *The Impending Crisis: America before the Civil War, 1848–1861* (repr., New York: Harper Colophon, 1976; New York: Harper Perineal, 2011), 177–384; and McEnany, *For Brotherhood and Duty*, 14–53.

15. Morrison, *The Best School*, 128–32; Crackel, *West Point*, 13–31; Ambrose, *Duty, Honor, Country,* 167–68; and Pappas, *To the Point*, 209–316.

16. Potter, *The Impending Crisis*, 385–584; and McEnany, *For Brotherhood and Duty*, 68–68.

17. See "Official Register of the Officers and Cadets of the US Military Academy, June 1861," West Point, NY; McEnany, 71–74; Morrison, *The Best School*, 132–36; and Pappas, *To the Point*, 320–35.

18. Crackel, *West Point*, 131–34; and McEnany, 74–86.

19. Pappas, *To the Point*, 343–45, 339–41; Morrison, *The Best School*, 132–36; and Crackel, 131–35.

20. McEnany, *For Brotherhood and Duty*, 104–6; Hess, *Field Armies and Fortifications,* 5–11; and Chuber, "Field Fortifications," 12–13.

21. "Official Registers of the Officers and Cadets of the US Military Academy, June 1861–June 1863," West Point, NY.

22. "Official Registers of the Officers and Cadets of the US Military Academy, June 1863–June 1864," West Point, NY; and Hess, *Field Armies and Fortifications*, 13.

23. "Official Registers of the Officers and Cadets of the US Military Academy, June 1864–June 1866," West Point, NY; McEnany, *For Brotherhood and Duty*, 230–37, 377–78; and Pappas, *To the Point,* 341.

24. Thomas H. Rees, "History of the Engineer Troops in the United States Army, 1775–1901," *Occasional Papers, No. 37* (Washington Barracks, DC: US Army Engineer School of Application, 1910), 6–7.

25. US Army Corps of Engineers Office of History, "Historical Vignette 087," https://www.usace.army.mil/About/History/Historical-Vignettes/Military-Construction-Combat/087-Engineer-Sergeant-Major/.

26. Second Lt. John W. Schulz, "The Engineer Battalion in the Civil War," *Occasional Papers, No. 44* (Washington Barracks, DC: Press of the Engineer School, 1910), 4.

27. Schulz, 4.

28. Schulz, 5–6.

29. "Official Registers of the Officers and Cadets of the US Military Academy, June 1852–June 1861," West Point, NY; and Philip Katcher, ed., *Building the Victory: The Order Book of the Volunteer Engineer Brigade* (Shippensburg, PA: White Mane, 1998), 6.

30. Rees, "History of the Engineer Troops," 6–7; Katcher, 2–3; Hess, *Field Armies and Fortifications*, 37–41; and Chuber, "Field Fortifications," 44.

31. Schulz, "The Engineer Battalion in the Civil War," 4; Mark Hoffman, *"My Brave Mechanics": The First Michigan Engineers and their Civil War* (Detroit, MI: Wayne State University Press, 2007), 7–19; and Hess, *Field Armies and Fortifications*, 11–16.

32. See Frederick H. Dyer, *A Compendium of the War of the Rebellion* (Des Moines, IA: Dyer Publishing, 1908); and New York States Military Museum and Veterans Research Center, "Other New York Civil War Units," accessed 10 March 2016, http://dmna.ny.gov/historic/reghist/civil/other/.

33. Hoffman, "*My Brave Mechanics,*" 9–25.

34. Hoffman, 9.

35. Hoffman, 3, 19.

36. Hess, *Field Armies and Fortifications*, 16–24; and Chuber, "Field Fortifications," 39–41.

37. Jedediah Hotchkiss, *Make Me a Map of the Valley: The Civil War Journal of Stonewall Jackson's Topographer*, ed. Archie P. McDonald (Dallas: Southern Methodist University Press, 1973), xv–xix.

38. Cited in Hotchkiss, 10.

39. For operational histories of the Civil War, see Russell F. Weigley, *A Great Civil War: A Military and Political History, 1861–1865* (Bloomington, IN: Indiana University Press, 2000); and Timothy H. Donivan Jr. et al., *The American Civil War*, The West Point Military History Series, ed. Thomas E. Griess (Wayne, NJ: Avery Publishing Group, 1987).

40. For a brief overview of the movement to and siege of Corinth, see Donovan, 64–67.

41. Cited in Hoffman, "*My Brave Mechanics*," 68.

42. Hoffman, 66–77.

43. For overviews, see George C. Rable, *Fredericksburg! Fredericksburg!* (Chapel Hill, NC: University of North Carolina Press, 2002); and Donovan, *The American Civil War*, 121–30.

44. Col. Wesley Brainerd, *Bridge Building in Wartime: Colonel Wesley Brainerd's Memoir of the 50th New York Volunteer Engineers,* ed. Ed Malles (Knoxville, TN: University of Tennessee Press, 1997), 111.

45. Brainerd, 112.

46. Schulz, "The Engineer Battalion in the Civil War," 24–26; Rable, *Fredericksburg!*, 157–73; and McEnany, *For Brotherhood and Duty*, 161–65.

47. For overviews, see Stephen Sears, *Chancelorsville* (New York: Houghton Mifflin, 1996); Donovan, *The American Civil War*, 130–42; and Weigley, *A Great Civil War*, 224–29.

48. Hotchkiss, *Make Me a Map of the Valley*, xxv–xxix, 135–38; and Sears, 189, 233–48, 270–81.

49. For an overview, see Mark Grimsley, *And Keep Moving On: The Virginia Campaign, May–June 1864* (Lincoln, NE: University of Nebraska Press, 2002).

50. Thomas James Owens, *"Dear Friends at Home": The Letters of Thomas James Owen, Fiftieth New York Volunteer Engineer Regiment, during the Civil War*, ed. and intro. Dale E. Floyd (Washington, DC: Government Printing Office, 1985), 34–45, 113–14; and Gustav J. Person, "Crossing the James River, June 1864: 'The Real Crisis of the War,'" *Engineer–The Professional Bulletin of Army Engineers* (September–December 2009): 58–59.

51. Noah Andre Trudeau, *The Last Citadel: Petersburg, Virginia, June 1864–April 1865* (Baton Rouge, LA: Louisiana State University Press, 1991), 21–25; Hess, *In the Trenches at Petersburg*, 16–18; Person, 62–63; and Weigley, *A Great Civil War*, 330–38.

52. John H. Westervelt, *Diary of a Yankee Engineer: The Civil War Story of John H. Westervelt, Engineer, 1st New York Volunteer Engineer Corps*, ed. Anita Palladino (New York: Fordham University Press, 1997), 143–44.

53. Petersburg was one of many sieges conducted during the Civil War. The other most well-known siege occurred in mid-1863 at Vicksburg, Mississippi. For engineering aspects, see Justin S. Solonick, *Engineering Victory: The Union Siege of Vicksburg* (Carbondale, IL: Southern Illinois University Press, 2015); and Robert M. Puckett, "Engineer Operations during the Vicksburg Campaign" (MMAS thesis, US Army Command and General Staff College, Fort Leavenworth, KS, 1992).

54. Cited in Katcher, *Building the Victory*, 90–91.

55. Katcher, 90–91.

56. Hess, *In the Trenches of Petersburg*, 78–90.

57. Hess, 90–91.

58. "From Grant's Army," *Missouri Democrat*, 5 August 1864.

59. Trudeau, *The Last Citadel*, 98–127; Hess, *In the Trenches of Petersburg*, 91–106; and Weigley, *A Great Civil War*, 338–40.

60. "Official Registers of the Officers and Cadets of the US Military Academy, June 1865–June 1867," West Point, NY.

61. Walter Scott Dillard, "The United States Military Academy, 1865–1900: The Uncertain Years" (PhD diss., University of Washington, 1971), 23.

62. Dillard, 24.

63. Pappas, *To the Point*, 361–62.

64. Ambrose, *Duty, Honor, Country*, 197.

65. See also Dupuy, *Men of West Point*, 38–43.

66. Ambrose, *Duty, Honor, Country*, 197.

67. Crackel, *West Point*, 141–42.

68. Crackel, 141–42.

69. Skelton, "West Point and Officer Professionalism," 35.

70. Dillard, "The United States Military Academy," vi–ix.

Chapter 4

New Homes for the Engineer School: Willets Point, 1866–1901, and Washington Barracks, 1901–17

In 1866, a year after the end of Civil War, the US Army Corps of Engineers and the US Military Academy parted ways. The Corps moved the Engineer School to its new post at Willets Point, New York. Thus ended sixty-four years of formalized engineering instruction at the academy. There seems to be an impression that this separation was an exile to the "wilderness" where the engineers would wander for the next forty-plus years. Historical coverage of education at Willets Point tends to be vague and brief, as if a narrow bridge between the Civil War and the First World War. Nothing is further from the truth. Between these two conflicts, the engineers used creative means to educate and prepare their branch for future conflicts, as well as to leverage lessons from past conflicts. They established an effective post-graduate curriculum to supplement the officer education at the Military Academy. The Corps of Engineers then helped fill US needs for civil, if not military engineering, functions. This chapter traces the evolution from a vibrant, albeit limited and informal, School of Application at Willets Point (1866 to 1901) into a formal and structured Engineer School at Washington Barracks, District of Columbia (1901 to 1917).

The Move to Willets Point: The School of Application and the Search for a Distinct Identity

In 1866, the Corps of Engineers separated from the US Military Academy as part of this institution's reorganization. No more would the superintendent be an engineer, nor could the academy be considered the Army's Engineer School. Instead, the superintendent position opened up to any branch, and the academy came under the War Department's control. Over the next few years, the academy slowly shifted its curriculum away from its previous engineering-centric curriculum. Several factors led to these changes, not merely the Corps of Engineers' departure. The death in 1871 of long-time engineering professor Dennis Hart Mahan ended his traditionalist influence on the academy's curriculum, and several other civilian faculty members favoring the engineering focus would choose to retire in the 1870s, further decreasing the institutional continuity that their presence once provided. Ultimately after 1866, the new leaders in the superintendent's office and the academy's boards made a calculated decision to mold the institution into a school for future US Army officers of all branches, rather than an engineering school that just happened to educate officers for other branches. “As a result, West Point became neither fish nor fowl,” writes historian Walter Dillard. “Graduates were suited to become Army officers. They needed further training and education to become professionals in other fields.”[1]

Dillard’s last sentence is key to understanding not only the next few decades, but also the entire history of the Engineer School up to this day. Once they entered the Corps of Engineers, newly commissioned officers still needed post-graduate education to compensate for the de-emphasis of engineering at the academy. Junior officers who graduated in the early 1860s and served in the Civil War understood combat engineering and maneuver support. Yet they had no practical understanding of the Corps of Engineers’ civil works missions, such as dredging rivers, harbor improvement, surveying terrain, building damns, and the like. In addition, the needs of younger cadets who did not have Civil War experience were even more acute because they possessed neither time in combat, nor in civil works.[2]

Stepping out of the 1860s context for a moment, it should be noted that the twentieth century saw the technical concentration return to the academy, as demonstrated by the fact that all cadets earned bachelor of science degrees. This particular degree required the student to undertake more mathematics and science courses than their peers in bachelors of art programs in civilian institutions. It is also significant that the academy has faithfully continued the recitation policy instituted as part of the Thayer System in the 1820s.

Returning to the 1860s, not only did the engineering-focused education need a new home, so too did the Engineer Battalion, which had been stationed at West Point since its inception in 1846. Beyond these two problems, the US Army did not have any tradition of formal post-graduate training or funds to establish such programs for engineers and officers from other branches.

These three problems confronted Brig. Gen. Andrew A. Humphreys, the corps’ newly promoted chief of engineers. He came to that position in 1866 after a distinguished career that included combat tours in the Seminole War and the Civil War, not to mention extensive surveying experience with the Corps of Topographical Engineers. Humphreys co-authored a classic work, *Report of the Physics and Hydraulics of the Mississippi River* in 1861, which established him as an engineer-scholar in the vein of fellow officers and West Point graduates George W. Cullum and James C. Duane.[3]

In the fall of 1866, after touring Willets Point in New York City, General Humphreys solved the first of two problems by choosing that same site to be the new home of the Engineer Battalion and engineering education. Willets Point was named after the prominent Willett family that lived in New York City for two centuries. One of the members—Marinus Willett—served under George Washington and later commanded units in the Mohawk Valley during the American Revolution. The alternate spellings of the family name and place name resulted from a lack of standardization many decades earlier. The Willetts had purchased the land in 1829 and later sold it the US Army in 1857; at that time, the Army established the 136 acres as a strategic piece of New York’s harbor defense. The plot of land sat on a peninsula extending out into Long Island Sound in northern Queens. Willets Point was to be paired with Fort Schuyler on Throggs Neck to protect the Long Island Sound entrance of the East River and the city’s bustling harbor. The Union Army started constructing fortifications in 1862 but suspended work because new artillery technology had already made conventional fortifications obsolete.[4]

Humphreys’ decision to move to Willets Point was what one officer later called “a child of necessity and not created by specific legislative enactment, or even recognized officially until 1885.”[5] He had no other reasonable course of action because, in the long term, no institution existed to prepare officers for service in the Corps of Engineers. Humphreys intended the School of Application to offer comprehensive post-graduate training and educational curricula commensurate with the professions of arms and engineering.[6] Such a structured process would create more competent and experienced officers.

In the late 1860s, General Humphreys mandated that all West Point graduates commissioned in the Corps of Engineers transfer to Willets Point, as was his prerogative. The graduates served in the Engineer Battalion and undertook courses at the School of Application. From an organizational standpoint, the battalion’s cadre of officers were dual-hatted as both leaders in that unit and as instructors in the school. In the unit structure, the officers reinforced among their subordinates the proper drill, discipline, marksmanship, and similar skill sets common to all soldiers. In the academic structure, senior engineer officers also served as instructors for junior officers, noncommissioned officers, and enlisted soldiers. In turn, the junior and noncommissioned officers would teach the enlisted soldiers. The engineering curriculum eventually included lectures, recitations, examinations, reading programs, scientific experiments, field exercises, and other activities.[7] In sum, historian Larry D. Roberts succinctly concludes that, "The battalion would serve as a School of Application."[8]

Although the School of Application may correctly be called a "child of necessity" and "unofficial" for students, these labels did not apply to the enlisted ranks of 1866 because Congress authorized instruction of all enlisted engineers in the battalion in July of that year. This sanction pre-dated the official recognition of the School of Application for commissioned ranks by two decades. Enlisted engineers volunteered to attend evening courses in mathematics, English grammar, French, Spanish, history, law, geography, and penmanship. Officers usually taught these courses. During daily training, the enlisted engineers developed their practical skills in masonry, carpentry, and other horizontal and vertical construction skills.[9] The engineers also performed essential bridging and combat engineering missions: "The course in pontoneering covered all details, including rowing, bridge building with wooden and canvas pontons, loading and unloading the wagons," while other courses covered "the practical driving of mining galleries, the explosion of gunpowder and dynamite mines, and the construction and breaking of improvised bridges over dry ravines."[10] Thanks to the above-named practical experiences and courses, the enlisted engineers successfully grasped the processes.[11]

At the officer level, some seemingly insurmountable disadvantages plagued the School of Application; it seemed to isolate engineers from their fellow soldiers in other branches, and the engineers lost some of the stature previously enjoyed when they were the driving force behind the nation's premier engineering school at the Military Academy. The new school at Willets Point also suffered chronic shortages in funding for equipment and buildings. Nevertheless, some advantages did emerge over time. The Corps of Engineers' separation from the academy brought with it the opportunity to focus exclusively on engineering research, development, procurement, and education. In his role as chief of engineers, Humphreys worked to secure the resources needed to improve existing buildings and add several new laboratories. The enlisted engineers in the battalion contributed to these efforts by putting their newly acquired skills in masonry and carpentry to use in various construction projects. For the officers, the unfinished fort at Willets Point also provided prime locations for engineer field-training exercises on designing and building fortifications. Last but not least, the new School of Application emerged as the primary site for the US Military's experimentation with submarine mine warfare. In sum, this setting quietly allowed engineering skills and ideas to ripen over time.[12]

The Essayons Club and Henry L. Abbot as the "Father of the Engineer School," 1866–68

While Brigadier General Humphreys built up expectations, Majors James C. Duane and Henry L. Abbot set about creating a coherent curriculum for the Engineer School of Application. Duane served as post commander at Willets Point and as commandant of the school from 1866 to 1868. Because of poor health, however, he transferred much of the workload to Abbot, who commanded the Engineer Battalion and functioned as the assistant commandant. Abbot finally assumed the role of school commandant in 1868 and served in this post for the next eighteen years. He gave the school and its curriculum much-needed continuity during years of relative obscurity. Henry Abbot left such a great legacy that he deserves the title "Father of the Engineer School."[13]

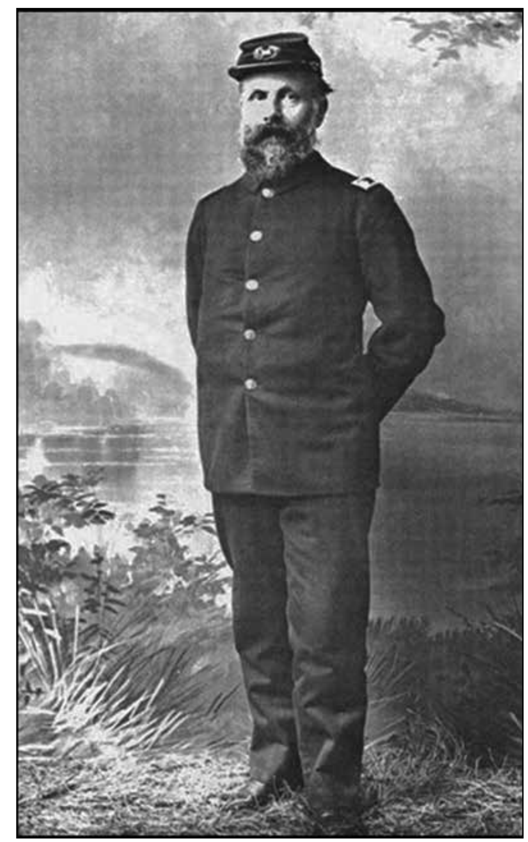


Figure 4.1. Henry L. Abbot as commander of the Engineer Battalion at Willets Point. Courtesy of US Army Engineer School History Office Archives.

Classes began at the School of Application in the summer of 1867. The first students designed and then constructed fortifications based on the classic seventeenth century models of the French military engineer Sébastien Le Prestre de Vauban. These exercises gave officers real-world experience in managing complex projects.[14]

The onset of winter weather, however, made outdoor activities unfeasible. Instead, to make productive use of student downtime, Majors James Duane and Henry Abbot decided in 1868 to create a study group to stimulate professional development. They called it the Essayons Club.[15] The club's informal gathering served as a conduit for ideas, tactics, techniques, procedures, and experiments to be disseminated at the school and across the Corps of Engineers. An earlier precedent for this type of extracurricular activity can be seen in the Napoleon Club, founded twenty years before by Dennis Hart Mahan at the US Military Academy, and dedicated to studying the military campaigns of that great general.

In creating the Essayons Club, Duane and Abbot realized yet another of General Humphreys's visions: to expand extracurricular learning opportunities at the School of Application. Thus, the club filled the need for further professional development; attending meetings and studying at the School of Application would help the officers competently perform their duties in the Corps of Engineers. The club eventually included all engineer officers on duty at Willets Point and other officers elected to membership.

The Essayons Club held its first meeting on 28 January 1868. Maj. James Duane set the standard by presenting the first paper on lessons from the Civil War, specifically best practices of pontoon bridging. Major Abbot followed in the second meeting with his study of the practical gauging of rivers. Discussions followed the presentations in which members critiqued one another's ideas, offered solutions to problems addressed in the presentations, and sought scientific applications to engineering doctrines and functions. More meetings followed each Monday night during the winter months for the next fourteen years. The club provided a venue for the exchange of ideas among professionals. The engineer officers, after all, considered themselves to be part of the engineering profession.

Topics varied widely, from practical activities to theoretical experiments, and battle analyses to topics relevant to the modern US Army as a whole. Officers from junior grades through flag rank read such papers as "Economy of Sea-Coast Defenses," "Notes of Military Surveying," "Lithographic and Photo-Lithographic Works," "Testing of Medium and High Tension Fuses," "The Horary Oscillations of the Barometer," "The Practice of Terrestrial Magnets," "Notes on the Chromium Battery," "Operations against Mobile [Alabama] Late in the War," and "Mortars in Sea-Coast Defense." The Engineer Battalion published fifty of the Monday night papers so that the contents could be disseminated well beyond the officers stationed at Willett's Point. As the technical coursework at the School of Application expanded in the 1870s, however, fewer Essayons Club meetings were held because the once extracurricular topics began to appear in the school's curriculum proper. The last meeting occurred in 1882.[16]

Figure 4.2. The old Officer's Mess at Willets Point circa 1880—home to the Essayons Club and the Engineer School of Application. Courtesy of Bayside Historical Society.

The Evolution of the School of Application Curriculum, 1868–85

As more funding and equipment became available at the School of Application, Commandant Henry Abbot slowly expanded the curriculum. Beginning in 1868, students in meteorology kept hourly records of barometric pressure, temperature, and humidity. They also studied hypsometry in order to make accurate measurements of land elevation relative to sea level. When combined with reconnaissance and surveying, students could collect data that allowed them to create maps with contours and terrain features. This equated to topographical engineering in everything but name.[17]

The next year, in 1869, saw the construction of a field astronomy laboratory containing an astronomical transit, zenith telescope, sextant, and chronometer. Students tracked movements of celestial bodies and recorded events like eclipses or sun spots. Given the budgetary constraints at the school, this laboratory was made possible only by the generous loan of the necessary instruments by Abbot's friend and former professor Robert Bartlett of West Point. The students used these instruments to make precise calculations of location, time, and distance that aided military and civilian projects requiring precisely accurate maps.[18]

A course on the systematic study of tidal current measurements was added in 1871. Students used double floats, electric current meters, and self-registering tide gauges to determine hourly water levels. They tracked the flood and ebb phases as the tides rose and receded, noting the resulting changes in horizontal currents. Two years later, in 1873, a new course in military photography supplemented ongoing work on mapmaking and terrain reconnaissance. These efforts fell under the broad category of topographical engineering. It is worth noting that the Military Academy's curriculum did not include course content on photography, nor did it offer other in-depth instruction like Willets Point.[19]

The early courses at the School of Application shared similar components of research, experimentation, and documentation that followed the scientific method. Whenever possible, the projects used resources at hand at Willets Point or the greater New York City area. This reduced the overall cost of projects. The school and the battalion also began to publish reference works that codified their courses' content. The officers, for instance, drew lessons from the Civil War to compile the *Ponton Manual*, created tables of organization, and prescribed drills during field exercises. Meanwhile, the enlisted engineers employed their carpentry skills to modify the standard French-designed pontoon, which had been in use since the Civil War.

In 1872, then-Commandant Henry Abbot combined the school's construction projects and scientific coursework into real-world military scenarios. His students surveyed and mapped the terrain in Queens from Willets Point, some fifteen miles south, to Jamaica Bay. A report by Chief of Engineers Brig. Gen. Andrew Humphreys summarized the rest of the exercise:

> [Each student submitted] a detailed projection of the line of field works against an anticipated invasion of one hundred thousand men landing on the east end of Long Island. The project will include a plan, estimates of time and materials required, and a full memoir showing the theory of defense adopted by each student. In addition, requirements for food and supplies had to be taken into consideration and a complete list of all tools needed must be submitted with the plan of defensive works.[20]

To hold this imaginary line, the defenders were allotted some 30,000 militia infantry, three engineer companies, and an artillery regiment. This exercise drew on the students' knowledge of topography and cartography, and gave them a deeper understanding of large-scale field fortifications. Lastly, the exercise called for the engineer students to arrange engineer, artillery, and infantry units in what amounted to a combined-arms wargame.[21]

Aside from the engineering-centric activities at the School of Application, students practiced their infantry skills with rifles and bayonets. In fact, they gained much recognition in the Army from achieving superior proficiency in marksmanship. Esprit de corps also doubtlessly swelled their pride in both unit and branch. Numerous individual and unit championships documented the pursuit of excellence in this, every soldier's most basic skill.[22]

By the mid-1870s, Henry Abbot instituted a standard two-and-one-half year program of study that incorporated all the subjects mentioned above, as well as one very significant addition—submarine mine warfare. Graduates of the Military Academy arrived at Willets Point the October after receiving their commissions. Abbot anticipated that the post-graduate education would be every engineer's first assignment as officers.[23]

The Most Important Subject in the Curriculum: Submarine Mines

Although all subjects at the School of Application possessed civil or military applications, the study of so-called submarine mines in the Torpedo Laboratory emerged as the most significant academic focus. The mines were self-contained explosive devices placed partially or completely underwater, and thus often invisible to observers on surface-sailing ships. Vessels triggered the detonations when touching or passing too close to the mines. The damage caused by the explosions depended on the type of mine and size of its charge. In the case of contact mines, holes were blown in ship hulls below the waterline; the subsequent flooding of the lower decks would then sink them. Or, if mines detonated at some distance away from a ship, the explosive force could dramatically change the water pressure near the targeted vessels. This change would send violent shockwaves reverberating through ship structures, which could buckle metal plates, pop rivets, cause leaks, and produce hull instability. The resulting dam-

FIRST YEAR

Winter Course
14 weeks of study in the Torpedo Laboratory.
- Evaluation: two five-hour examinations.

8 weeks of study and practical work in the Photographic Laboratory.
- Collection and analysis of barometric and hypsometric data.
- Recitations by students.

Regular attendance and active participation at weekly Essayons Club meetings for extracurricular professional development.

Summer Course
7 months of study, field exercises, experimentation, and instruction.
- Weekly torpedo practice in lab and on water.
- Systematic instruction in Practical Astronomy, including the use of an astronomical transit, zenith telescope, sextant, and personal equation machine.
- Surveying one square mile of land, including transit and stadia work, and contours with the spirit level.
- Reconnaissance on foot using a pocket compass and hand level.
- Under supervision of faculty: student instruction of enlisted.
- Engineers in Infantry drill, target practice, military reconnaissance, the use of railroad transit, field fortifications in the moulding room, pontoon drill on land and water, and military mining on land; and recitations by enlisted engineers.

SECOND YEAR

Winter Course
7 weeks of study in the Torpedo Laboratory.
- Historical survey of previous 15 or more years of submarine mining systems in the United States and foreign nations.
- Evaluation: two five-hour examinations.

8 weeks of study and practical work in the Photographic Laboratory.
- Completion of Photography class, including making negatives with gelatin emulsion plates, silver printing, map printing including glass and paper negatives, the blue process, photo-lithography, and the heliotype process.
- Collection and analysis of barometric and hypsometric data.
- Recitations by students.

Regular attendance and active participation at weekly Essayons Club meetings for extracurricular professional development.

Summer Course
7 months of study, field exercises, experimentation, and instruction.
- Weekly torpedo practice in the laboratory and on the water.
- Completion of Practical Astronomy, including use of the latest patterns of combined transit, zenith telescope instruments, and 5.5-inch equatorial telescope, tertiary triangulation and hydrographic work with current measurements and self-registering tide gauge.
- Under supervision of faculty: student instruction of enlisted.
- Engineers in Infantry drill, target practice, etc., as in previous summer course; and recitations by enlisted engineers.

THIRD YEAR

Winter Course
7 weeks of study in the Torpedo Laboratory (ending on 1 May).
- No required examinations.
- Review or investigation of individual, student-selected topics.
- Collection and analysis of barometric and hypsometric data.
- Preparation of drawings and memoirs on problems of fortifications or in field-unit operations, which after discussions and revisions were sent to the Chief of Engineers.
- Under supervision of faculty: students offer lectures and hear recitations from enlisted engineers.

Regular attendance and active participation at weekly Essayons Club meetings for extracurricular professional development.

Sources: Michael Murrin Harmon, "The Formation of the Engineer School of Application and its Early History, 1866–1898" (MA thesis, George Washington University, 1985), 42–45; Brevet Brig. Gen. Henry L. Abbot, "The Early Days of the Engineer School of Application," *Occasional Papers, No. 14* (Washington Barracks, DC: US Army Engineer School of Application, 1904), 33–34; and "General Orders No. 4, 28 April 1875," General Orders of Headquarters, Willets Point, NY, US Army Engineer School History Office Archives.

Figure 4.3. Timeline for School of Application Curriculum in the mid-1870s and 1880s. Created by Army University Press.

age from a distant mine could prove more devastating than direct contact. A similar nineteenth-century term was torpedo mines—hence engineers studied submarine mines in the Torpedo Laboratory or during torpedo practice at the school. Torpedo and submarine can be used interchangeably when referring to explosive mines in this historical context. The use of torpedo at the School of Application should not to be confused with the self-propelled, explosive-tipped weapons of the twentieth and twenty-first centuries, nor with the land mines used during the American Civil War.[24]

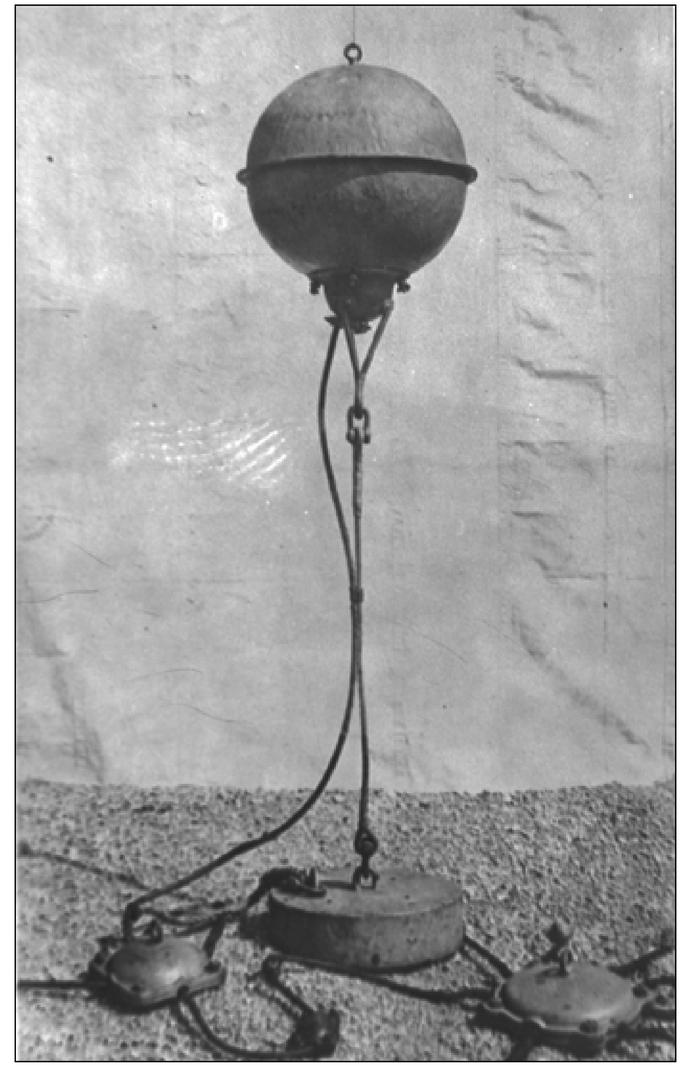


Figure 4.4. Torpedo mine example at Willets Point circa 1875. Courtesy of US Army Engineer School History Office Archives.

During the three winter courses at the School of Application, the curriculum devoted twenty-eight weeks to studying explosive devices in the Torpedo Laboratory. The engineering students could be found there six hours each day identifying the best triggering mechanisms, most explosive materials, and other similar experiments. During summer courses, the students spent still more time on exercises and experiments with weaponry. They tested the blast effects of up to 50,000 pounds of dynamite or similar substances.[25]

Two examples of this type of work are worth noting. To measure the damage of exploding mines on actual vessels, in 1878 the students detonated a mine near an old unmanned schooner. Six cameras captured the results as described by Abbot: "The first view, taken at the instant when the mine exploded, shows the vessel lifted high amidships, with bow and stern, depressed. . . . The maximum height of the water jet (180 feet) was reached in 2.3 seconds, showing the air full of fragments."[26] The irreparably damaged schooner sank quickly thereafter, demonstrating the extent of damage caused by submarine mines.

In another experiment using what amounted to anti-personnel land mines, the engineers detonated dynamite behind a mule's ears. The explosion left the animal dead but still standing with legs slightly buckled and its detached head hanging from its neck by a sliver of skin. The engineers measured the effects of the mine blast on flesh and bone in this rather macabre exercise.[27]

This heavy emphasis on mines resulted from the Corps of Engineers being designated as the US Military's proponent for the development of submarine mines in harbor and coastal defenses. Stringing submarine mines outside harbors or in river mouths represented the only real alternative to building additional shore fortifications, which were shown during the Civil War to be vulnerable to the newer and more powerful warship cannons. The mines could stop enemy warships before they could strike against coastal areas or sail upriver into the nation's interior. Indeed, the use of mines during the American Civil War likewise demonstrated the weapon's great potential. The Confederacy's mines sank twenty-seven Union warships and damaged countless others. Just as land mines were force multipliers in defensive ground operations, so too were submarine mines in defensive naval operations.[28]

In his role as commandant, Maj. Henry Abbot spearheaded the effort to perfect the submarine mine. Years of research culminated in the school's publication of two editions of the *Submarine Mining Manual* in

1877 and 1886, respectively. These codified all the tactics, techniques, principles, and materials found most suitable for these mines. By the 1880s, US Army artillery officers started taking classes on submarine mine warfare at Willets Point; thereafter, the independent Coast Artillery branch assumed responsibility for coastal defense and submarine mining from the Corps of Engineers.[29]

Formalizing the United States Engineer School and Its New Curriculum, 1885–1901

In a lengthy letter to the secretary of war dated 20 February 1885, Chief of Engineers Brevet Maj. Gen. John Newton recommended a reorganization of the School of Application at Willets Point under the new designation, The Engineer School of Application of the Army of the United States. In what is best considered its new mission statement, he declared:

> The object of the establishment [of the Engineer School of Application of the Army of the United States] should be to conduct researches in the branches of science applicable to the duties of the Corps of Engineers, to instruct newly assigned officers in the profession, and to train the enlisted men of the Battalion of Engineers to the highest possible degree of efficiency.[30]

In this statement, Newton showed a clear link between science and practice. He also unequivocally declared engineering to be a profession. Moreover, he placed a premium on creating competent engineer soldiers in the enlisted and noncommissioned ranks who shared in the professionalism of the officers in the Corps of Engineers. [31]

The most significant practical change occurred in the academic structure of the new school. Newton called for the establishment of five individual departments, detailed in these excerpts from his letter to the secretary of war:

• *Submarine Mining.* Including electricity, our own and foreign systems of defensive torpedo warfare, and modern high explosives.

• *Military Engineering*. Including the operations of armies in the field, seacoast defense, modern siege operations, and modern ordnance.

• *Military Photography.* Including all methods of map multiplication in the field and the use of the camera.

• *Practical Astronomy*. Including the best methods and use of instruments employed upon the more important boundary surveys.

• *Civil Engineering*. Including practical surveying, river and harbor improvements, and barometric hypsometry.[32]

These new departments reflected and expanded on the history of Army engineering. Submarine Mining was built on experience and expertise gained in the Torpedo Laboratory in the previous decade.[33] The photography and astronomy pieces likewise followed the course content that had been in effect for a decade or more. The other two departments of Civil Engineering and Military Engineering call to mind the Military Academy's pre-Civil War courses: Civil and Military Engineering, offered by Dennis Hart Mahan, and Practical Military Engineering, offered by George W. Cullum.[34]

Nevertheless, Newton's recommendations resembled the old school and old curriculum developed by Commandant Henry Abbot. No major changes occurred in the academic staffing by the Engineer Battalion, enrollment of West Point-educated engineer officers, and coursework in a two-and-one-half-year period. The newly commissioned West Point graduates continued to come to Willets Point to receive their post-graduate training during their first tours of duty. Indeed, Abbot serving as commandant just one year after the reorganization detected no "radical change" in the operations of the new school.[35]

In 1886, after eighteen years at Willets Point, Lt. Col. Henry Abbot stepped down as commander of the Engineer Battalion and commandant of the school. He left this institution with a firmly established curriculum, strong reputation, and recognized status as a school in the Army. The strength of the Engineer School of Application stood at twenty-one officers and 351 noncommissioned officers and enlisted men. The Engineer Battalion totaled five companies, containing seventeen officers and 296 men, of which three companies were stationed at Willets Point. Abbot's successor, Lt. Col. Cyrus Comstock, maintained the status quo established by Newton and Abbot, serving for a few months as a temporary placeholder for the next commandant.

In 1887, Lt. Col. William R. King took the reins as commandant at Willets Point. He maintained the departmental structure and basic curriculum that he inherited. Yet new developments in science and technology made it necessary for King to revise some existing courses. He changed, for example, the study of submarine mining by requiring officers to assume the roles of noncommissioned officers with the goal of learning the basics of setting charges, laying, fusing, and detonating the mines. Such cross-training between the ranks made the officers more knowledgeable leaders and teachers.

King likewise added new courses to his engineering curriculum. Reacting to the exceptional work of the French on the Suez Canal in Egypt, he introduced Canal Engineering into the curriculum to allow them to keep abreast of best practices around the world. This particular addition foreshadowed the herculean undertaking to construct the Panama Canal in the early twentieth century. Reacting to new paving techniques, King initiated a course on macadamizing roads. Engineer students learned how to layer small crushed stones on roadways, which, when kept completely dry, could protect the soil from water and wear. Lastly, King recognized that the ever-increasing complexity of machines and engines required better skills in creating and reading schemata; thus, he added a blueprinting course to the curriculum.[36]

Three years into King's commandancy, the cumbersome title Engineer School of Application of the Army of the United States was shortened to the more utilitarian United States Engineer School. That same year marked additional efforts to increase the professionalism of the Army's engineers. The program was shortened and tightened around three departments: Military Engineering, Electrical Engineering, and Civil Engineering. The school's extracurricular professional development expanded to include guest lectures by science and engineering experts, tours of military and civilian organizations, and interactions with organizations like the American Society of Mechanical Engineers and the American Society of Civil Engineers. These activities offered the opportunity for Army engineers to take their places among their peers outside the military. Both the engineer officers and civilian engineers benefitted from the exchange of decades of practical experiences. Such cross-fertilization with the goal of improving efficiency mirrored the push throughout American society to harness new technology through progressive management and labor techniques.[37]

The Army engineer efforts to remain current continued under the next two commandants, Majors William T. Rossell and John G. D. Knight. In 1898, the Spanish-American War began and the Engineer School closed as its officers and enlisted engineers deployed as the new Engineer Battalion.

Standing up a New School at Washington Barracks, 1901–05

Following the end of the Spanish-American War, many US Army engineers returned to Fort Totten (formerly Willets Point before 1898) in New York harbor, where they spent the next couple of years restarting the curriculum. As of 30 June 1901, the Report of the Chief of Engineers to the War Department identified the school's new mission statement:

> To supplement the theoretical and primary course of engineering instruction given at the United States Military Academy, by theoretical and practical work, and by examination of works of engineering which are being carried on in the vicinity. The course is intended primarily for officers assigned to the Corps of Engineers, and secondarily for officers of other branches of the service who may desire to obtain a knowledge of special branches of the course.[38]

The engineers did, however, face numerous challenges in fulfilling this mission at Fort Totten. That same 1901 report acknowledged that insufficient space existed there to support the activities of the Engineer School and the artillery. The report pointed to a future move from Fort Totten to Washington Barracks in Washington, DC. Senior engineer officers objected to the move in part because the new location possessed less space and none of the facilities that they enjoyed at Fort Totten. Despite this dissension among the engineers, the Headquarters of the US Army ordered this transfer of the school to the Washington Barracks on 3 September 1901. The name of the school also reverted from the United States Engineer School to an earlier version—the Engineer School of Application, United States Army.[39]

At first, the move and the following two years proved to be chaotic and rocky at best. According to a 1935 article looking back to 1901, "The move to Washington Barracks was a retrograde step."[40] This put a negative spin on the situation. The author then summarized the perspective of the school's commandant, Maj. William M. Black, who identified the departure from Fort Totten as the cause for "tangled confusion, the instructors at the school were all new, there were no electrical apparatus, the school furniture was inadequate and decrepit, the school buildings were in need of alterations and repairs . . . and no money was available."[41] It would take ample time and funding to bring the school's facilities up to appropriate standards at Willets Point, let alone to keep pace with science and technology advances in the civilian world.

Despite these setbacks, the first post-graduate classes began in November 1902 and lasted two years when practical, but possibly shorter if duties required those officers to leave early. This timeframe, it should be noted, was shorter than the two and half years at Willets Point. Ideally, the new second lieutenants should have graduated from West Point and then spent one year on active duty with units or on projects before entering the school.[42]

Military Engineering

- Field and permanent fortifications, to include types, location, construction, attack and defense.
- Military mining.
- Construction of roads, bridges, camps, and telegraph lines.
- Reconnaissance, to include military topography, photography, and mapmaking.

Civil Engineering

- Survey and astronomy.
- Strength of Materials.
- Mechanical Engineering.
- Construction.
- Municipal Engineering.
- Improvement of rivers and harbors.
- Contract laws, specifications, and estimates.
- Business methods and records.

Electrics

- Electrical measurements.
- Military uses of electricity.
- The generation, transmission, and application of electric power to lighting, heating, and propulsion.

Ordnance and Armor

- Artillery use of fortifications.
- War ships, guns, mortars, projectiles, and explosives.

Source: "General Orders No. 146, Headquarters of the Army, Adjutant General's Office, 9 November 1901," in *General Orders and Circulars, Adjutant General's Office, 1901* (Washington, DC: Government Printing Office, 1902), 3.

Figure 4.5. Washington Barracks Curriculum. Created by Army University Press.

The Washington Barracks curriculum was divided into four departments, each with respective subjects. The Civil Engineering Department added new courses to the Engineer School of Application curriculum to include Municipal Engineering, Contracts, and Business, while other courses were either expanded or deleted from previous curricula.[43]

The concept of municipal (or urban) engineering originated in England as a reaction to problems caused by industrialization and urbanization in the nineteenth century. It mainly focused on improving city infrastructures including waste management, water supply, energy sources, and public housing. The United States experienced similar growing pains in the nineteenth and early twentieth centuries as more people moved to ever-larger cities in search of manufacturing jobs. Those urban areas could not expand haphazardly without augmented infrastructures.

The other two additions to the curriculum, contracting and business methods, reflected how the Corps of Engineers kept current with the realities and needs of modern construction projects. The corps was tiny, with a cadre of 130 officers and a few hundred enlisted soldiers in the Engineer Battalion. This number was hardly sufficient to undertake one major project, let alone several such efforts. Instead, the engineer officers served as managers or subject-matter experts on the staffs of hired contractors. They developed technical acumen in courses, but they also needed to understand the legal and managerial facets of complex projects. The courses on contract law, specifications, and estimates equipped the officers to supervise, inspect, or provide advice on Corps of Engineers civil works. The business methods and recordskeeping courses gave the officers skills akin to the civilian world. Indeed, the school likely taught progressive managerial and organizational principles developed by the likes of Frederick Winslow Taylor and Max Weber. Such courses added value by strengthening officer education at the US Military Academy.[44]

Coursework on torpedoes and underwater mines was missing after 1902. The Corps of Engineers lost its responsibility for harbor defenses and underwater mining to the Coast Artillery branch and its new School of Submarine Defense. This shift of roles was logical because that branch already operated the guns in American fortifications. Thus, it was reasonable to add underwater mining to their mission.[45] This loss of activity notwithstanding, the Engineer School of Application retained coursework on military mining in support of ground operations, as well as on the effects and types of artillery on fortifications.

During the winter months of November through April, the engineering students studied theoretical topics then turned to practical lessons in the summer months. Instructors combined lectures, discussions, and reading in the theoretical components of courses. The term “recitation,” so firmly ensconced throughout the nineteenth century at West Point and Willets Point, was missing from the descriptions of the new school at Washington Barracks. Nevertheless, students were expected to teach others in turn. Whenever possible, the instructors tried to use practical experiments or activities to illustrate theories. The faculty prescribed examinations as they deemed appropriate. The students received one of three final grades: proficient with honor, proficient, or deficient. These grades were then reported to the chief of engineers and the War Department.[46]

Not only did officers receive instruction at the Engineer School of Application, but enlisted engineer specialists also gained skills in carpentry, masonry, blacksmithing, plumbing, drafting, photography, and surveying.

And, of course, they needed to learn the operational roles that they may have in the field and especially in wartime. Engineer officers and noncommissioned officers instructed enlisted engineers in marksmanship because they might be called upon to set aside their pick or shovel and fight as infantry. They also received training in other obvious topics such as field fortifications, bridge and road building, and reconnaissance and mapmaking.[47]

Work in 1901 and 1902 proceeded as the school acquired the necessary resources to become a viable organization with a legitimate curriculum. Courses with sixteen officers in attendance began in November of that second year, but they only lasted until April 1903. Then the secretary of war, with the concurrence of Chief of Engineers Brig. Gen. George Gillespie Jr., made the decision to suspend the school’s activities. They chose this drastic measure to fill the great demand for engineer officers for duties elsewhere. Fewer than 150 officers in the entire Corps of Engineers were spread all over the United States and some overseas locations such as the Philippines. They fulfilled such missions as instruction at the Military Academy, membership on the California Debris Commission, service as division engineers, and work on various boards and other commissions dealing with rivers, harbors, canals, lighthouses, fortifications, and other civil works. With so many responsibilities, the thinly spread Corps of Engineers needed every available officer, no matter the amount of their post-graduate education. Thus, in the case of the sixteen students entering the School of Application, they received only six months of coursework. The 1903 and 1904 West Point graduates did not attend the School of Application at all once they received their commissions. They made the best of any on-the-job training available at their posts.[48]

Reopening the Engineer School and Preparations for Modern Warfare, 1905–17

When the institution reopened in 1905, the name changed to the simpler “Engineer School.” The school also fell directly under the authority of the War Department General Staff, though the chief of engineers still exercised considerable influence on the curriculum.[49] The War Department gave the Engineer School its new mission statement:

> To prepare the junior officers of the Corps of Engineers for the active duties of their arm and corps; to make researches in such branches of science as relate to the duties of the Corps of Engineers; to disseminate information so obtained; and to make such experiments and recommendations and to give such instruction as may be necessary for the civil engineering work of the Army.[50]

The tone clearly changed from the 1901 mission statement presented at the beginning of this chapter. The 1905 version dropped the school's role as a "supplement" to the education obtained by young officers at the Military Academy. More emphasis was placed on research and experimentation with the goals of applying the results across broad and practical levels.[51]

Courses at the Engineer School got underway in November 1905 with its first class of ten newly commissioned officers. The new curriculum made a few changes from the 1901 version. The four departments shrank to three: Military Engineering, Civil Engineering, and Electricity and Mechanical Engineering. Over two years of study, the curriculum covered several new subjects, deleted some altogether, and folded others into pre-existing departments.

Department of Military Engineering

- Permanent, semi-permanent, and hasty land defenses.
- Seacoast defenses, ordnance, armor, and explosives.
- Warships and sea power.
- Organization and equipment of troops.
- Military hygiene.
- Field duties of line and staff engineer officers.
- Drill regulations, minor tactics, logistics, sieges, and campaigns.
- Administration, hippology [the study of horses], military and international law.

Department of Civil Engineering

- Surveying, military reconnaissance, topography, field sketching, and photography.
- Field astronomy.
- Roads and railroads.
- Cements, mortars, concretes, masonry, and foundations.
- Roofs and bridges.
- Building construction.
- Water supply and sewage disposal.
- River and harbor improvements.
- Contracts, specifications, estimates, and accounts.

Department of Electricity and Mechanical Engineering

- Direct and alternating current machines and apparatus.
- Storage batteries.
- Transmission of energy and intelligence.
- Electric lamps.
- Steam engines and boilers.
- Gas and oil engines.
- Construction plan.

Source: "General Orders No. 136, War Department, 16 August 1905," in *General Orders and Circulars, Adjutant General's Office, 1905* (Washington, DC: Government Printing Office 1906), 3–4.

Figure 4.6. Engineer School Course List, November 1905. Created by Army University Press.

Several observations provide context for this new 1905 curriculum. The addition of Military Hygiene to the subjects likely harkened back to the US Army's dismal showing in logistics and medical treatment in the Spanish-American War. Six times as many American soldiers died in that conflict because of poor medical care and limited supplies, as died in combat proper. The Military Engineering Department also absorbed the subject covered in the 1901 version's Ordnance and Army Department.

The Department of Civil Engineering retained most of its competencies. Although the names of the subjects changed between 1901 and 1905, the functionalities remained comparable. The general subject of Construction in the earlier curriculum was fleshed out in several new subjects such as roads, railroads, roofs, and buildings. Municipal Engineering in the 1901 curriculum likewise became more specific with the addition of water supply and sewage. And finally, the old subject of strengths of materials was covered in cements, mortars, concretes, masonry, and foundations.

In 1905, the Department of Electrical and Mechanical Engineering kept pace with commercial and civilian technological advances by adding new subjects such as "direct current and storage batteries" and "gas and oil engines." Electricity as a power source had spread into areas of American life, and the advent of the combustion engine made travel and transportation increasingly easy. Contact time between faculty and students in the courses fell into four categories: theoretical texts, laboratory practices, lectures, and engineering problem-solving.[52]

Two commandants—Maj. Edward Burr and then-Maj. Eben Eveleth Winslow—served during the suspension of the School of Application in 1903 and directed the reopening of the Engineer School in 1905 and the subsequent revisions to the curriculum. During this time of uncertainty in the school's history, these two officers helped first to preserve the mission and second to update course offerings to be relevant to new officers. One of the highlights occurred on Winslow's watch when the *Engineer Field Manual* was published. This codified the techniques, procedures, and doctrines for engineering functions, both civil works and combat operations.

After Major Winslow departed in 1907, Maj. William Campbell Langfitt became the new commandant. He initiated several changes in the curriculum during his tour, which lasted until 1910. The Department of Civil Engineering maintained most of its original subjects, adding geodetic and hydrographic components to the Surveying coursework, and losing Photography and Topography to the Department of Military Engineering. Heating and Ventilation also found its way into the Civil Engineering curriculum. The Department of Electrical and Mechanical Engineering experienced the most change. Advances in electricity required the addition of electric lighting and searchlights, fire control apparatus, steam-powered electric machinery, hydroelectric power machinery, and electric power plant design to the curriculum. Attaching expertise in these subjects would be invaluable to Corps of Engineers officers when they worked on flood relief and New Deal projects in the 1920s and 1930s. Lastly, the Department of Military Engineering lost much of its coursework because it was reasoned that officers could develop these competencies during on-the-job training later in their careers.[53]

A primary driver for deleting courses was because the program dropped from two years in 1907 to only one year by 1910. This required the faculty to maintain quality of instruction in the classroom, laboratory, library, and field training exercise. Major Langfitt essentially reacted to external pressures from the Corps of Engineers and the War Department to condense the Engineer School's curriculum and made the best of a difficult situation.

Still, there may have been some benefits to the one-year curriculum. By order of the chief of engineers, all newly commissioned engineer second lieutenants would no longer proceed immediately to the Engineer School following their graduation from West Point. Instead, they would spend one full year as apprentices to a senior engineer managing civil works projects. This afforded opportunities to the young officers to observe real-world problems, solutions, and behaviors. During the last two weeks of their first tours in the field, they had to write a memoir applying theory and practice to what they had learned in the projects. This task would ideally make them better able to understand the applications of their coursework at the Engineer School during that second year of their careers.[54]

In what was likely his greatest contribution to the Engineer School and the engineering community as a whole, Major Langfitt helped establish a bi-monthly journal titled *Professional Memoirs*. The first issue appeared in 1909. He wanted the publication to help maintain institutional memory and become a conduit to circulate informative reports on scientific, technical, or engineering topics. A few article titles illustrate the range of coverage: "Lithographic Reproduction in the Field," "The Grade of Wagon Roads," "Timber for Ponton Material," "Railway Transportation Required for a Pioneer Battalion," "Test of the Bangalore Torpedo," and "The Modern Siege." Engineer officers quite often wrote articles based on their own experiences; the journal continued to be published until 1919.

Looking Ahead to the First World War and the Dawn of the Combat Engineer

While the US Army Engineer School at Washington Barracks gave students skills in civil works to fulfil their peacetime missions, graduating officers did not acquire all the necessary combat engineering skills required for modern warfare. Barely a dozen graduates of the Army Field Engineer School at Fort Leavenworth, Kansas, received training in combat functions. However, the majority of engineer soldiers still needed to add those combat skills to their existing civil works background. It would fall to the Engineer School to provide training in both military and general engineering functions. With these deficiencies in mind, efforts were made to apply lessons from the Spanish-American War and other conflicts to create more effective engineers in the future.[55]

Chief of Engineers Brig. Gen. William H. Bixby addressed these curricular strength and weaknesses when he commissioned a report in 1913 titled "Duties, Organization, Equipment, and Training of Engineer Troops and War Preparations of the Engineer Service."[56] This report formed the foundation for future doctrine developed at the school and also forced the Corps of Engineers to develop new structures. The industrialized warfare of the new century required mobile armies to fight on a fluid battlefield. Transportation challenges increased because vehicles with steam and combustion engines reduced the time required to move people and materials over long distances. Engineers were uniquely qualified to provide the combat forces with what in the twenty-first century is called maneuver support.

The 1913 report detailed both combat and general functions in modern warfare. Providing mobility to unit commanders required engineers to perform several activities, just as they had dating back to the Mexican War and earlier. The engineers needed to conduct reconnaissance missions to identify how bridges, roads, and terrain features would affect both friendly and enemy troop movements. Once the operational environment was assessed, they could start building bridges, paving roads, and breaching obstacles to ensure the combat force commander could maneuver his units on the battlefield. In the twenty-first century, this freedom of movement is called assured mobility. It is also worth noting that the report affirmed that engineers should be trained and armed to fight as infantry if needed.[57]

Apart from mobility in battle, the 1913 report outlined the countermobility and survivability functions of engineer units. The former entailed creating temporary defenses to protect friendly forces or to disrupt enemy movements. Survivability referred to more permanent defensive fortifications designed to resist full-fledged enemy assaults. The topographical and general engineering functions complemented these combat-related missions by providing commanders with expert terrain analysis and accurate maps. Combined, these presented a better picture of their operational environments.[58]

Next, the report turned to the tables of organization and equipment for engineer units. Each company should possess wartime strength of four officers, thirteen noncommissioned officers, and 158 enlisted men for a total of 175 soldiers. Three companies combined to form an engineer battalion, and two battalions in turn comprised an engineer regiment. Extensive lists of tools and supplies for these units, as well as roles of staffs at division and higher echelons, appeared in the reports.[59]

Beyond explanations about organization and equipment, the 1913 report introduced a new engineer rank called the master engineer. The noncommissioned officers holding this rank would receive higher pay than their peers and serve on staffs of battalion headquarters and echelons above battalion. The master engineers had to possess expertise in one of the following: lithography, photography, drafting, or surveying so they could provide commanders with accurate maps and analyses of reconnaissance and topography. This unique rank looked forward to the geospatial engineer warrant officer in the twenty-first century US Army.[60] While it was not produced at the Engineer School proper, the report generated important insights into how and why the school's curriculum evolved in the subsequent decades to offer the best training and education.

The First World War and Engineering in Modern Combat

While the engineers wrestled with new doctrines and force structures, the outbreak of hostilities in Europe in July 1914 quickly spiraled out of control and into the First World War. The realities of modern, industrialized warfare magnified the importance of engineering functions as critical components for planning, logistics, offensive, and defensive operations. The first few months of the conflict in Western Europe saw the German Army trying and failing to capture Paris by September 1914. Then the opposing armies settled into trenches by early 1915. These complex and virtually impregnable lines of field fortifications became permanent and symbolic fixtures of the First World War. Over the next three years until American units arrived en masse in 1918, stalemate and attrition reigned on the Western Front.

The Allied and German forces tried many times to achieve decisive victories by breaking through the enemy's trench system. After preparatory artillery bombardments, tens of thousands of soldiers would go over the top of their own trenches, race across no man's land, and attack the enemy's fortified trench systems. The assault forces would sometimes penetrate the enemy's outer defenses, but always lost momentum due to horrific casualties and enemy counterattacks. Machine guns, razor wire, and landmines gave the defenders advantages in firepower and survivability. Not even the frequent use of artillery shells with poisonous gas or the early employment of armored tanks changed the outcomes. Quite the contrary, the death tolls climbed higher and higher into the millions during the months-long battles of Verdun and the Somme in 1916. That next year started with little hope of ending the war.[61]

Maj. Paul S. Bond: The "Clausewitz" of Combat Engineering

Against the backdrop of war in Europe, a seminal article titled "Duty, Organization, Training, and Equipment of the Engineer Troops for Field Service" appeared in the November–December 1915 issue of *Professional Memoirs*. The article's author, Maj. Paul S. Bond, offered a remarkably sweeping portrait of what the Corps of Engineers should look like during field service, or combat operations.[62]

Bond drew on an active sixteen-year career. He graduated from West Point in 1900 and took a commission in the Artillery branch. In 1902, he transferred to the Corps of Engineers then spent a year studying at the Engineer School of Application at Washington Barracks. Between 1902 and 1915, Bond served on civil works assignments in several engineer districts in the United States and the Philippines. He completed two years as a student at the Army service schools at Fort Leavenworth, where he became the first honor graduate of the Army Field Engineer School. This curriculum exposed him to the Army's contemporary concept of mobile warfare. Bond was not content merely to execute his duties in these postings, however. He also engaged in research and writing about the future of military engineering in industrialized warfare.[63]

Bond's article in *Professional Memoirs* expanded upon the chief of engineer's 1913 report. Not only did Bond explore combat realities for engineering, he also integrated the engineering functions into what would evolve into combined arms doctrine and mechanized operations later in the twentieth century. Even during the first year of conflict in Europe, he recognized that engineers brought essential skills and expertise to the front lines and supply alike.

Figure 4.7. Maj. P. S. Bond. Courtesy of US Army Corps of Engineers Office of History Archives.

Bond first encapsulated the "special duties of engineer troops in the mobile army:"

• Reconnaissance of the natural and cultural features of the terrain, preliminary to tactical operations, or for other purposes.

• Reconnaissance of hostile works and dispositions.

• Collection of maps and other data from local sources.

• Correction and amplification of existing charts.

• Mapping of limited portions of the terrain within the sphere of tactical operations, and other minor survey duties.

• Map reproduction [and related] field methods.

• Collection and utilization of local engineering resources in personnel and material.

• Laying out of defensive positions and points of support.

• Planning and superintendence of offensive or defensive field fortifications, including obstacles, sapping and mining, etc., and the execution of the more difficult tasks in connection therewith.

• Laying out and improving camps.

• Construction and repair of roads, railroads, and bridges.

• Construction of temporary buildings, and repair of permanent buildings and other structures.

• [Use and placement of] military demolitions.[64]

This inclusive list remains as applicable to more recent conflicts as it did to the First World War. Bond concurred with Chief of Engineers Maj. Gen. William Murray Black and his 1913 report when Bond called for specialization of individual engineers and their units. All would be engineer soldiers, yet each would receive training in extra skills necessary to respective tasks listed above.[65] Unwittingly, Bond also looked forward in time to today's military occupational specialties, including Combat Engineer, Bridge Crewmember, Plumber, Carpenter/Mason, Geospatial Engineer, Horizontal Construction Engineer, and Asphalt and Concrete Equipment Operator.

Bond also reminded his readers never to forget the other key role in combat that every engineer must be able to play. "So long as the engineers retain their rifles, they have all the fighting power of the best infantry," stated Bond. "And even if they be not actually employed on the firing line, [the engineers] form at all times a not inconsiderable reserve to the combatant troops, enabling the commander to commit more troops to action than would otherwise be practicable."[66] In other words, engineers needed to be both builders and fighters.

After the United States entered the First World War in April 1917, Major Bond put his theories into practice as commander of the 107th Engineer Regiment in the 32nd Division and as commandant of the Army Engineer School at Langres, France. His long-term influence on the Corps of Engineers and the Engineer School cannot be overstated. For example, Bond published several books and manuals on military topics, including the classic *Engineer in War* (1916) and the multiple volumes of *R.O.T.C. Manual, Infantry* and *R.O.T.C. Manual, Engineers*. Writing decades later, one author made the legitimate claim that Maj. P. S. Bond should be called the "Clausewitz of Combat Engineering."[67]

US Army *Field Service Regulations* and Lack of Attention to Combat Engineering

The 1913 report by Major General Bixby and the 1915 article by Major Bond argued that engineers would make many contributions to modern warfare. Despite the obvious lessons coming from Europe before the US involvement in the First World War, however, the US Army as an institution did not yet grasp how integral engineering functions had become. This ignorance was evident in the 1916 version of the Army's *Field Service Regulations*. This document's table of contents listed many sections that required engineering activities or at least assistance from engineers: "Coast Defense," "Service of Military Railways," "Transportation by Rail," "Reconnaissance," "Field Maps," "Intrenchements [sic]," "Passive Defense," "Defense Seeking a Favorable Position," and "Shelter during Sieges."[68] Nevertheless, no meaningful explanations of the engineering contribution were made in the *Field Service Regulations*. A section on offensive operations only mentioned mobility in passing: "Engineers are usually attached to an advance guard to remove obstacles, repair roads, etc. Circumstances may require a bridge train to be attached."[69] Elsewhere, a terse passage explains countermobility: "Engineers are usually attached to an outpost to assist in constructing entrenchments, clearing the field of fire, and opening communications laterally and to the rear."[70] The other functions of survivability and topographical engineering received no attention at all.

The only major exception to the limited coverage of engineering in the *Field Service Regulations* appeared in a section titled "Engineer Train" in the table of contents. This three-page section focused on the general engineering function during combat operations.[71] In retrospect, the American experiences in the First World War demonstrated how unrealistic the limited emphasis on engineering functions truly was in the *Field Service Regulations,* and why the US Army needed a more accurate statement on engineers in modern combat operations.

Conclusion

The US Army training program for engineers went through several phases between 1866 and 1917. Its name changed several times before becoming the simple yet descriptive US Army Engineer School. The school's location moved from West Point to Willets Point in 1866 and then Willets Point to Washington Barracks in 1901. Nevertheless, the school's mission remained consistent throughout the intervening decades. The faculty used the curriculum to prepare engineer officers, noncommissioned officers, and enlisted specialists to perform engineering functions. The school also proved to be a place where doctrine and equipment could be developed. The publications by faculty and the experimentation on submarine mines stand as prime examples of the vibrant engineering environment cultivated first at Willets Point and later at Washington Barracks. All these efforts helped the school and Corps of Engineers prepare engineers to execute their five functions in the First World War and contribute to the Allied victory.

Notes

1. Walter Scott Dillard, "The United States Military Academy, 1865–1900" (PhD diss., University of Washington, Seattle, WA, 1972), ix.

2. Michael Murrin Harmon, "The Formation of the Engineer School of Application and its Early History, 1866–1898" (MA thesis, George Washington University, Washington, DC, 1985), viii; Brevet Brig. Gen. Henry L. Abbot, "The Early Days of the Engineer School of Application," *Occasional Papers, No. 14* (Washington Barracks, DC: US Army Engineer School of Application, 1904), 4–5, 31–32; and David C. Chuber, "Field Fortifications during the American Civil War: A Tactical Problem" (MMAS thesis, US Army Command and General Staff College, Fort Leavenworth, KS, 1996), 102–3.

3. Harmon, 6–9. For Humphreys and his wartime career, see Matthew T. Pearcy, ed., "Andrew Atkinson Humphreys' Seminole War Field Journal," *The Florida Historical Quarterly* 85, no. 2 (2006): 204–30; and Matthew T. Pearcy, "'No Heroism Can Avail': Andrew A. Humphreys and his Pennsylvania Division at Antietam and Fredericksburg," *Army History* 76 (Summer 2010): 7–26.

4. Gustav J. Person, "The Engineer School of Application at Willets Point 1866–1901," *Engineer–The Magazine for Army Engineers* 42 (May–August 2012): 49; New York City Parks, "Willets Point Playground," accessed 4 April 2016, http://www.nycgovparks.org/parks/willets-point-playground/history; and Joan Wettigfeld, "Colonel Marinus Willett–A Link to Bayside's Past," *Bayside Historical Society News* (March 1990): 3.

5. R. R. Raymond, "The Engineer School," *Professional Memoirs, Corps of Engineers, United States Army, and Engineer Department at Large* 1, no. 2 (1909): 185, www.jstor.org/stable/44534866.

6. Chuber, "Field Fortifications," 102–3; Harmon, "The Formation of the Engineer School," 40; and Abbot, "Early Days of the Engineer School of Application," 4–5.

7. Barry Fowle, "Beginning at Willets Point," *Engineer–The Magazine for Army Engineers* 21, no. 2 (May–August 2012): 64; and Harmon, 18–20.

8. Larry D. Roberts, "A School for Officers: A History of the Engineer Officer Candidate School," (unpublished manuscript, US Army Engineer School, n.d.), 1, US Army Engineer School History Office Archives.

9. "General Orders No. 14, 11 December 1867, and General Orders No. 2, 6 January 1868," General Orders of Headquarters, Willets Point, NY, 1866–80, US Army Engineer School History Office Archives.

10. Abbot, "Early Days of the Engineer School of Application," 7.

11. Abbot, 8, 23; Harmon, "The Formation of the Engineer School," 20–21; and Person, "Engineer School of Application," 50.

12. Kenneth M. Moore, "The Engineer School," *The Military Engineer* 27, no. 151 (January–February 1935): 9.

13. David M. Dunne, "The Engineer School," *The Military Engineer* 41, no. 284 (November–December 1941): 412.

14. "General Orders No. 6, 19 March 1868," General Orders of Headquarters, Willets Point, NY, 1866–80, US Army Engineer School History Office Archives.

15. For sources on the Essayons Club, see Dunne, "The Engineer School," 412; Abbot, "Early Days of the Engineer School of Application," 4, 8–10; Harmon, "The Formation of the Engineer School," 32–33; Person, "Engineer School of Application," 50; and Moore, "The Engineer School," 9–10.

16. Abbot, 9. For the fifty published presentations, see *Printed Papers of the Essayons Club of the Corps of Engineers*, vol. 1 (Willets Point, NY: Battalion Press, 1868–72); and *Printed Papers of the Essayons Club of the Corps of Engineers*, vol. 2 (Willets Point, NY: Battalion Press, 1872–82).

17. "General Orders No. 12, 30 June 1868," General Orders of Headquarters, Willets Point, NY, 1866–80, US Army Engineer School History Office Archives; and Harmon, "The Formation of the Engineer School," 22–23.

18. Fowle, "Beginning at Willets Point," 64; Harmon, 21–24; and Abbot, "Early Days of the Engineer School of Application," 11–14.

19. "General Orders No. 11, 8 December 1876," General Orders of Headquarters, Willets Point, NY, 1866–80, US Army Engineer School History Office Archives; Abbot, 14; and Harmon, 25–26.

20. "Annual Report of the Chief of Engineers to the Secretary of War for the Year 1873" (Washington, DC: Government Printing Office, 1873), 28. See also Harmon, 23–24.

21. Fowle, "Beginning at Willets Point," 64.

22. Person, "Engineer School of Application," 50; and Harmon, "The Formation of the Engineer School," 20, 34–35.

23. Abbot, "Early Days of the Engineer School of Application," 30–33, 39.

24. Abbot, 17; and Harmon, "The Formation of the Engineer School," 26.

25. "General Orders No. 9, 6 December 1874," General Orders of Headquarters, Willets Point, NY, 1866–80, US Army Engineer School History Office Archives; Dunne, "The Engineer School," 412.

26. Abbot, "Early Days of the Engineer School of Application," 19.

27. Abbot, 19.

28. Craig L. Symonds, *The Civil War at Sea* (Westport, CT: Praeger, 2009); James N. Tomb, *Engineer in Gray: Memoirs of Chief Engineer James N, Tomb, CSN*, ed. R. Thomas Campbell (Jefferson, NC: McFarland, 2005); Abbot, 17–22; and Harmon, "The Formation of the Engineer School," 26–28.

29. Abbot, 22.

30. Cited in Abbot, 37. See also Moore, "The Engineer School," 10.

31. Roberts, "A School for Officers," 2.

32. Cited in Abbot, "Early Days of the Engineer School of Application," 37. See also Person, "Engineer School of Application," 51–52.

33. Moore, "The Engineer School," 10.

34. Raymond, "The Engineer School," 185–86; and Moore, 10.

35. Chief of Engineers, "Annual Report, 1886," US Army Engineer School History Office Archives; Abbot, "Early Days of the Engineer School of Application," 35–41; and Harmon, "The Formation of the Engineer School," 43–50.

36. Harmon, 57–60.

37. Fowle, "Beginning at Willets Point," 6; and Harmon, 61–62. For a classic study of progressivism in the 1890s, see Robert Wiebe, *The Search for Order, 1877–1920* (New York: Farrar, Straus, and Giroux, 1966).

38. "Report of the Chief of Engineers, Part 1," in *Annual Reports of the War Department* (Washington, DC: Government Printing Office, 1901), 38–39.

39. "Report of the Chief of Engineers," 42; Larry Roberts, *Engineers in World War II* (Fort Belvoir, VA: US Army Corp of Engineers, forthcoming), 2; and "General Orders No. 146, Headquarters of the Army, Adjutant General's Office, 9 November 1901," in *General Orders and Circulars, Adjutant General's Office, 1901* (Washington, DC: Government Printing Office, 1902), 1–2.

40. Moore, "The Engineer School," 11.

41. Moore, 11.

42. "General Orders No. 146, 1901," 2.

43. Harmon, "The Formation of the Engineer School," 56–61.

44. Lt. Col. William Wallace Wotherspoon, "The Training of the Efficient Soldier," *Annals of the American Academy of Political and Social Sciences* 26 (July 1905): 154–58.

45. "The School of Submarine Defense Now Open at Fort Totten," *Brooklyn Daily Eagle* (11 May 1902).

46. "General Orders No. 146, 1901," 2–3.

47. Wotherspoon, "The Training of the Efficient Soldier," 149–60; Dunne, "The Engineer School," 412; and Capt. Lytle Brown, "The Engineer Soldier: His Training," *Professional Memoirs* 1, no. 3 (July–September 1909): 240–46.

48. "Report of the Chief of Engineers," *Annual Reports of the War Department*, vol. 2 (Washington, DC: Government Printing Office, 1903), 255; "Report of the Chief of Engineers" (1901), 42; and Moore, "The Engineer School," 11.

49. Roberts, "A School for Officers," 2; Moore, 11.

50. "General Orders No. 136, 16 August 1905, War Department," in *General Orders and Circulars, Adjutant General's Office, 1905* (Washington, DC: Government Printing Office, 1906), 1.

51. Moore, "The Engineer School," 11.

52. Earl Wheeler, "The Work of the Department of Electrical and Mechanical Engineering," *Professional Memoirs* 1, no. 1 (January–March 1909): 65–72.

53. "General Orders No. 136, 1 October 1909, War Department," in *General Orders and Circulars, Adjutant General's Office, 1909* (Washington, DC: Government Printing Office, 1910), 3–4.

54. "Editorial Notes," *Professional Memoirs* 2, no. 2 (April–June 1910): 259; Moore, "The Engineer School," 11; and Martin Reuss, "The Evolution of Engineer Officer Education, *Engineer–The Professional Bulletin of Army Engineers* (February 1992): 46–47.

55. Office of the Chief of Engineers, War Department, "[Extracts] Duties, Organization, Equipment, and Training of Engineer Troops and War Preparations of the Engineer Service," 19 February 1913, 28, World War I Collection, US Army Engineer School History Office Archives.

56. Office of the Chief of Engineers. See also Roberts, *Engineers in World War I*, 7–11.

57. Office of the Chief of Engineers, 11, 20–21, 25.

58. Office of the Chief of Engineers, 11–19.

59. Office of the Chief of Engineers, 1–3, 7–9.

60. Office of the Chief of Engineers, 7–8.

61. For surveys, see Hew Strachan, *The First World War* (New York: Viking, 2004); and Gerard J. DeGroot, *The First World War* (New York: Palgrave Macmillan, 2001).

62. Maj. P. S. Bond, "Duty, Organization, Training, and Equipment of the Engineer Troops for Field Service," *Professional Memoirs* 7, no. 36 (November–December 1915): 691–718.

63. Paul Stanley Bond, Biography Files, US Army Corps of Engineers Office of History, Alexandria, VA.

64. Bond, 692–93.

65. Bond, 705–17.

66. Bond, 699.

67. Maj. Robert M. Butts, "P. S. Bond, the Clausewitz of Combat Engineering: Does Assured Mobility Follow His Principles?" (monograph, School of Advanced Military Studies, US Army Command and General Staff College, Fort Leavenworth, KS, 2003), 4–8, www.dtic.mil/dtic/tr/fulltext/u2/a430934.pdf. For an overview of the evolution of combined arms operations, see relevant chapters in Jonathan M. House, *Combined Arms Warfare in the Twentieth Century* (Lawrence, KS: University Press of Kansas, 2001).

68. War Department, *Field Service Regulations, United States Army, 1914*, rev. 20 December 1916 (New York: Army and Navy Journal, 1916), 5–8.

69. War Department, 27.

70. War Department, 34.

71. War Department, 7, 143–45.

Chapter 5

The Great War and Its Aftermath at the Engineer School at Camp Humphreys and Fort Belvoir, 1917–19

The United States of America made a late entrance into the First World War. Despite watching nearly three years of conflict from July 1914 to April 1917, the US military was ill-prepared for the realities of twentieth-century combat. Once at war, the Army's engineers found themselves playing integral roles in combat and sustainment efforts in a modern and industrialized conflict. A simple fact that cannot be ignored is that this conflict became a turning point in the history of the engineers in regard to how the Corps of Engineers functioned and trained, what equipment was required, and the size and number of the units themselves.

Although the Engineer School's operations at Washington Barracks were suspended in 1917, the mission of providing specialized training for engineers of all ranks continued in several other venues in the United States and Europe. Following the end of the First World War, the US Army Engineer School reopened in its new location, Camp A. A. Humphreys, in northern Virginia. Beginning in 1919, the faculty and students spent two decades trying to accomplish two major goals: first, to analyze lessons from the First World War to better prepare engineers for future conflicts; and second, to survive downsizing during post-war demobilization followed by ongoing meager budgets in the 1920s and the 1930s.

Effects of Rapid Wartime Mobilization on the Engineer School and Corps of Engineers

The United States remained ostensibly neutral in the First World War from 1914 through early 1917. In reality, however, the United States increasingly supported France and Great Britain against Germany by loaning money and supplies to the Allies. The Germans, aware of this assistance, began to take countermeasures to blockade Atlantic shipping lanes and covertly supported several different factions in Mexico, where a revolution had been taking place since 1910. Germany thought that the United States was unlikely to intervene in Europe as long as its neighbor to the south was in turmoil. The 9 March 1916 cross-border raid on Columbus, New Mexico, by Mexican revolutionary Francisco "Pancho" Villa and his followers caused a partial mobilization of the US Army with the goal to bring Villa to justice and secure the southern border. The Mexican Expedition, often referred to as the "Punitive Expedition," lasted about eleven months.

General John J. Pershing was severely restricted in his conduct of his campaign because the Mexican head of state, Venustiano Carranza, refused to accept the presence of American soldiers on Mexican soil. Pershing had to walk a thin line between attempting to find Pancho Villa and his followers while at the same time avoiding an outright war with Carranza and his Constitutionalists. Even though Pershing was unsuccessful in his attempt to capture Pancho Villa, this expedition had enormous effects on the US Army's war readiness as well as its large-scale mobilization efforts in support of World War I. While European powers used motorized vehicles, airplanes, machine guns, rapid-firing artillery, and other modern novelties in large numbers for several years at this point, the American military was still in its infancy. The expedition into Mexico became a testing ground for the American modernization attempt and saw the first deployment of motorized vehicles and the use of airplanes in a reconnaissance and courier capacity. Cold weather and rough terrain complicated logistics and mobility efforts even with these new capabilities.[1] Only the engineers could help alleviate these problems. In *The Military Engineer*, Col. Henry A. Finch describes how engineers provided maneuver support and assured mobility support during the Mexican Expedition:

> The compulsion laid on members of that group to be willing . . . to forget "what the book says," and, on occasion, even to act in direct opposition to the dictates laid down in the manuals. . . . In the beginning the existing road was of packed earth and it wandered over hill and dale in the semi-desert country. Quite adequate for the light Mexican wagons that had been using it for decades, it quickly went to pieces under the pounding given to it by our army trucks. . . . As fast as our force of engineer soldiers, and some hundreds of Mexican hired laborers, could be brought to the worst spots, the ruts were filled by hand and by road scrapers, and the road was crowned in strictly conventional fashion. The theory was that the expected rains would pack the loose material—and so they would have done—but they never came.[2]

Finch next explains how engineers solved the problem by field expediency, more popularly known as a soldier's solution:

> There happened to be an answer, which was discovered toward the last by some unsung genius unhampered by reverence for the textbooks. This was to reverse the blade of the scraper, thus removing the loose material to the shoulder of the road instead of mounding it in the center. This improved traction by exposing the harder material on the lower levels.[3]

Finch concluded that "Service in Mexico was good experience for the test to come" in the First World War.[4] Now-famous leaders such as George S. Patton experienced their first taste of combat during the expedition, and relationships built by Army leaders during this time were invaluable. Not only did the approximately 10,000 US Army soldiers who served in Mexico gain valuable experience; an additional 110,000 or so National Guard members received much-needed training while securing the border with Mexico from May 1916 through February 1917.[5]

Figure 5.1. Engineer Corps testing a road scraper behind a Jeffery truck at Columbus, New Mexico, before entering Mexico in 1916. Courtesy of US Army Engineer School History Office Archives.

While Pershing campaigned in Mexico, the US Congress recognized the potential threat of future cross-raids along the Mexican border and the possible upcoming involvement in Europe and therefore passed the National Defense Act of 1916. This legislation included plans for the creation of a Reserve Component, the establishment of the Reserve Officers Training Corps (ROTC), and the wartime expansion of the US Army and National Guard. It is debateable if the act would have passed without the US Army's involvement in Mexico.

Following the withdrawal of US troops from Mexico in February 1917, the possibility of the United States entering the First World War turned into a probability. The dwindling resources of Germany in particular left that nation desperate to break the stalemate. Thus in February 1917, the German Navy launched a campaign of unrestricted submarine warfare wherein vessels from any nation could be attacked and sunk by German submarines without warning. The outrage among Americans after the Germans sunk several American ships finally pushed the United States to declare war against Germany in April 1917.

Some six weeks after entering the First World War, Congress passed the Selective Service Act, which mandated the compulsory enlistment of American men into military service. The Army's prewar strength in April 1917 was a little more than 200,000 men, of whom 80,000 were federalized National Guard soldiers. While the National Defense Act of 1916 provided for the gradual expansion of the regular army and reserves, the Selective Service Act made available twenty-four million men who registered for the draft; almost 2.7 million of those men were provided to the US Army by conscription. Voluntary enlistments during this time were slightly more than 300,000.[6] The coinciding demand for officers in all Army branches could not be met by graduates of the US Military Academy, Officers Reserve Corps volunteers, or university ROTC students. In fact, the Military Academy's four-year program was reduced to two years in order to fill the Army's officer slots more quickly with newly commissioned graduates.

In the meantime, the French and the British had exhausted their own manpower reserves, not to mention the goodwill of their citizens. Both nations believed that only the influx of Americans could tip the scales against the enemy, especially Germany. The First Expeditionary Division, later designated the 1st Infantry Division, deployed its first units to France in June 1917 but the entire 1st Division did not arrive in France until December 1917. The 26th Division from New England, the first National Guard Division, deployed to France in September 1917. When the United States entered the First World War, very few of its men in uniform had served in the military, let alone experienced actual combat. A still greater challenge came in recruiting and training soldiers for the artillery and engineer branches, both of which required more skills and knowledge than the basic infantry. The Corps of Engineers tried to attract civilians with previous experience in technical, scientific, engineering, or industrial fields. There was simply no time to train engineer soldiers of all ranks in surveying, demolitions, or bridge building from scratch. They needed to come into service with these skill sets, so the Corps of Engineers used advertisements to targeted qualified recruits. In specific cases, such as finding individuals with forestry or railroad backgrounds, entire lumber and railroad businesses were brought into service. The managers and foremen became officers and noncommissioned officers, and the laborers became enlisted engineers.

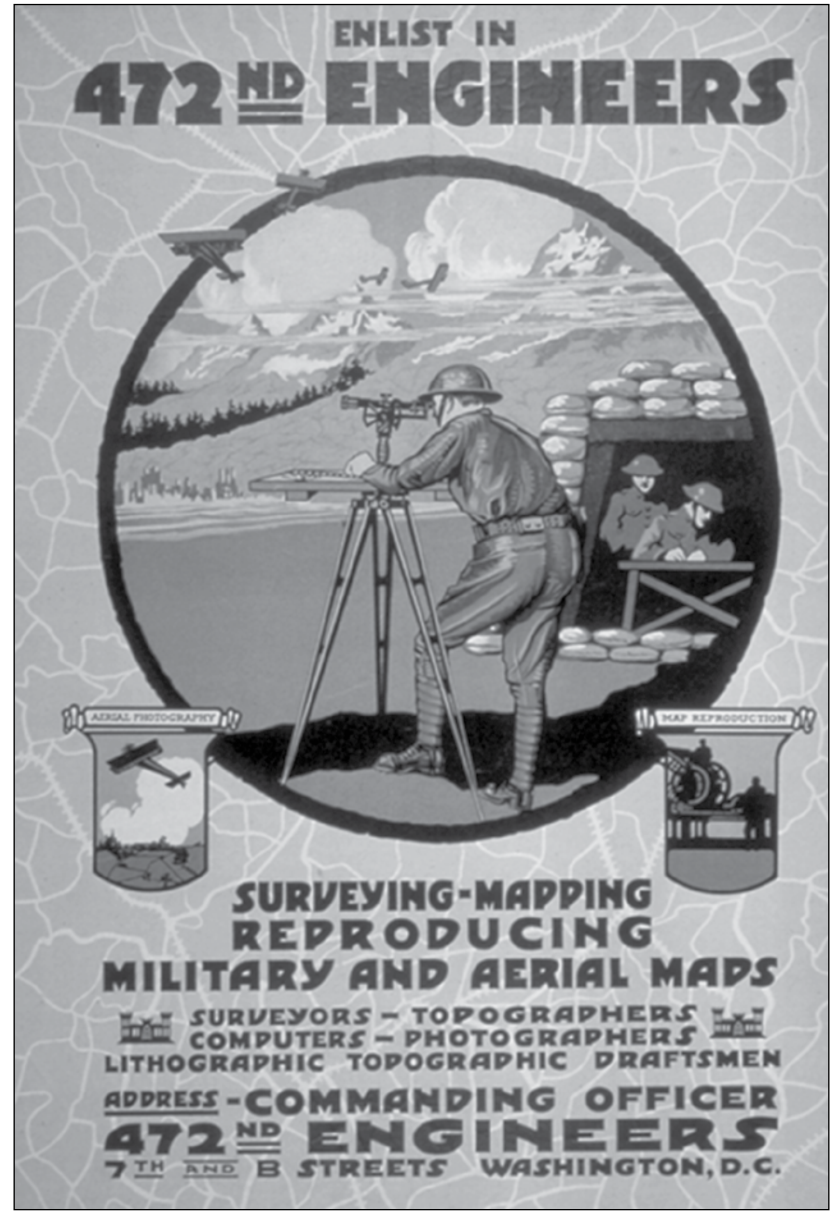


Figure 5.2. Engineer recruitment poster in the First World War. Note the obvious appeal to recruits with technical and professional skill sets. The Corps of Engineers did not want the average enlistee or draftee. Courtesy of the National Archives and Records Administration.

Apart from American combat units, the Allies also desperately needed engineers to help maintain and expand the existing infrastructure that connected the French ports with the front lines. Continental roads and railroads had been run ragged over the previous three years, leaving the infrastructure in France in poor shape. Moreover, the eventual deployment of some two million American soldiers required many new facilities, roads, docks, and railroads to accommodate increased troop movement. To meet these various logistical needs during the summer of 1917, the US Army organized nine railway regiments and sent one combat element—the 1st Regiment of Engineers (expanded, reorganized, and redesignated on 1 July 1916 from the 1st Battalion of Engineers) organic to the 1st Division. These units, each numbering some 1,500 men, sailed for France by August 1917. Several of the railway regiments went immediately into service with French or British forces, sometimes constructing trenches and field fortifications while under enemy fire, in addition to their primary work on the railroads.[7]

Filling its units with competent soldiers was hard enough for the US Army Engineer School during the pre-war years. The scope and scale of wartime demands quickly overwhelmed the resources at Washington Barracks. The influx of new recruits forced the chief of engineers, Maj. Gen. William M. Black, to suspend the school's coursework at Washington Barracks on 28 April 1917, just three short weeks after the declaration of war. This did not mean, however, that training ceased altogether. Instead, the school's instructors and students transferred to other training camps or to newly organized units.[8] The engineer officers coming out of the US Military Academy also took assignments in the camps and units, thus skipping the pre-1917 post-graduate education offered by the Engineer School.

The Corps of Engineers gradually expanded a multi-tiered system for officer training during the First World War:

• Engineer sections in sixteen Army officer training camps in the United States (1917–18).

• Three regional Engineer Officer Training Camps in the United States (1917).

• Temporary attendance at French and British engineering schools (1917).

• Two consolidated Engineer Officer Training Schools in the United States (both in 1918).

• Engineer sections at three permanent Corps of Engineers schools in France (1917–18).

• Engineer section at a permanent Army Candidate School in France (1918).

• Two permanent Army Engineer schools in France (1917 and 1918).[9]

Each institution catered to a particular group of officers or would-be officers. The growth of this school system was partly pragmatic and partly haphazard because no American blueprint existed for training officers or replacing them while in the field in France.

Beginning in May 1917, Americans seeking commissions needed to pass an examination to become officer candidates. Those who passed as well as men holding commissions in the Engineer Officer Reserve Corps entered one of sixteen Army training camps across the United States. These camps provided initial introductions to military drill, discipline, tactics, and the specific roles of all branches. An engineering section exposed the men to the basic skills required in that particular branch. They received instruction while in regiments, each of which included one engineering company.

After one month in the Army camps, the engineer officer candidates and Reserve officers moved to one of three specialized training areas at Fort Leavenworth in Kansas, Vancouver Barracks in Washington state, or a site near Washington, DC. At these training areas, the soldiers acquired more in-depth skills and knowledge of infantry and engineering during a two-month program. They learned to be instructors who could train other officers and men in future units, unit managers who could fulfill Army administration responsibilities, and leaders who could command units in the field and combat, as needed.

Because so many of the engineering officers-in-training had backgrounds in engineering, scientific, or technical vocations, they were not required to learn about construction roles. In August 1917, after three months of training, some 1,966 soldiers graduated from what became known as the Engineer Officer Training Camps. Those already possessing Reserve commissions started to fill slots in engineer units, while the officer candidates first had to earn their commissions before joining units. Then from September through November 1917, a second set of training cycles ran at the three camps.[10]

A better organized, more coordinated training structure for engineers was finally adopted in January 1918. The activities of each specialized school consolidated into a single Engineer Officer Training Camp at Camp Lee, Virginia. Some courses previously offered at the US Army's Engineer

School at Washington Barracks also moved to Camp Lee. According to the chief of engineers, Maj. Gen. William Black, “No attempt was made at these training camps to teach civil or other branches of engineering as such, since all officers and candidates had to be trained and qualified engineers before they could be commissioned or admitted to the camps.”[11] The curriculum at Camp Lee focused mainly on combat engineering functions, because the 1,500 candidates would need practice implementing their training in the field.

Later in August 1918, the Engineer Officer Training Camp moved to its final location at Camp A. A. Humphreys, where the name also changed to the Engineer Officer Training School. Humphreys comprised 1,500 acres of land along the Potomac River not far from Mount Vernon. This area, known as Belvoir, possessed ample space for training in marksmanship and engineer-specific tasks like bridge-building and road construction. Engineers had trained at Humphreys for several years before the 1914 start of the First World War.[12]

Prior to August 1918, Camp Humphreys served as an engineering training center for enlisted personnel. Its capacity rose to 16,000 troops in late 1917 and then to 30,000 by late 1918. Not only did the camp include officer candidates, but it also provided courses for noncommissioned officers, enlisted personnel, and technical specialists. More than 50,000 engineer soldiers received their basic training at Humphreys between January 1918 and the end of the war that same year.[13]

Approximately two-thirds of the Engineer Officer Training School’s curriculum focused on training not directly associated with the engineer branch. The majority of time was devoted to non-engineering topics because, as historian Larry Roberts asserted, “The Corps did get men, of whatever quality, from whatever source. The next challenge was turning them from civilians to soldiers. Training was a far greater challenge than convincing American citizens to rally to the flag.”[14] The school committed 544 of the total 789 hours of instruction, study, and examination hours to non-engineering topics. Of these hours, the biggest single block of time—144 hours—concentrated on Infantry drill. Another 200 hours covered marksmanship, physical fitness, general tactics, and bayonet practice, all of which were basic soldiering skills. Students spent 120 hours on company-level administration of units, personnel, and regulations.[15]

The remaining hours in the school’s curriculum focused on training in engineering-specific missions and skills. Students spent ninety-eight hours learning about fortifications, which made sense given the prominence of

defensive and offensive operations in the trenches in the First World War. Two blocks of forty-seven hours each were dedicated to reconnaissance and bridging, respectively. Demolition and rigging garnered only ten hours of training. Lastly, almost as an afterthought, the surveying, construction, and maintenance of roads took up a mere two hours of the entire 789-hour curriculum. Although there was an expectation that future officers possessed engineering backgrounds in road construction, this limited training at the school belied the huge amount of time spent by engineer units rehabilitating roads and constructing new ones in France.[16]

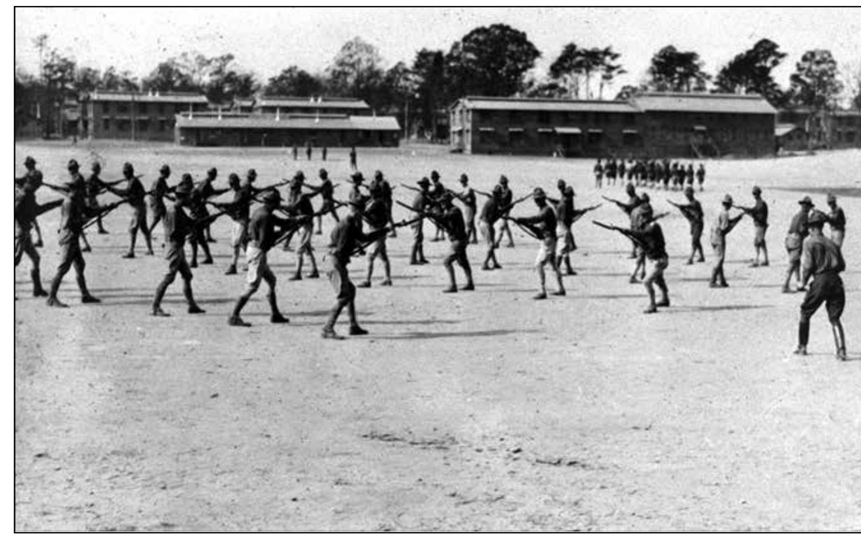


Figure 5.3. Bayonet drill at Engineer Officer Training School during the First World War. Courtesy of US Army Engineer School History Office Archives.

In organization, the Engineer Officer Training School resembled the US Army Engineer School of the late twentieth and early twenty-first centuries. It had seven or eight training companies, each with approximately 250 officer candidates; twelve active-duty Army officers filled administrative and instructional roles. These companies were divided between two sections, and the classes were staggered with one section starting one week before the next, which allowed for continuous training cycles. Unlike the US Army Engineer School of the late century, however, the officer candidates of 1917/18 then crossed the Atlantic Ocean with newly assigned units, landed in France, and received still more training in preparation for service with general or combat engineering units.[17]

When the Engineer Officer Training School opened at Humphreys in August 1918, the daily training load numbered 750 soldiers before growing to more than 1,600 by October. The entire system only began to achieve a level of efficiency by the war's end the following month. A total of 4,900 engineer officers were trained at Humphreys between August and November 1918.[18]

Additional Training for Engineers "Over There" in France

Despite the school's best efforts, many engineer officers left the United States in 1917 without fully adequate military training. Once they disembarked in France or Britain, the still-raw American officers received further instruction from the Allies, such as in mining courses at Chatham, England, and in sapper (i.e., combat engineering) courses at Chalons-sur-Marne, France. The engineers also shadowed their French and British counterparts to learn real-world applications of mobility, countermobility, survivability, general engineering, and topographical engineering. These assignments were temporary, however, because the senior leadership of the American Expeditionary Force (AEF) planned to create their own engineering schools and other branch schools in France. They simply needed to wait until a critical mass of American soldiers set foot in that nation.[19]

Several schools gradually came on line in France by late 1917. First, the Army Engineer School at Langres opened at the end of October. The next two months saw final preparations for the first class, which started in January 1918. The curriculum covered topics such as bridging, camouflage, mining, pioneering, topography, searchlights, and flash and sound ranging.[20] One AEF staff officer identified the mission statement for the school at Langres and the job description of its commandant:

> The Engineer School affects not only the instruction of engineer troops and services, but by the instruction they give in fortification and in the organization of the ground, also the instruction given to all branches of the service. It is essential that the commandant of the Army Engineer School, which trains instructors of all engineer schools, be an officer not only with engineer training and experience but also with tactical and staff training.[21]

Both the mission statement and description resemble the Engineer School of the twenty-first century. On 1 March 1918, the Engineer School moved several miles north of the city of Langres to Fort St. Menge, where Col. P. S. Bond became its new commandant. With unit command, staff work, and doctrinal publication in his background, he epitomized the qualifications of an engineer commandant. Bond's expertise helped prepare the engineer

officers for duties they would face in combat opérations during the last year of the war.[22]

After three months of classes at Langres or Fort St. Menge, the officers spent four or five weeks of advanced training in the engineer sections of one of the corps-level schools established by the AEF in late 1917 and early 1918. The three schools included the First Corps at Gondecourt, Second Corps at Chaillon-sur-Seine, and Third Corps at Clamecy. In this case, the term "corps" referred to the echelon above division. The First Corps School was tasked with returning graduates to other schools to serve as instructors and with preparing officers and noncommissioned officers "for duty in the line" in six divisions comprising the AEF's First Corps, or officially I Corps.[23]

The curricula at the corps-level schools were mandated to achieve the following objectives:

> Sufficient knowledge of divisional operations in open and trench warfare to ensure a correct understanding of the pioneer and engineer work required, proper organization for work, and cooperation with other arms of the service; instruction, theoretical and practical, in all classes of pioneer and engineer work which may be required and for which the divisional engineers are equipped (except instruction in bridging); instruction in the handling of engineer detachments, sections, and companies, and in the supervision of pioneer work of other troops. The instruction for noncommissioned officers will be devoted chiefly to practical work and to handling of detachments and sections in such work.[24]

By the time the last class ended in March 1919, the three schools had enrolled some 1,095 officers and 1,230 noncommissioned officers. No statistics are available for the completion rates. Once they completed the four- or five-week coursework, the officers and noncommissioned officers received still more training in bridging through the Army Engineer School and in infantry tactics at the corps schools.[25] This scope and content of the corps-level schools resembled those of today's Engineer Captains Career Course at the US Army Engineer School and the Advanced Leadership School at the Noncommissioned Officer Academy at Fort Leonard Wood, Missouri.

The Army Engineer School at Langres, together with the Engineer Replacement and Training Depot at Angers, also taught engineering skills to soldiers just arriving in France. The replacement depots at Langres and Angers helped rectify possible preparation shortcomings experienced by engineers before they were deployed to front line units.[26]

The flow of Army officers from the United States could not meet the demands of newly organized units or units needing replacements in France. This problem was caused, in part, by the increasingly high number of casualties at the platoon and company levels by the summer of 1918. To fill these gaps, particularly at lieutenant and captain ranks, the AEF established an additional organization—the Army Candidate School—to train prospective Army officers from among the noncommissioned ranks.[27] According to the *Chief of Engineers Historical Report for the AEF*, the noncommissioned officers would be selected to attend Army Candidate School because they demonstrated "fitness as officer material" and "previous efficient work." The curriculum lasted for three months with coursework in an engineer section, as well as infantry, artillery, cavalry, and signal corps sections for each respective branch. The candidates had to perform at high levels to graduate and receive their battlefield commissions. Conversely, any individuals who exhibited "incapacity for commission grade" during their courses "were relieved and returned to a replacement depot for reassignment" at their previous ranks.[28]

In theory, this program of identifying potential officers from among existing units should have worked well, but that was not always the case. At times, unit commanders did not choose to send their best noncommissioned personnel to the Army Candidate School. Quite simply, they did not want to lose key squad, platoon, and company leaders so necessary for effective combat operations. This was to say nothing of the experienced officers who left their units at the front and spent three months serving as instructors, absences that left voids in the role of company commander or other higher ranks. The war ended in November 1918 before the educational system could be fully operational.[29]

General and Topographical Engineering in the First World War

The maneuver support and sustainment contributions provided to the AEF by engineers during the First World War were nothing short of incredible. In late 1917, a *Scientific Monthly* editorial praised the Corps of Engineers for creating "the free arteries through which flow great armies, reinforcements, supplies, and ammunitions to the extremities of the lines" in France. The corps' work in general engineering started from the moment American soldiers and materials arrived in French ports, some of which were built or enlarged by US engineer units. Next, the men and materials travelled on roads and railroads and across bridges often surveyed, constructed, or repaired by US engineer units.[30]

Figure 5.4. Forestry engineers in the First World War. Courtesy of US Army Engineer School History Office Archives.

Railroad ties and wooden piles came from lumber harvested and milled by US Forestry engineers. Thanks to ongoing efforts by US engineers, many barracks, hospitals, and storage facilities also sprang up between the ports and the front lines. Once at the front, US topographical engineers also helped operations by creating accurate maps and models based on existing maps, surveys, photographs, and ground and aerial reconnaissance. Even so, stepping back and using hindsight, the American engineering efforts were only starting to increase during 1918. The maximum wartime results would not have been seen until 1919. The following partial list of projects provides a snapshot of the massive scale and scope of logistics (i.e., sustainment) contributed by approximately 240,000 engineers and some civilian laborers in France between April 1917 and November 1918:

• Production of 200 million board feet of lumber and four million railroad ties.

• Operation of 107 sawmills by engineers.

• Construction of docks and harbor facilities, including ten 410-foot berths at the port of Bassens on France's Atlantic coast.

• Construction of 937 miles of standard-gauge railroad tracks and an extensive sixty-centimeter narrow-gauge light rail system to the front lines.

• Construction of several hundred bridges of all sizes and types, including a 2,190-foot railroad bridge over the Loire River.

• Erection of twenty-two million square feet of storage buildings, aircraft hangars, and other facilities.

• Construction of medical facilities.

• Construction of 16,000 barracks capable of housing more than one million soldiers.

• Production of more than twenty-two million maps of all formats and sizes.[31]

This list was all the more impressive because the majority of those American engineers did not arrive in France until the spring of 1918. This timeframe left them less than eight months to complete all of these tasks. Some of the sustainment efforts were even accomplished while under enemy artillery or aerial bombardment.

On a side note, today's US Army Chemical Corps traces its origin to the Corps of Engineers during the First World War. The use of poisonous chlorine, chloropicrin, phosgene, and mustard gases on the European battlefields resulted in the push of the senior American commander, General John J. Pershing, to create a Gas Service Section. He looked to the Corps of Engineers and appointed his chief engineer, Lt. Col. Amos Fries, to increase American offensive and defensive capabilities with these chemical weapons. General Pershing redesignated the 30th Engineer Regiment (Gas and Flame) as the 1st Gas Regiment in July 1918, and elements of the 1st Gas Regiment saw action in the Battle of Saint-Mihiel and the Meuse-Argonne Campaign. A month earlier, the US War Department created the Chemical Warfare Service. Maj. Gen. William Sibert, a fellow engineer officer who was the architect of the Panama Canal and former commander of the 1st Division, became the first chief chemical officer of the Chemical Warfare Service and is considered the "father of the US Army Chemical Corps."[32]

The Advent of "Combat Engineers" and their Functions in the First World War

The First World War proved to be a turning point for the US Army Corps of Engineers because of the magnitude of the American war effort and the new technologies of modern warfare. The conflict was the first time in American military history that so many engineer units were attached

to Army divisions engaged in frontline fighting. The three combat engineering functions of survivability, countermobility, and mobility were witnessed by most engineers during the American experience in World War I.

The planning by the Corps of Engineers in 1913 and the ideas of then-Maj. P. S. Bond in 1915 set the stage for the new specialized role of "combat engineer." This term did not, however, come into common use until after the First World War ended. Bond, for example, called them "field engineers" to differentiate their frontline duties from those engineers maintaining "lines of communications." He believed that each set of engineers should have specialized training, yet also possess sufficiently broad skill sets to take on any task.[33] American wartime engineering units attached to divisions were sometimes referred to as "sapper" units, while European armies designated them as "pioneers" or "assault pioneers." Even if "combat engineer" did not come into use until after the conflict had ended, the term aptly describes the soldiers who performed the three combat functions of the AEF's engineering units while attached to its divisions during the First World War.

Like their counterparts in the French, British, and German armies, the AEF's engineers played roles in the design, placement, and construction of trenches in 1918. These efforts fulfilled the function of survivability. The intricate trench systems were designed to maximize the defenders' ability to halt or blunt major enemy assaults until friendly forces could launch a counterattack. The engineers also dug deep bunkers to secure their fellow soldiers against enemy artillery bombardment.[34] Although made of earth, lumber, and concrete rather than stone and masonry, the trenches of the First World War drew on fortification doctrines developed more than two centuries earlier by the great French engineer Sébastien Le Preste Vauban.

Once the trenches were completed, engineers provided their AEF units with countermobility by placing obstacles like razor wire to disrupt enemy movements or funnel enemy troops into killing zones. Writing in December 1918 in his "Experience Report," Maj. William M. Hoge recalled how his engineer battalion "encountered all of the difficulties of laying out and constructing trenches and wire in actual warfare. Though at drills and from the books this had always seemed very simple, I found it to be quite the reverse on unfamiliar terrain under shell fire . . . it was a valuable experience."[35] His quote referenced training exercises, field manuals, and lessons learned—showing the link between engineering training and combat operations, albeit acknowledging that reality can be messier than classroom studies and field training exercises.

In what mirrored their defensive efforts, the combat engineers also worked to ensure tactical mobility for AEF offensive operations. They led the way during assaults that went "over the top" and across "no man's land." As the engineers neared the enemy trenches, they breached obstacles by cutting razor wire and destroying pillboxes. Ideally their efforts neutralized opposition defenses so AEF forces could reach the trenches beyond, hopefully break through, and drive deeper into enemy territory.[36]

While on the move, the combat engineers frequently built temporary bridges over gaps, laid railroad tracks for logistics, or constructed roads in no man's land. All these tasks enabled the infantry units to move more freely.[37] Once again, Hoge provided an example of this type of maneuver support in bridging the Meuse River in November 1918. He explained how two of his companies "put the bridge across besides ferrying a battalion of infantry over. This was done under direct machine gun fire from the enemy."[38] Hoge then credited "the success of the operation being due in large part to the bravery and devotion to duty" of his company-grade officers.[39]

Whether serving in combat or general engineering units, the engineers also set aside their shovels and took up rifles to defend themselves or serve as infantry in battle. The prioritizing of soldiering skills in training, like marksmanship, thus paid dividends at the front in France. During the Meuse-Argonne Offensive, for example, Hoge described how he and his unit fought as infantry:

> That was my first real tast [sic] of what warfare is and it was quite interesting. The orders came late so that by the time we got up the Germans had dropped their barrage between us and the second wave of the infantry. We got through this some way, though the details of the next hour or two are rather vague in my mind. We finally got into position however. Several patrols which were sent out captured about thirty prisoners together with a machine gun and anti-tank gun and cleaned out a wood.[40]

The actions of Hoge's unit embodied what P. S. Bond described in his prewar article about engineers fighting as infantry.

Engineering Lessons from the First World War

Many lessons from the First World War can be found in the War Department's *Field Service Regulations* from 1923. The fourth chapter established the engineer branch as both a "combatant arm" and a "combined arm" alongside the infantry, cavalry, artillery, signal corps, and air service.[41] The wartime engineering functions appeared later in that chapter and are excerpted in the following:

> Engineer troops are essentially organizations of skilled labor designed to increase the combat capacity of other arms through the execution of work facilitating their movement, increasing their defensive powers, and providing for their shelter and water supply.
>
> Engineers contribute to the mobility of armies by the maintenance of their routes of communication and the elimination of obstacles to their movement. They decrease the mobility of hostile forces by the execution of demolitions and the creation of obstacles. They increase the defensive powers of other arms by the construction of certain defensive works, by technical assistance to those arms in the construction of these works of defense, and by furnishing them with the necessary supplies and materiel for the execution of field fortifications. They assist in maintaining the efficiency of troops of all branches by making the necessary provisions for their shelter and water supply. . . .
>
> Engineer troops are classified as general and special. General engineer troops cover a wide field of engineering duties. These duties are, in general, in the nature of a pioneer service. General engineer troops include combat engineer regiments of infantry divisions, mounted combat engineer battalions of cavalry divisions.[42]

This lengthy quote exhibits much greater detail about the interconnectedness of the engineer branch with the other branches than did the 1916 *Field Service Regulations*. Only such lessons from the First World War could account for the higher official visibility of the engineers. This 1923 version also bore witness that the term "combat engineers" had officially entered the Army's lexicon.

It would fall to the newly reopened US Army Engineer School to draw upon the lessons of the First World War and train engineers to perform all anticipated missions in war and peace. Two other documents supplemented the 1923 *Field Service Regulations* with more detailed discussions of roles and missions: The US Army Engineer School's *The Engineer Service in War: A Manual of Instruction* (1922) and Lt. Col. P. S. Bond's *Field Engineering: A Practical Exposition of the Organization of the Ground for Defense* (1922). These documents, together with the *Field Service Regulations,* served as resources for the US Army Engineer School in its training mission. Indeed, the increasing wartime expectations for the Corps of Engineers required a corresponding expansion of the school's curriculum, doctrine writing, and research and development. The focus on trenches and field fortifications, however, continued to dominate the school's publications to include the 1932 *Engineer Field Manual*.

Post-War Years: Re-Opening of the Engineer School at Camp Humphreys

Following the end of the First World War in November 1918, the US military experienced a dramatic demobilization. Minimal funding restricted engineering research and development activities, let alone any actual procurement of new equipment. This left the engineers to train for combat with a surplus of First World War-era materials. The next two decades saw the armed forces languish in the wake of meager appropriations and token manpower levels. An isolationist American public and their elected officials refused to consider increasing support for the military. Their feelings grew more acute during the Great Depression in the 1930s, when most Americans worried much more about putting food on their tables than about growing military threats across vast oceans.

The Corps of Engineers returned to performing its many peacetime duties just as it had done following other wars in the past. Engineers constructed or repaired bridges, roads, railroads, dams, levees, harbors, coastal fortifications, military buildings, and other elements of infrastructure across the United States. Catastrophic flooding along the lower Mississippi in 1927 spurred the corps to become more active in flood control and disaster relief. These efforts intensified during the Great Depression when the Corps of Engineers assumed responsibilities for managing New Deal programs like the Work Progress Administration.[43] Projects in civil works and disaster relief efforts provided invaluable experience in planning and managing major projects with enumerable moving parts. This knowledge likewise prepared engineer officers to face even larger challenges later in the Second World War. In essence, therefore, each civil works or disaster relief project became a training exercise. Because some of these were life-and-death situations, they came close to simulating the stresses of wartime combat.

With civil works to be completed as well as wartime lessons to be learned, engineer officers needed to develop many different skill sets. "Officers of the Corps of Engineers have two distinct functions: one purely military, covering fortifications and military construction and operations, including the training and handling of engineer troops; the other, almost

purely technical in a civilian sense," wrote Lt. Col. W. H. Lanagan in *Professional Memoirs* in late 1919. "Each of these functions requires a high degree of technical training."[44] Future officers did receive some relevant instruction at the US Military Academy, in the National Guard, or in Reserve Officers Training Corps courses at colleges and universities. However, after the nineteenth century, officers coming out of these institutions lacked fundamental engineering skills and knowledge to perform peacetime and wartime duties. To correct these deficiencies among the recently commissioned engineer officers, Lanagan outlined a dual-phased training program:

> The Military phase of the work requires not merely a knowledge of current military engineering practice, but also a thorough grasp of engineering principles upon which such practice is based. . . . The enormous advance of the late war in the use of mechanical devices, both in actual combat and in the numerous technical auxiliary services, has greatly broadened the field which the military engineer officer is called upon to cover. . . .
>
> The public engineering work with which the Corps of Engineers is charged covers a very broad field and throws upon the engineer officer the same responsibilities as those carried by the foremost civilian engineers of the country. His training as an engineer should therefore equal if not exceed that given by the best civilian technical institutions.[45]

Lanagan and others like him called for a post-graduate curriculum focused on practical military engineering, an idea which resembled the schools at Willets Point (1866–1901) and Washington Barracks (1901–16).[46]

With all these factors in mind, the chief of engineers, Maj. Gen. William M. Black, decided to reopen the US Army Engineer School. He believed that the school's home should move from Washington Barracks to Camp A. A. Humphreys, where courses were already being offered under the auspices of the wartime Engineer Officers Training School. The new location provided ample space, mild climate, diverse terrain, and several waterways for field exercises. The post could also be placed under unified control of the Corps of Engineers. After the move was completed, the new US Army Engineer School reopened in early 1919. It remained at this location under the name Camp Humphreys from 1919 until the name changed to Fort A. A. Humphreys in 1922 and finally to Fort Belvoir in 1935. During these years, many new buildings, barracks, and facilities were added to the school and post.[47]

Evolution of Organization and Curricula at the US Army Engineer School

The first task facing the Engineer School in 1919 was to provide supplemental training to commissioned officers who graduated from the US Military Academy after just two years. The classes of 1919 and 1920 left the academy early in 1917 and 1918, respectively, to fill officer slots in the AEF. With this reduced education, the sixty-two officers possessed only limited understanding of the engineer profession, let alone the pure mathematics and sciences that form its theoretical basis. Once again, Major General Black used his authority as chief of engineers and directed the Engineer School to provide remedial training to prepare these officers to serve in the Corps of Engineers. Beginning in the spring of 1919, the curriculum included courses on structural engineering, sanitary engineering, and electrical and mechanical engineering. These subjects were substitutes for second- and first-class coursework at the Military Academy.[48] One of these students was Hugh Casey, who graduated from West Point early in 1918 to serve in the war. After the conflict's end, he went to the engineering course at Camp Humphreys in 1919. Looking back during a 1979 oral history interview, then-Maj. Gen. Hugh Casey praised the course:

> The Engineer School training was excellent. Up at West Point you had courses in chemistry, electricity, physics, but they were basic, fundamental courses, which I think is ideal. I mean, you got a good solid foundation in the basic educational principles of mechanics, chemistry, physics, math, and so on. But this [course in 1919] was sort of a second step beyond that in just getting into a book on electricity and chemistry or mechanical engineering or civil engineering. Here they'd get into the actual operation of major equipment, design of a bridge or other engineer structure, and so on. . . . [The first course] was comparable to the postgraduate training that you now get in civilian institutions. But I think in some ways they tailored the Engineer School course toward what you were going to do in the Corps of Engineers and specifically in civil works.[49]

The remedial course was supposed to be a three-year undergraduate course for the above-discussed sixty-two engineer officers; but due to the lack of time and resources, the officers were graduated after only one year of additional training and education.[50]

Meanwhile, the Engineer School created multi-tiered programs to train all ranks of officers on active duty, in the Reserve, and in the National Guard. They attended postgraduate courses as newly commissioned and junior officers, advanced courses for noncommissioned officers, occupational courses for enlisted specialists, and basic training courses for recent enlisted soldiers.

Completing the five-month Basic Course for officers would "qualify officers of the Corps of Engineers, upon their initial entry into the service to function intelligently when assigned to duty with engineer troops."[51] This postgraduate curriculum was designed for junior officers with no prior military training. As such, completion of relevant coursework at the Military Academy or in ROTC programs at other institutions exempted those officers from attendance.

The incoming class of twenty students for the first Basic Course received instruction in four departments: Military Art, Military Engineering, Civil Engineering, and Administration and History. The pedagogy of course and school alike can be gleaned from a *Professional Memoirs* article published in the fall of 1919:

> [The school presents] interesting engineering problems to the student in such a way that he is impelled to think them out for himself, and seek the methods of solution. . . . In the law school the student is presented with concrete cases, and from the analysis of them he learns the general principles of law. Similarly, in the school of medicine, the student learns anatomy in the laboratory by the dissection of a cadaver. The Engineer School at Camp Humphreys endeavors to teach engineering by the same method, wherever feasible. It teaches the investigation of concrete problems and encourages the student to do his own thinking as far as possible.[52]

In addition to outlining a hands-on approach different from the time-honored recitation system at West Point, the article makes the tacit claim that engineering as a profession deserved to be placed alongside the medical and legal professions. Taking this one step further, the officers graduating from the Basic Course and other Engineer School courses could consider themselves to be professional engineers.

Initially, the course ran for five months, from April to September 1919. Then beginning in 1920, it started each September and ended in February the following year. Classes were held eight hours each day for six days per week. Apart from classes, field exercises, and examinations at Camp Humphreys, extracurricular activities helped enrich the formal training. For example, students and instructors without any combat service during the First World War went to France where they toured battlefields and learned practical applications of military engineering. Upon passing examinations, the officers received certificates of proficiency.[53]

In May 1920, the War Department directed the Engineer School to reorganize its curricula for its officer students as well as make arrangements to offer courses in engineer specialties to noncommissioned officers. Because Maj. Gen. Clement A. F. Flagler's dual-hatted roles as the school's commandant and the Camp Humphreys commanding general kept him busy with so many tasks, daily supervision of the reorganization process fell to his two assistant commandants, Col. V. L. Petersen and Col. H. C. Jewett. Given the lessons of the First World War, the school covered some theoretical subjects but devoted more time to practical military engineering and essential officer skills.[54]

The Basic Course structure witnessed two major changes as part of the school's 1920 reorganization process. First, the Departments of Military Art and Administration and History were combined into a single entity, because many subjects and case studies covered in theory (Military Art) drew on lessons of the past (Administration and History). Consolidation therefore cut down on the number of instructors and their contact hours.[55]

Second and perhaps the more significant change, the Department of Civil Engineering in the Basic Course was dissolved as most of its courses could be taken at civilian universities. Many outstanding officers, for example, attended civil engineering programs at Massachusetts Institute of Technology, Cornell University, the University of Iowa, and the University of California at Berkeley. This decision to outsource some coursework offered at least three benefits to the Engineer School: it reduced the size of the cadre of faculty at Camp Humphreys, decreased the number of required courses for students, and exposed students to cutting-edge engineering theories and practices at civilian schools. This final point proved most beneficial to graduating officers who had worked on many public works and disaster relief projects during the interwar years. Only instruction in harbor and river improvements, formerly under the Department of Civil Engineering, remained part of the school's curriculum. Many of the officers would spend some of their future careers working in these areas, especially as part of the New Deal programs of the 1930s.[56]

In addition to lectures and small group activities, the Basic Course used a wide range of readings from the *Engineer Field Manual*, various training manuals, occasional papers, professional papers, regulations, and other documents. Many of the problem-solving exercises drew on historical case studies from the First World War or the American Civil War. The Basic Course only lasted until 1924, when it was terminated because it was believed the newly commissioned officers could learn most about these subjects at duty stations. Sending all newly commissioned officers to serve in harbor and river duties—and to assignments with units for at least one year—became the accepted career track of the Corps of Engineers. Only then could new officers attend the Company Officers Course at the Engineer School.[57]

Basic Course at the Engineer School, 1921–24

- Training Methods and Principles of Teaching – 7 hours
- Elements of Administration – 10 hours
- Law – 60 hours
- Military Hygiene and First Aid – 15 hours
- Hippology – 10 hours
- Interior Guard Duty – 8 hours
- Rules of Land Warfare – 10 hours
- Organization – 10 hours
- Infantry Weapons – 8 hours
- Gas Warfare (defensive) – 4 hours
- Tactics – 60 hours
- Infantry Drill – 10 hours
- Cavalry Drill – 8 hours
- Rifle and Pistol Marksmanship – 28 hours
- Stable Management and Care of Animals – 25 hours
- Military Sketching and Map Reading – 85 hours
- Photography and Map Reproduction – 45 hours
- Field Engineering [i.e., Combat Engineering] – 100 hours
- Topographic Surveying – 44 hours
- Hydrographic Surveying – 60 hours
- Geodetic Surveying – 32 hours
- Railroad Surveying – 44 hours
- Field Astronomy – 32 hours

Source: Faculty Board, Engineer School, "The Courses at the Engineer School," *The Military Engineer* 15, no. 80 (March–April 1923): 160–63.

Figure 5.5. Basic Course at the Engineer School, 1921–24, a total of 715 subject hours. Created by Army University Press.

After attaining the rank of captain, the engineer officers returned to the Engineer School to take the five-month-long Advanced Course (1919–21) or the nine-month-long Company Officers Course (1921–34). The latter course absorbed some content of the discontinued Basic Course after 1924, and also streamlined and combined content.[58] The resulting curriculum for the Company Officers Course contained 1,275 subject hours.

Similar to the Basic Course, the Company Officers Course used a variety of readings. Among the most significant were documents on engineering from the Russo-Japanese War, the textbook *Military Policy of the*

United States by the late Col. Emory Upton, excerpts from the *Historical Report of the Chief Engineer Including All Operations of the Engineer Department, American Expeditionary Forces 1917–1919,* and a variety of articles published in *Professional Memoirs* and *The Military Engineer*. *Professional Memoirs* was published bi-monthly at Washington Barracks, DC, by direction of the US Army Office of the Chief Engineer Training Section from January 1909 to December 1919 and was copyrighted by the Engineer School. *The Military Engineer* was first published in January 1920 as the official journal of the non-profit Society of American Military Engineers, which was established in 1920 as a direct result of World War I.[59] Most individual courses used historical case studies in the assigned readings and problem-solving exercises. In fact, the Company Officers Course devoted 130 hours to conspicuously historical content: Elementary Military History and Engineer Operations in Past Wars. The commitment to these topics equated to approximately three weeks of the nine-month-long course.

Company Officers Course at the Engineer School, 1921–34

- Administrative Duties of Officers in Engineer Department-at-Large, including Law of Trusts and Commercial Law, with Special Reference to Federal Contracts – 75 hours
- Engineer Supply – 50 hours
- Elementary Military History – 80 hours
- Training Methods and Principles of Teaching – 10 hours
- Organization and Equipment – 20 hours
- Musketry – 50 hours
- Care of Animals and Stable Management – 25 hours
- Tactics and Troop Leading – 375 hours
- Military Sketching and Map Reading – 80 hours
- Map Making – 60 hours
- Engineer Operations in Past Wars – 50 hours
- Permanent Forts, Seacoast Defenses, and Naval Power – 100 hours
- Field Engineering [i.e., Combat Engineering], as applied to Divisional and Corps Engineer Troops to include the Battalion – 200 hours
- River and Harbor Improvements – 100 hours

Source: Faculty Board, Engineer School, "The Courses at the Engineer School," *The Military Engineer* 15, no. 80 (March–April 1923): 163–67.

Figure 5.6. Company Officers Course at the Engineer School, 1921–34. Created by Army University Press.

As the regular unit assigned to the school and stationed on post, the 13th Engineer Regiment supported the training programs for all other courses at Fort A. A. Humphreys. This unit, as one officer observed, "provided the personnel for many demonstrations exhibited for the school. This regiment held the unique distinction of being the only one in the

country which was filled to peace strength. Its equipment was in excellent condition; it stood ready to move out and serve as the combat regiment for one of the eastern Regular Army divisions."[60] The 13th ran the rifle ranges and other training areas on post. The unit displayed the destructive power of various explosives when used to bring down structures. Meanwhile, the engineer students learned to calculate the sizes of charges and then double those sizes to be certain of success. As part of another course, the regiment helped teach the students how to construct and launch pontoon-based footbridges. The 13th even played the role of opposition infantry in combined field maneuvers, which were observed and critiqued by engineer students.[61]

In 1934, the Engineer School changed the title of the Company Officers Course to the Regular Army Officers Course. The curriculum did not undergo any major revisions in content or duration between 1924 and the late 1930s.[62] Several decades later in an oral history interview, then-retired Maj. Gen. William E. Potter recalled what the Regular Army Officers Course was like when he attended from 1936 to 1937. "It's a rounding out process—no matter what your work had been in a District, and not too many officers had District experience, I mean in the Corps, at my grade," said Potter of the value of the course. "And it brought you up in studies and theory of the responsiblities of, let us say, a major or lieutenant colonel. In other words, you studied the broader aspects of handling battalions and so on and so forth."[63] After graduating in 1937, Potter passed along long-term career lessons as well as fresh ones from his education to ROTC students at the Ohio State University, where he taught classes in Military Science and Tactics through the summer of 1940. During the Second World War, Potter commanded the 25th Engineer Battalion (1942–43) and later the 1138th Engineer Group (1943), before moving into staff positions at the theater-level in the European Theater of Operations for the duration of the conflict.[64]

Not unlike the Engineer School of the twenty-first century, the school at Belvoir, née Humphreys, provided training for all ranks and specialties. The school created shorter three-month courses for Reserve officers and six-week courses for National Guard officers. These officers could not take much time away from their civilian lives. Their courses focused on soldiering and field (combat) engineering skills as outlined in various editions of the *Military Handbook for National Guard and Reserve Officers*.[65]

Apart from the officer-level training, the Engineer School offered courses for enlisted specialties such as machinists, and in topics like map reproduction, topography, surveying, and drafting. The Department of Enlisted Specialist Schools provided expert classroom instruction and used practical exercises. The program for these specialists did, however, face a serious problem with the low caliber of many of its students. In 1920 and 1921, for example, some 15 percent of the enlisted engineers were illiterate. Thus, part of the training concentrated on bringing those students up to standard in reading, writing, and mathematics, which were necessary to fulfill their military occupational specialties.[66] Throughout the 1920s and 1930s, the US Engineer School suffered from constant shortages of qualified instructors. Staffing the officer slots at the school required between fifteen and thirty officers in any given year. These billets were not given to mediocre or underachieving engineer officers. A premium was placed on having the best instructors. The Enlisted Specialist School needed approximately ten expert instructors, also drawn from a small pool of competent personnel in the noncommissioned officer ranks of the Corps of Engineers. Too often this stripped the active duty units of their most qualified engineers, leaving voids that could not be filled easily. The Army and its Corps of Engineers were hardly alone in suffering from shortages during the 1920s and 1930s. The other armed services fared just as poorly. The entire US military had to learn how to squeeze as much as possible out of every appropriated dollar.[67]

Conclusion

The strain of the Army's mobilization for war in 1917 caused classes at the Engineer School to be suspended. This did not, however, mean that training ceased altogether. Instead, engineers of all ranks attended temporary schools set up across the United States and Europe. They received abbreviated instruction in general military topics and in practical engineering skills. Then many of the graduates served in general or combat engineering units in the American Expeditionary Force during the First World War. Most of the veterans returned to the United States and demobilized in 1918 or 1919, while a tiny cadre of engineers remained in the Army. They spent the next two decades eking out an existence in a resource-poor army. Nevertheless, lessons gleaned from the First World War found their way into the Engineer School curriculum and into the formulation of new doctrine. Despite shortages of all types, the school continued fulfilling its mission of training future engineers at Camp Humphreys, later named Fort Belvoir. Consequently, when the 1930s drew to a close and another global conflict loomed on the horizon, the Corps of Engineers possessed units, albeit severely understrength and very few in number, with competent soldiers of all ranks.

Notes

1. Julie Irene Prieto, *The US Army Campaign of World War I—The Mexican Expedition 1916–1917* (Washington, DC: US Army Center of Military History, 2016), 5–8.
2. Col. Henry A. Finch, "Reminiscences of an Old 'Enjine'," *The Military Engineer* 48 (March–April 1956): 123.
3. Finch, 123.
4. Finch, 123.
5. Prieto, *The US Army Campaign of World War I*, 7.
6. John Whiteclay Chambers II, *To Raise an Army: The Draft Comes to Modern America* (New York: Free Press, 1987), 186.
7. Charles Hendricks, *Combat and Construction—US Army Engineers in World War I* (Fort Belvoir, VA: US Army Corps of Engineers Office of History, 1993), 3.
8. US Army Corps of Engineers, *History and Traditions of the Corps of Engineers* (Fort Belvoir, VA: US Army, 1953), 96.
9. *Historical Report of the Chief Engineer Including All Operations of the Engineer Department, American Expeditionary Forces 1917–1919* (Washington, DC: Government Printing Office, 1919), 133–36; and Editorial, *The Scientific Monthly* 5, no. 6 (December 1917): 569.
10. *The Scientific Monthly*, 569; Larry D. Roberts, "A School for Officers: A History of the Engineer Officer Candidate School" (unpublished manuscript, US Army Engineer School, n.d.), chap. 1, 7, US Army Engineer School History Office Archives; and Larry D. Roberts, "Engineers in the Great War" (unpublished manuscript, US Army Engineer School, n.d.), 50–53, US Army Engineer School History Office Archives.
11. Cited in Roberts, "A School for Officers," chap. 1, 7.
12. "Engineer Officers' Training School at Camp Humphreys," editorial, *Science* 48, no. 1228 (July 1918): 38; and US War Department Committee on Education and Special Training, "The Engineer School at Camp Humphreys: A Report on Methods of Teaching Engineering," Washington, DC, 1919, 8–9, US Army Engineer School History Office Archives.
13. David M. Dunne, "The Engineer School—Past and Present," *The Military Engineer* 41, no. 284 (November–December 1949): 414; and Gustav Person, draft manuscript article for *Belvoir Eagle*, n.d., US Army Engineer School History Office Archives.
14. Roberts, *Engineers in the Great War*, 43.
15. Roberts, 52.
16. Roberts, 52–53.
17. Roberts, "A School for Officers," chap. 1, 9.
18. Roberts, 8.
19. *Historical Report of the Chief Engineer*, 134.

20. *Historical Report of the Chief Engineer*, 134–37; and US Army Corps of Engineers, *History and Traditions of the Corps of Engineers*, 50.

21. *Historical Report of the Chief Engineer*, 142.

22. *Historical Report of the Chief Engineer*, 141.

23. *Historical Report of the Chief Engineer*, 134–36.

24. "General Orders No. 77, 22 May 1918," cited in *Historical Report of the Chief Engineer*, 137.

25. *Historical Report of the Chief Engineer*, 146.

26. *Historical Report of the Chief Engineer*, 147–50.

27. Roberts, "A School for Officers," chap. 1, 10–12; and *Historical Report of the Chief Engineer*, 139–40.

28. *Historical Report of the Chief Engineer*, 140.

29. Roberts, "A School for Officers," chap. 1, 12–13; and *Historical Report of the Chief Engineer*, 141.

30. Editorial, *The Scientific Monthly*, 569.

31. Hendricks, *Combat and Construction*, 5–14; and US Army Corps of Engineers, *History and Traditions of the Corps of Engineers*, 44–50.

32. Al Mauroni, "The US Army Chemical Corps: Past, Present, and Future," accessed 18 June 2016, https://armyhistory.org/the-u-s-army-chemical-corps-past-present-and-future/.

33. Maj. P. S. Bond, "Duty, Organization, Training, and Equipment of the Engineer Troops for Field Service," *Professional Memoirs* 7, no. 36 (November–December 1915): 692–93; see also Office of the Chief of Engineers, War Department, "[Extracts] Duties, Organization, Equipment, and Training of Engineer Troops and War Preparations of the Engineer Service," 19 February 1913, World War I Collection, US Army Engineer School History Office Archives.

34. For operational examples, see Roberts, *Engineers of the Great War*, 118–20, 127–29, 136–38.

35. Maj. W. M. Hoge, "Experience Report," 16 December 1918, 1, World War I Collection, US Army Engineer School History Office Archives.

36. US Army Corps of Engineers, *History and Traditions of the Corps of Engineers*, 53–54.

37. US Army Corps of Engineers, 53–54.

38. Hoge, "Experience Report," 2.

39. Hoge, 2.

40. Hoge, 2.

41. War Department, *Field Service Regulations, United States Army, 1923* (Washington, DC: Government Printing Office, 1924), 11.

42. War Department, 20.

43. *The U.S. Army Corps of Engineers: A History* (Alexandria, VA: US Army Corps of Engineers Office of History, 2008), 62–66, 246–47, 263–64.

44. Lt. Col. W. H. Lanagan, "Proposed New Engineer School and Post and College of Military Research at Camp Humphreys, VA," *Professional Memoirs* 11, no. 60 (November–December 1919): 719.

45. Lanagan, 719.

46. Capt. E. F. Gaebler and Capt. W. E. Duckering, "The Engineer School at Camp A. A. Humphreys, VA," *Professional Memoirs* 11, no. 59 (September–October 1919): 584–87.

47. Lanagan, "Proposed New Engineer School," 722–28; Roberts, "A School for Officers," chap. 2, 1–2; Person, draft manuscript, 8–9; Maj. Rufus W. Putnam, "The Engineer School, Camp A. A. Humphreys, Virginia," *Journal of the United States Artillery* 54, no. 2 (February 1921): 113–14; Dunne, "The Engineer School," 413–14; and Maj. James A. Dorst, "Ft. Humphreys and Historical Belvoir," *The Military Engineer* 15, no. 82 (July–August 1923): 335.

48. Kenneth M. Moore, "The Engineer School," *The Military Engineer* 27, no. 151 (January–February 1935): 12.

49. Maj. General Hugh J. Casey, *Engineer Memoirs* (Washington, DC: US Army Corps of Engineers Office of History, 1993), 54–55.

50. Roberts, "A School for Officers," chap. 2, 1.

51. Faculty Board, Engineer School, "The Courses at the Engineer School," *The Military Engineer* 15, no. 80 (March–April 1923): 160.

52. Gaebler and Duckering, "The Engineer School," 586–87.

53. Faculty Board, Engineer School, "The Courses at the Engineer School," 160–63.

54. Putnam, "The Engineer School," 117–18; "Current News—Service Schools," *The Military Engineer* 12, no. 61 (January–February 1920): 96.

55. Moore, "The Engineer School," 12.

56. Martin Reuss, "The Evolution of Engineer Officer Education," *Engineer–The Magazine for Army Engineers* 22 (February 1992): 46; and Moore, 12.

57. Roberts, "A School for Officers," chap. 2, 3.

58. Dunne, "The Engineer School," 415.

59. Society of American Military Engineers website, accessed 11 December 2019, https://www.same.org/Discover-SAME/About-SAME/History-of-SAME.

60. First Lt. Horace W. Pote, "A Resume of Engineer School Training," *The Military Engineer* 24, no. 138 (November–December 1932): 632.

61. Pote, 632–33.

62. Dunne, "The Engineer School," 415; and Moore, "The Engineer School," 12–13.

63. Maj. Gen. William E. Potter, *Engineer Memoirs* (Washington, DC: US Army Corps of Engineer Office of the Chief of Engineers, 1983), 14.

64. Potter, vii-viii.

65. "The Regular Army—The Engineer School," editorial, *The Military Engineer* 26, no. 146 (March–April 1934): 155.

66. "Army Educational and Vocational Training at Camp Humphreys, Va.," editorial, *The Military Engineer* 12, no. 65 (September–October 1920): 471; Dunne, "The Engineer School," 415; and Lanagan, "Proposed New Engineer School," 716–18.

67. “Commandant, Report of Operations of the Engineer School for the School Years 1924–1939,” n.d., US Army Engineer School History Office Archives.

Chapter 6

The Engineer School in the Second World War, 1939–45

During the two decades after the First World War, the US Army Engineer School at Fort Belvoir, Virginia, remained a small institution training a few officers and enlisted men. Beginning in 1939, the school grew exponentially to meet the manpower demands for engineers in the Second World War from 1941 to 1945. New locations, such as Fort Leonard Wood in Missouri, added more space for training. During the war years, the school's faculty tried to adapt new doctrine and curricula to the changing wartime needs. This entailed developing feedback loops between the school and the battlefield for lessons, experimentation with new equipment, and rotating experienced engineers back to train incoming recruits.

Effects of War in Europe on the US Army Corps of Engineers and the Engineer School

In June 1939, just three months before the Second World War started in Europe, the US Army numbered about 189,000 soldiers. The US Army ranked as the nineteenth largest in the world—even smaller than the Portuguese Army. Meanwhile, the forces of future enemies, Germany and Japan, each boasted some 1.5 million soldiers with millions more to join in the coming years. Although disheartening in themselves, these facts tell nothing of the low preparedness levels of most units in the US Army. All of the thirteen active-duty divisions were undermanned and deprived of modern weapons, equipment, and vehicles. Instead, the American soldiers trained with surplus materials from the First World War era. In the worst case of unpreparedness, broomsticks were sometimes mounted on vehicles as machine guns. In no way could the Army's units be considered combat-ready.[1]

During 1939, the US Army Corps of Engineers' manpower stood at 786 officers and 5,790 men. This amounted to about 3.5 percent of the entire Army. One dozen engineer units existed on paper, but reality revealed them to be understrength and ill-equipped formations. Only one third of all the engineer officers served in these units. Most of the remaining officers were scattered across the United States directing New Deal or other civil works projects.[2]

Germany's invasion of Poland on 1 September 1939 signaled the outbreak of war in Europe. President Franklin Delano Roosevelt immediately reacted to this aggression by declaring a limited national emergency in the

United States. Germany defeated Poland in less than a month. The following year, France, Belgium, Luxembourg, and the Netherlands fell into the hands of Nazi Germany in a brilliantly executed campaign which lasted only six weeks. After the fiasco of Dunkirk in June 1940, the last British forces were driven off the European continent and Germany's Western Front would be quiet until 6 June 1944 when Allied troops stormed the beaches of Normandy. The German Navy extended its reach with the fall of France by gaining several new submarine bases along the French Atlantic Coast. In a bid to starve the British into submission, the German Navy began its unrestricted submarine warfare campaign that would later be known as the Battle of the Atlantic.

On the other side of the world, Japan continued its nearly decade-long military expansion on the Asian mainland. The Japanese used brutal force to gain control of Korea, Manchuria, and most of coastal China by 1940. The Japanese Navy dominated the western Pacific Ocean with a fleet superior in quantity and quality to the US Navy at the time. The Japanese thus threatened the American forces in the Philippines and the European colonies in Southeast Asia. In late September 1940, Japan joined Germany and Italy in signing the mutual assistance agreement called the Tripartite Pact. The three nations became the Axis Powers.[3]

By late 1940, more and more Americans recognized the escalating German and Japanese threats to national security. American isolationist tendencies, so dominant in the 1920s and 1930s, slowly gave way to support for a strong defense of the United States and the Western Hemisphere. Nevertheless, before the Japanese attack at Pearl Harbor on 7 December 1941, neither the American public nor Congress favored offensive combat operations or the nation's unilateral entrance into the Second World War.

The ongoing hostilities in Europe and Asia spurred US military growth, even though the nation had yet to commit itself to war. From June 1939 to June 1940, the Corps of Engineers expanded from 6,576 to 10,783 officers and men. The pace of mobilization quickened after the Selective Training and Service Act was passed by Congress and signed into law by President Roosevelt in September 1940. This act required every American male between twenty-one and thirty-five years of age to register for the draft, and some 900,000 were chosen by lottery to enter military service. The Corps of Engineers' portion of these draftees represented a windfall of about an additional 69,000 men by July 1941. This influx raised the Corps of Engineers' strength to about 80,000, which was a seven-fold increase of soldiers compared to 1939; at the same time, the entire Army only expanded about five and a half times.[4]

The Engineer School entered this era of mobilization with Brig. Gen. Roscoe C. Crawford as its commandant. He shepherded the school through the extraordinary expansion from June 1940 through November 1943. Roscoe served almost the entire first two years of the American involvement in World War II as the commandant and therefore dealt with the most severe growing pains experienced by the Engineer School and the Corps of Engineers. By the time Crawford left the commandancy, the school's programs were running as smoothly as possible. He deserves credit for setting the school, and ultimately the Engineer Regiment, on a path to operational effectiveness.[5]

In the summer of 1940, only nine new officers joined the school's cadre for a total of thirty officers. As cadre, the officers were the command elements in the engineer units and instructors at the school. The Regular Army Officers Course ending in February 1940 numbered around forty officers. The course's standard nine-month curriculum was cut in half to 4.5 months, presumably to prepare the school for its incredible expansion later that year. Most subjects lost between one-third and one-half of their allotted course hours, including General Subjects; Training Management and Instructional Methods; Command, Staff, and Logistics; Tactics and Techniques of Associated Arms; Equitation; Surveying and Map Making; Tactics and Techniques of Engineers; and Field Fortifications. The biggest time reduction within the Regular Army Officers Course occurred in Engineering Construction, which plummeted from 229 to a mere fifteen hours. Many incoming junior officers, it was reasoned at the time, already possessed some construction experience from previous duty stations or civilian careers; or alternatively, those skills could be learned through on-the-job-training. In addition to active duty officers, another forty-six engineer officers completed the standard three-month-long National Guard and Reserve Officers Courses. In all, the school's officer training programs produced eighty-eight graduates by the summer of 1940.[6]

Apart from the formal curricula in the Engineer School, the regular Army officers took "research courses" between November 1940 and February 1941. These stand-alone courses examined assault tactics and other topics drawn from the war in Europe. The instructors showed combat engineers could learn lessons and adapt new skills for the new, modern battlefield. To the degree that funding and sourcing allowed, the students experimented with new vehicles and equipment. Then, they broke into committees to write reports on the topic studied. These were submitted to the Engineer School and Corps of Engineers.[7] One such course covered amphibious landing operations. The reality of projecting American force across the globe necessitated amphibious operations involving assaults against enemy defenses, or at the least landings on shores with no infrastructure. Because neither the Army nor the Corps of Engineers could provide this doctrine or techniques for amphibious operations, the school turned to the US Marine Corps and Navy for expertise in early 1941. In two memoranda to the chief of naval operations and the commandant of Marine Corps, Brig. Gen. John Kingman stated that "it is considered very desirable" that the "landing operations be authentically covered."[8] He requested guest lecturers from both seaborne services to address several issues in the Research Course at the Engineer School. Among the listed issues relevant to engineers were:

- Organization, mission, and weapons.
- Desired conditions of landing.
- Technique of landing.
- Tactics of landing under various conditions.
- Use of "alligator" (amphibious tractor) and other special equipment.
- Influence of bases on naval strategy.
- Naval action against coastal operations.
- Joint operations.

Kingman wrote these requests in his role as assistant to the chief of engineers for the Military Division. He exercised the ultimate authority for training in the Corps of Engineers and thus represented the higher headquarters to which the Engineer School's commandant reported.[9]

The Engineer School also maintained its mission of training enlisted engineers. The Enlisted Specialists Courses ran nine months from September 1939 through May 1940. It graduated twenty-five students in Surveying, Drafting, and Aerial Photographic Mapping, sixteen in Map Reproductions and Photography, and fourteen in Electrical, Motors, and Water Purification for a total of fifty-five students. They ranged in rank from private to master sergeant. The demand for engineers with these skills would grow much more serious in the coming war years.[10]

Establishing Engineer Replacement Training Courses in 1941

As 1940 ended, the Engineer School's biggest challenge became training thousands of draftees and volunteers each and every month. To smooth this process, the school began setting up the Engineer Replacement Training Course (ERTC) at Fort Belvoir. While the Engineer School was responsible to furnish many of the lesson plans, the ERTC reported directly to

the Army Service Forces school element and not to the Engineer School. It was no small feat to turn this small post with a few dozen soldiers attending the courses each year during the 1930s, into a major post that trained 82,301 engineer soldiers between June 1942 and June 1943 alone. Before the exponential increase in training was possible, many structural and curricular pieces had to come together. For example, the ERTC needed to train instructors from among the officers and noncommissioned officers to a certain competency level. Barracks and other facilities at Belvoir needed to be built as quickly as possible. Large areas of land needed to be cleared for field training exercises. Additional training materials, from field manuals to bridging equipment, needed to be procured and transported to post. Only when a sufficient quantity of these necessities became available at Fort Belvoir could the ERTC effectively train engineers.[11]

By year's end, the ERTC received a cadre of officers and noncommissioned officers with Lt. Col. William M. Hoge as commanding officer. As a combat veteran from the First World War, he envisioned what the end products of ERTC should be in 1940. Most of those completing the program would become combat engineers. Hoge recognized likewise that engineer soldiers, for example, may become specialists in carpentry within the function of general engineering. These carpenters, however, also needed instruction in other engineering functions because they might have to set aside their hammers and saws for rifles or landmines in wartime.[12]

Just as Hoge began work at the Engineer School at Belvoir, an article in *The Military Engineer* reinforced the importance of engineering versatility. Writing in the November-December issue of 1940, Lt. Col. Donald B. Adams applied lessons from his own combat experience in the First World War to the current time, analyzed engineering functions in the current fighting in Europe, and incorporated ideas from existing doctrines and publications into his article.[13] Adams's approach resembled that of Maj. P. S. Bond's pre-war writings of 1915 and 1916. Both authors' publications were platforms to forecast important engineering roles in coming conflicts and to call for relevant training.[14]

Adams presented several examples of how competent engineers could achieve success in future operations. First, relating to mobility and general engineering in modern mobile warfare, Adams argued that mechanization had increased "the speed of movement" since the First World War, and therefore amplified "the importance of roads, bridges, and supplies of corresponding mobility."[15] He then explained how, "without the engineers, any dash of armored vehicles to the front to establish contact, or on sweeps around the enemy flanks, was considered unlikely to reach the objective. Engineers were considered necessary to overcome the obstacles" installed by the enemy.[16]

Relating to contested rivers crossings as specific examples of mobility, Adams described how, as soon as enemy resistance is encountered, "Engineer reconnaissance will begin at once."[17] The combat engineer unit commander must anticipate requirements for the "most favorable locations for crossing the troops in an attack, as to the best sites for pontoon bridges, and for the engineer phases of a plan of attack."[18] The commander next needed to ensure "that the material, sufficient for his troops to perform properly their missions in a river crossing, has been ordered forward, and that such material will be at proper locations at the designated time."[19] Relating to countermobility, Adams wrote that, when in use, bridges should "be mined with TNT [and] ready for instant demolition," and that roads should "be prepared for defense" by minefields, abatises, earthen barricades, or other barriers.[20] He next proposed that Engineer battalions be supplied with 50,000 pounds of explosive for anti-vehicle landmines for every mile of their front lines. Adams predicted these countermobility efforts, used earlier in May and June 1940, "will go a long way toward obviating such advances as the German mechanized units were able to achieve in Holland, Belgium, and France."[21] Near the end of his article, Adams concluded that a "well-equipped, well-supplied, and well-trained engineer force can play a most important part in bringing such vehicles to a halt."[22]

Finally, relating to mobility, countermobility, survivability, and general engineering, Adams pointed to bulldozers as perhaps the most vital tool in all these functions: "It is quite possible that more of these will be needed in actual warfare, bearing in mind that, to make speed, the motorized forces must keep to roads."[23] Craters created by enemy artillery fire, mine detonations, or aerial bombing "must be filled and filled quickly. For this the bulldozer is admirably suited. New roads, bypasses, cutoffs, earth barricades can all be easily constructed by his machine."[24]

Adams's 1940 article was not particularly groundbreaking because existing sources, like the *Engineer Field Manual* (1932), already developed doctrine like those mentioned in his article.[25] Even so, Adams synthesized engineering functions and combined-arms operations into a few pages for any officer to read and apply. His article also directly linked effective training and predictive doctrine as precursors to success in combat operations.

By early 1941, Hoge and the Engineer School established a new training center for the ERTC at Fort Belvoir. He recalled decades later that "we started from scratch. . . . We had all sorts of classes, innovated a number of

things."[26] The center ran several five-week courses to train Engineer Reserve officers to become instructors for selectees (the draftees) and volunteers. Some 900 soldiers also completed the nine-week Noncommissioned Officers' Instructors Course by early March of 1941. Together they formed the nucleus for the cadres of the ERTC at Belvoir and for a second ERTC starting up at Fort Leonard Wood, Missouri. The two posts subsequently split the new instructors evenly between them.[27]

According to plan, Belvoir's training center included the headquarters company and two training units segregated according to race. The 1st Training Group, also known as the "white" group, contained seven battalions of Caucasian selectees. Three other battalions of African-American selectees and mostly Caucasian officers comprised the 2nd Training Group, otherwise referred to in 1941 as the "colored" group. The ten battalions contained forty companies with each numbering 229 trainees plus cadre of five officers and twenty-three enlisted men. All the companies in turn included four platoons. The courses ran in cycles so that new arrivals could begin their training almost immediately. The full capacity of the two groups reached more than 10,000 soldiers by late November 1941.[28]

Figure 6.1. African-American engineers from a segregated training unit receive instruction using a model of a M3 floating bridge at Fort Belvoir. Courtesy of US Army Engineer School History Office Archives.

Some 250 selectees arrived at Fort Belvoir and started ERTC as its first trainees on 17 March 1941. Not all the buildings or facilities were completed by then, and many trainees were not promptly issued proper uniforms. Despite these deficiencies, they joined one of the companies and started their twelve-week course totaling 564 hours.[29] One of their officers and instructors was a young engineer second lieutenant named David C. Pergrin. Recalling early 1941 in his memoirs, he explained his responsibilities:

> I helped shepherd four thirteen-man squads of enlisted recruits through combat engineer basic training. The training was rigorous and without let-up: close-order drill and five- to twenty-mile marches; maintaining and firing rifles and machine guns; work with mines, demolitions, and fixed and floating bridges; map reading, scouting, and patrolling in rugged terrain; physical fitness, athletics, and obstacle courses; night training in laying mines and demolitions; bridging in the assault of rivers; tactical engineer action in close support of infantry and armor in the offense and defense; and plenty of classroom time. My noncommissioned officers (NCOs) and I learned a lot ourselves and became superbly physically fit.[30]

Pergrin also recognized that teaching those subjects made him a better combat engineer and Army officer. He learned to read his superiors and subordinates, evaluating strengths and weaknesses in their performances and behaviors.[31] This intangible skill, common to so many effective leaders, would pay great dividends three years later in combat in 1944 at the Battle of the Bulge.

Later in 1941, more selectees arrived every week or two at Fort Belvoir. They became trainees who entered the second and subsequent training cycle at the ERTC. More than 1,000 trainees completed the first course by the end of May and even larger training cycles graduated the following months. Most of the new engineer soldiers became "fillers" who joined recently activated engineer units. A few outstanding soldiers were selected to attend the Noncommissioned Officers' Instructors Course and then be assigned to the ERTC cadre at Belvoir.[32]

Despite impressive numbers, the ERTC encountered its share of problems in 1941. The cadre suffered from chronic shortages of qualified instructors. Other deficiencies occurred in the inadequate amount of available equipment and number of vehicles. Training aids, including charts, posters, models, and film footage, also needed to be updated. The curriculum proved to be antiquated because too few of the ERTC instructors

possessed any experience in writing lesson plans and manuals based on the most current doctrine.[33]

The most serious problem facing the Engineer School at Fort Belvoir—that of space for training and field exercises—was partially solved in May of 1941 when a second ERTC started its first class of draftees at Fort Leonard Wood. The post took its name from General Leonard Wood, a career Army officer who received the Medal of Honor in Geronimo's War (1886) and fought in Theodore Roosevelt's Rough Riders during the Spanish-American War (1898). Later, he helped to modernize the US Army as its Chief of Staff (1910–14). Because Wood stressed military preparedness and effective training as cornerstones of any successful fighting force, his name made a logical choice for a post devoted to educating new soldiers.[34]

Fort Leonard Wood sat almost midway between St. Louis and Springfield in Missouri, along what became Interstate 44 by the 1960s. The post encompassed about ten times more area than did Fort Belvoir. The hilly terrain and many waterways in Missouri allowed for realistic training exercises for bridging, road building, tactical maneuvers, and the like. The ERTC at Fort Leonard Wood reached its capacity of 10,000 trainees within several weeks after opening. The curriculum mirrored that of Fort Belvoir.[35]

Making the completely unimproved area at Fort Leonard Wood into an operational post took millions of man hours and millions of dollars. The first architects and construction workers arrived on site in November 1940. The groundbreaking occurred in the first week of December. At its peak in March of the next year, a workforce of some 30,000 contractors built barracks, mess halls, latrines, officer's quarters, lecture halls, and others, numbering 1,600 structures in all. These could handle an anticipated maximum capacity of 32,000 trainees and a cadre of several thousand officers and noncommissioned officers. The contractors also added sewage disposal, electrical wiring, and similar infrastructure. The cost reached $37 million.[36]

During the latter half of 1941, the ERTC at Fort Leonard Wood experienced growing pains similar to those at Belvoir. Among the most troublesome problems were deficiencies in training materials, qualified instructors, and barracks capacity. In addition to training thousands of engineers, Fort Leonard Wood served as a divisional training center for the Infantry branch. This larger population generated still more pressure by overextending the already limited resources. Identifying and training qualified instructors, for example, required another program—Engineer Officers

Candidate School—to be established at Fort Leonard Wood. Despite the best efforts of Brig. Gen. Ulysses S. Grant III in his role as commanding general at the ERTC, these problems could not be solved until after the United States entered the Second World War in December 1941.[37]

Figure 6.2. Aerial view of the main cantonment at Fort Leonard Wood during the Second World War. Courtesy of US Army Engineer School History Office Archives.

Establishing the Engineer Officers Candidate School at Fort Belvoir in 1941

While the ERTCs trained large groups of selectees and volunteers for the enlisted ranks, a limitless need for engineer officers also developed in 1941. The peacetime sources of newly commissioned second lieutenants, such as the US Military Academy and ROTC programs, could not begin to support the Corps of Engineers' mobilization. Not only were there many junior officer slots to fill in both standing and newly organized units, but the training programs also required competent officers to serve as instructors in the Engineer School's various courses. Because spending nine full months of training for a few dozen junior officers could not be justified, the Engineer School terminated its Regular Army Officers Course in the summer of 1941. This action allowed for more engineering specialties, faster training cycles, and bigger student enrollments.[38]

In January 1941, the War Department directed the Army's combat arms—Infantry, Cavalry, Field Artillery, and Coast Artillery—to establish their own Officer Candidate Schools (OCSs). Every curriculum included training in leadership, branch-specific competencies, and soldiering skills

such as drill and marksmanship. The structure and curriculum of the OCSs in 1941 went back to the Army Officer Training Schools of World War I.[39]

The combat arms were not the only branches suffering from low numbers of officers in 1940 and 1941. Each branch struggled to meet its quota. In many ways, the Ordnance Department, Signal Corps, and Corps of Engineers faced greater challenges than the combat arms branches, because these technical branches required additional knowledge of science, mathematics, and engineering. The Corps of Engineers, for example, pushed hard to recruit individuals with educations or professional backgrounds in these areas. Such men stood an obviously better chance of passing examinations and earning a commission. The combined engineering commissions from the US Military Academy and ROTC programs could not fill the gaps among the Corps of Engineers' officers. Consequently, the War Department expanded the OCS program to all branches three months after their original establishment of the combat arms' OCSs. It was with this mandate that the Engineer School established the Engineer Officers Candidate School (EOCS) at Fort Belvoir, a sensible choice because this post was already home to the ERTC.[40]

The EOCS, according to historian Larry D. Roberts, tried to achieve three main objectives: selecting candidates "who showed aptitude and fitness as officer material," eliminating those "who showed lack of aptitude or fitness," and training worthy candidates "to carry out all the function of an engineer platoon leader."[41] Once admitted to EOCS, the candidates took courses in a curriculum set by the Engineer School with input from the Operations and Training Section of the Corps of Engineers' Military Division. The EOCSs at Forts Belvoir and Leonard Wood ran for three months, just like the other branches. A breakdown of the 1941 curriculum shows the 552 hours of instruction, drills, exercises, and examinations split into three blocks. The initial two blocks resembled the content of the twelve-week Regular Army Officers Course run by the Engineer School in 1940. The first block of 184 hours on General Subjects familiarized the candidates with how to function as officers in their units and within the Army as a whole. They spent a significant portion of this block learning about drill, discipline, and physical fitness. The second block devoted 118 hours to studying Weapons and Tactics. The third block on Combat and General Engineering represented a major change from the previous Regular Army Officers Course in 1940. The new EOCS block gave 203 hours to the candidates to learn about Field Fortifications, Demolitions, Camouflage, Assault Tactics, Obstacles, River Crossings, Road Construction, Water Supply, Engineering Tools, and Defense against a Mechanized Attack.[42]

Two of these classes should be highlighted to show the inclusion of current operations and its impact on the instructions at EOCS. First was the instruction on Assault Tactics, which added engineering components to second block's coverage of Weapons and Tactics. Their mutually reinforcing content satisfied guidance stated in an August 1941 memorandum from the War Department to all commandants and faculty at all the Army schools:

> Success in battle is the result of local successes gained by small combat units. The success in combat of small units is based on full knowledge of combat technique and tactics and the exercise of initiative and judgment by each individual. The first step is through instruction in technique and tactics. This training in the mechanics combat must be followed by practical application of the doctrine and methods in tactical exercises under simulated battle conditions. Emphasis must be placed on the exercise of leadership by the commanders of each subordinate unit in order to systematically develop and foster sound judgment and initiative.[43]

The objectives mentioned in this quote remain timeless. They are as applicable in the twenty-first century as when they were written in 1941.

Next, the material on Defense against a Mechanized Attack clearly acknowledged the realities of mobile operations with tanks and wheeled vehicles, as witnessed in the fighting in Europe at the time. This subject also implicitly pointed toward combined arms operations as, according to the 1941 memo, "an outstanding development of the present war."[44] The success in 1940 of Germany's "mechanized units do not result from the independent employment of such units. These successes are based upon the carefully integrated employment of these modern means in the team of combined arms."[45] The memo explained that, in US Army training, such "combined exercises for small units should be conducted as a normal element of unit training."[46]

The first class of ninety-seven soldiers began the EOCS on 7 July 1941. Of this total, only forty-eight spent one or more years in college. During the next three months of the EOCS, thirty candidates dropped out due to shortcomings in leadership or "other psychological qualities necessary to an officer." Of the remaining sixty-seven who completed EOCS, sixty-six took commissions as engineer officers.[47] No documentation revealed why the single candidate did not accept a commission.

Sadly, however, the size of the first class with a 70 percent completion rate could not satisfy the burgeoning demand for junior officers. Therefore, at the request of the War Department, the EOCS's enrollment increased to

230 candidates later in the fall of 1941. The second class started on 21 October, but did not meet its enrollment quota of 230. Enough qualified individuals simply were drafted or directed into the Corps of Engineers. In reality, the class started with 218 candidates enrolled, of whom 167 graduated on 8 December 1941.[48]

The Effects of Wartime Expansion on the Corps of Engineers

As 1941 drew to a close, so too did hopes for peace. The American entrance into the Second World War seemed to be imminent. Meanwhile, the US military, including the Engineer School and Corps of Engineers, struggled to prepare for the possibility of combat. Making matters worse, American assumptions completely underestimated Japan's military capability and strategic audacity which resulted in the Japanese surprise attack on Pearl Harbor on 7 December 1941 which temporarily crippled the US Pacific Fleet.

Across the United States, people were stunned, and any remaining anti-war or isolationist feelings dissolved into anger and passionate patriotism. On 8 December 1941, President Franklin Roosevelt made his famous "Day of Infamy" speech; and Congress voted to declare war on Japan. Later that week, Germany and Italy joined their Axis partner in declaring war on the United States. To defeat these new enemies, the US military would require some sixteen million American men and women to serve over the next forty-five months, until August 1945, in two major theaters. Immediately following the Japanese attack, the US military embarked on an unprecedented mobilization effort. The Second World War started with about 1.4 million US Army soldiers in 1941; this number doubled in each of the next two years, before finally peaking around 8.2 million in 1945.[49] Like the rest of the US Army, the Corps of Engineers and the Engineer School ramped up recruitment and training efforts to meet growing demands for manpower. In fact, the second class of EOCS graduated on 8 December 1941, one day after the Pearl Harbor attack and on the same day as Roosevelt's "Day of Infamy Speech," which makes this class the last class to be fully trained on a peacetime, albeit preparedness-conscious, footing. The subsequent incoming classes of EOCS and at the ERTC shifted to focus on the urgency of wartime expectations.[50]

The engineer units were attached to one of three major components, which were created during a wartime reorganization of the US Army in 1942. The Service of Supply, renamed the Army Service Forces in 1943, focused on all logistics and transportation, both in and outside the United States. The Army Air Forces handled all aspects of aircraft and airfield operations, construction, and maintenance. And, the newly established Army Ground Forces bore responsibility for the organizing, training, equipping, and manning of combat units inside and outside of the United States. All three forces retained engineer units, but the Army Service Forces represented the higher headquarters to which the Corps of Engineers reported.

Wartime Expansion and Evolution of the Engineer Officers Candidate School

The Engineer School had already set mechanisms and structures for mobilization in place at the ERTC and EOCS before the United States entered the war in 1941. Yes, larger class sizes were still needed, along with many more specialized courses, numerous doctrinal changes, and additional training venues. The key to effective wartime growth lay in the proper scaling of all programs. The quantity of engineers coming from these programs needed to be balanced against the quality of engineering, combat, and leadership training they had received. Herein lay the toughest challenge facing the Engineer School—one that was not overcome until the summer of 1943—for neither the scaling for quantity nor the training of quality engineers were easy tasks.

The expansion of the EOCS and ERTC at Fort Belvoir and of the second ERTC at Fort Leonard Wood began just immediately after the Pearl Harbor attack. The Military Academy and ROTC programs failed to produce enough officers. These two pools could not keep up with the manpower requirements of new units being activated, new vacancies for instructors, or work on Corps of Engineers construction projects. The remaining slots were filled by recruiting college-educated civilians and by promoting noncommissioned officers and enlisted engineers into the EOCS system. The chief of engineers, Maj. Gen. Eugene Reybold, informed the leadership at the War Department in a memorandum dated 18 December 1941, that "present plans call for the early expansion of the Officer Candidate Training Courses at the Engineer School to four times the present capacity."[51] To release "congestion" at Fort Belvoir in particular, Reybold requested that engineering units not directly involved in training, yet stationed at that post, would be relocated to other Army posts. This decision, he summarized, would "allow for centralization and concentration of the activities of the Engineer School and provide additional housing at Fort Belvoir, Virginia, without delays attendant upon construction."[52]

The EOCS began a dramatic expansion in January 1942. Eventually, six classes ran simultaneously on cycles. As soon as one class graduated, a new class began the very next day. The EOCS's daily training load rose

from around 200 candidates to over 5,000 in the months from December 1941 to June 1942.[53] The Engineer Officer Candidate School wasn't receiving "the caliber of men who should be available" according to Brig. Gen. Roscoe C. Crawford, the Engineer School commandant during this time.[54] Only about 6 percent of the candidates attending EOCS were college graduates in engineering of which 90 percent would successfully complete the course. Only about 82 percent of candidates who had a bachelor's degree in another subject completed EOCS while only 77 percent of candidates who had some college classes in engineering successfully completed EOCS. The chief of engineers and the Engineer School's commandant fought hard to enroll candidates with technical backgrounds.[55] The candidates who were deficient in leadership or could not pass because of academic deficiencies in mathematics, reading, or writing, became part of the newly established "Special Development Platoon" which taught remedial academic subjects. The remedial courses took between two to four weeks. These efforts resulted in saving about 80 percent of candidates who would have been eliminated from the program.[56]

A number of other factors reduced the completion percentages, not least of which was poor instruction by faculty with little expertise or experience. By August 1942, 35 percent of the officers serving as EOCS instructors possessed less than three months of commissioned service. The Engineer School reacted to this shortcoming among faculty by creating the Instructional Methods Course. The reasoning behind this course was simple, as articulated in an article in *The Military Engineer*: "If instructors are expected to do a first-class job of instruction they must be given some formal training in the theory and practice of teaching."[57] Every incoming instructor at EOCS, and the ERTCs for that matter, had to take this four-week course that trained them how to teach more effectively. They studied learning processes, lesson plans, training aids, testing techniques, speaking skills, among other things, as developed by a new organization in the Engineer School, the Instructional Method Branch.[58]

Another problem emerged in 1942 when the Army initiated a quota system that provided the specific number of candidates each Army command, corps, divisions, and training camps needed to provide to OCS. Each organization responsible to provide candidates had to establish a screening or selection board to determine the most qualified applicants. The Corps of Engineers asked for a central selection board later in the war to make sure that EOCS would receive the best candidates but the decentralized selection boards and its quotas remained in effect for the rest of the war.[59]

The EOCS at Fort Belvoir enjoyed success, despite facing various internal and external problems. Between December 1941 and December 1942, some 9,000 out of 11,000 candidates completed the program and received commissions in the Corps of Engineers. Part of this figure came from the integration of ROTC cadets into EOCS in May 1942, after the War Department decided that the ROTC summer camps sapped resources from EOCS and offered redundant coursework. Overall, this figure of 9,000 amounted to an 80 percent success rate.[60]

The twelve-week curriculum at EOCS began in 1942 with 528 hours and ended the year with 598 hours on instruction, examinations, physical fitness, practical exercises, and eventually nighttime field exercises. The typical work week ran six days per week and each day began at 0600 with physical training, personal hygiene, breakfast, and police call. Classroom instruction took up most mornings until lunch, and practical exercises most afternoons until the end of the day at 1700. The candidates added an extra two hours of individual study each evening.[61]

During 1942, the EOCS curriculum included 228 hours, or 38 percent of the total coursework, for engineering functions. The realities of fast-moving mechanized units and fluid battle space prioritized the instruction on maneuver support missions. The combat units needed to be able to move quickly from one objective to another, to bypass or overcome obstacles, and to engage and defeat the enemy. Candidates had to learn the functions of mobility and countermobility, in particular, they studied field fortifications, mine detection, assault tactics, breaching obstacles, road construction, camouflage, demolitions, floating and fixed bridging, and vehicle and engineer equipment operation and maintenance. The remaining 370 hours, or 62 percent, of the EOCS coursework concentrated on subjects not related to engineering, yet still essential to candidates functioning as Army officers. These courses taught the candidates about combat and non-combat subjects. The combat courses contained the obligatory courses on weapons, patrolling, small unit tactics, map reading, and principles of war and combat, among others. The set of non-combat courses included an entire week of instruction on practical tasks like personnel actions and company-level management.[62]

Throughout 1942, the EOCS curriculum changed very little. However, some minor revisions occurred after lessons learned from two major unit maneuvers in Louisiana in 1941 and Tennessee in 1942 trickled back to the EOCS. Engineer units participated in bridging operations, terrain reconnaissance, field fortification construction, and other combat functions.

This provided the units and commanders with invaluable field applications of their training at the ERTC and the EOCS.[63]

The Tennessee maneuvers in 1942 gave the Engineer School and the Corps of Engineers opportunities to rotate officers with practical field experience back to teach at EOCS or ERTC. Not only did engineers understand the challenges of spreading competent officers across training programs and field units, so too did the leaders at the highest levels of the War Department. As of the summer of 1942, the secretary of war sought to ensure that competent engineer officers alternated between units overseas and the training programs in the United States. While the Engineer School gained instructors with experience in the field, the newly activated units obtained experienced personnel from the Engineer School, and troop units received qualified loss replacements junior in rank to those officers on duty with the Engineer School.[64] This new system created constant feedback between the units in the field and the Engineer School which aided the quick dissemination of lessons from the field to classrooms, into doctrinal manuals, and then filter back into other field units.[65]

Through surveys, the Engineer School also received the latest lessons from the field, how EOCS trained officers performed in their engineer units, and what additional instructions might be necessary to improve performance. The commanders' answers to these questions contained few harsh criticisms of EOCS. The commanders observed that their officers gradually grew more aggressive and effective as small unit leaders due to on-the-job training in their units. Most of the surveys called for more training in military law, mess management, and personnel actions. A few responses likewise pointed to the need for more instruction of engineer-specific subjects.[66]

The responses from the surveys, the first-hand experiences of officers returning as instructors, and other documents like after-action reports helped EOCS to adapt its curriculum to real-world needs. In addition, the collected data also found its ways into numerous revisions of field manuals and teaching materials.[67]

The year 1943 saw a decline in manpower requirements due to the 1942 officer training requirements being met. With this reduced demand, enrollments at EOCS gradually shrank from 700 candidates per class in early 1943, down to 160, and finally to 125 candidates by the year's end. In addition, the composition of each EOCS class was altered significantly due to the War Department's directive which discontinued ROTC summer camps and placed ROTC cadets into EOCS to complete their commissioning training. By late spring and summer of 1943, half of each EOCS class would consist of ROTC cadets in already smaller classes, which produced superior officers compared to the previous year.[68]

In mid-1943, the Engineer School reacted by increasing EOCS from twelve to seventeen weeks, with 816 hours of coursework. Only thirty-two of the additional 216 hours went to engineer-specific instruction. These thirty-two hours were spread proportionately over the range of engineering subjects from the 1942 EOCS curriculum and the remaining extra 184 hours augmented the curriculum's non-engineer content. The time devoted to small unit and tactical-level leadership almost doubled, and the time on management tripled. The restructuring of the program was largely driven by the Engineer School and only about half of the hours added to the 1943 EOCS curriculum consisted of classes directed by the War Department and the Services of Supply.[69]

In late 1943, Col. H. X. Price, while serving on the War Department Observers Board in Europe, conducted an informal survey of engineer unit commanders. He found that most engineer commanders believed their officers that received the seventeen-week version of EOCS were sufficiently well-trained. However, several complaints or suggestions for improvement arose that called for more study of basic engineering skills like construction planning and equipment operations. The commanders also commented on the lack of leadership, aggressiveness, and poor managerial skills.[70]

The surveys and other data collection efforts did spark some changes. The Engineer School, for example, initiated several "special courses" during the Second World War. These new courses lasted between two and six weeks each and helped fill gaps in existing knowledge or taught new skill sets to soldiers of all ranks, both inside and outside the engineer branch. These courses also trained engineers on topics such as Camouflage, Mapping, Mechanical Equipment, Bailey Bridge Construction, and Passage of Mine Fields. Another special course, Attack of Fortified Positions, was created at the request of the Army Ground Forces and provided detailed instruction to other combat arms officers. The course focused on demolitions to destroy enemy pillboxes and other field fortifications.[71] The Engineer School also created a Post-Graduate Course for commissioned officers coming out of the US Military Academy. Beginning in late 1942, these post-graduates spent their first six weeks of instruction primarily on engineering functions not well covered at West Point, and then a second block of six weeks gaining leadership and administrative practice as platoon leaders in ERTC. The new and special courses demonstrated the agility of the Engineer School to fix problems on the fly.[72]

As the surveys with commanders indicated, EOCS commissioned officers often lacked administrative skills to function properly on battalion staffs up to corps-level headquarters. To alleviate these shortcomings, the Engineer School created the Divisional Training Course and the Field Officers Course which were offered for the first time in 1942. The Divisional Training Course was meant for battalion staff officers as well as company commanders that were about to take assignments in newly activated divisions. The officers received practical instruction in planning and supervision of unit training and in administration. Between January 1942 and June 1943, 371 officers completed the four-week course. The Field Officers Course was first taught in February 1942 when forty-three students attended the three-month course. This course had its origins in the chief of engineers Operations & Training section's concern due to the shortcoming of National Guard and Reserve officers that were observed during the 1941 maneuvers. Due to the lack of field officers in 1942, the course was shortened to two months and soon became the most heavily attended general course given. It was taught between 7 September 1942 and 20 October 1945 during which time a total of 2,487 officers graduated. The course was designed to prepare officers as battalion staff officers and would "fill the distinct gap between the basic instruction in the Corps of Engineers and the instruction for division staff officers as carried out by the Command and General Staff School."[73]

The senior leaders of the Army Service Forces planned for a revision of all branch OCS curricula and informed its service schools of these new plans in November 1944. Major discussions between the individual service schools and the Army Service Forces prolonged the implementation of any new curriculum and the alterations never came to fruition as the Second World War ended in August 1945.[74]

Wartime Expansion and Evolution of the Engineer Replacement Training Centers

During the years of 1942 to 1944, the ERTC programs at Fort Belvoir and Fort Leonard Wood experienced even more growth than did the EOCS. In the wake of the attack on Pearl Harbor, the ERTC programs decreased from twelve weeks down to eight weeks. This decision helped push through as many new engineer soldiers as possible, but sacrificed time on technical subjects. The new units could, it was hoped, pick up the slack by providing training overseas. The stop-gap measure only lasted until March 1942, when the ERTCs reverted back to twelve weeks. This change remained in force until August 1943.[75]

The first few weeks of ERTC introduced drill, marksmanship, and military discipline and courtesy—among other similar topics—to the trainees. The rest of the course turned to engineer-specific subjects. The trainees developed skills in reconnaissance, bridge building, and obstacle breaching and placement. The instruction on bridging, for example, started with work on scale models, followed by field exercises at Fort Belvoir and Fort Leonard Wood. Several companies of trainees could practice building steel bridges, wooden trestle bridges, and foot bridges at one time on both natural and manmade waterways. After Bailey Bridges were adopted by the Corps of Engineers, training on these supplemented the existing exercises. Similar shifts from classroom to field exercises occurred in subjects ranging from demolitions to road construction. Meanwhile, both posts continued to add more and more buildings to support the growing enrollments. In June 1942, the ERTC at Fort Belvoir graduated 4,444 new engineer soldiers, and Fort Leonard Wood added several thousand more graduates to that total.[76]

Beginning in the spring of 1943, the mission of the ERTCs shifted from training "fillers" to join newly organizing units to training "replacements" for units already deployed to Europe and the Pacific theaters where they suffered attrition from casualties. To better prepare these soldiers, higher headquarters required that the replacements be subjected to "every sight, sound, and sensation of battle," which translated into training being conducted in realistic conditions mirroring battles fought in the recent African theater.[77]

The memoirs of an enlisted engineer named Roger O. Austin yield some evocative descriptions of training at the ERTC at Fort Leonard Wood. He was a thoughtful and artistic young man whose eye for good photography captured telling images. Austin received his draft notice in May 1943 while living in the tiny town of Fonda in upstate New York.[78]

Austin first received four weeks of basic training at Camp Upton on Long Island, and then made the railway trip to Fort Leonard Wood, what he justifiably called "88,000 acres carved out of a remote section of the Ozark Mountains."[79] Austin and his comrades had very little time for recreation because, as he remembered:

> We were trained not only how to build, but how to fight; our group was to be instantly available to go in ahead of the tanks and infantry if bridges or roads had to be prepared so the column could move ahead. Combat engineers were just that—in combat, there would be no time to wait for the Army engineering group—we had to be prepared to work, and to work fast.[80]

Figure 6.3. Bridging exercise at Fort Leonard Wood ERTC in 1943. Courtesy of US Army Engineer School History Office, Roger Austin Collection.

Austin's description of his training resembles what many engineers have experienced on the very same grounds while training for combat throughout the years at Fort Leonard Wood. Austin matter-of-factly explained:

> We had brutal obstacles courses. We learned to how [sic] cross rivers and ravines, how to repair roads, how to locate and disarm mines as well as to lay them. We built roadblocks with trees, metal barriers, traps, and wrecked equipment. We used whatever worked. . . .
>
> Using the nearby Great Piney River, we build wooden bridges, pontoon bridges, and the hasty bridges. . . . On one blistering hot day our assignment was to construct a bridge over a small stream. As we got under way, a flash storm hit and that stream rose up to our armpits. We were literally swamped. Did we stop? No way.
>
> My training at FLW was tough, thorough, and interesting. It was an experience that I could never forget and I would miss the men in my barracks. What I would never miss was the heat, the dust, and the Great Piney River.[81]

After completing the ERTC, Austin deployed with an engineer unit attached to an American armor unit. He survived combat in Europe, returned to the United States, and went on to become a successful architect.[82]

Despite the incredible numbers of troops passing through Fort Leonard Wood and Fort Belvoir, a third ERTC program opened at Camp Abbot in Oregon, presumably for the selectees and volunteers in the western United States. Camp Abbot started its first training cycle in July 1943. This post eventually rivaled Fort Belvoir and Fort Leonard Wood for production of enlisted engineers.[83] Still, these three posts could not match all the Army's engineering needs. The most significant disparity can be seen in the amount of technical specialist training and whole unit training before deployment overseas. The Engineer School filled these gaps with two additional posts: the Army Service Forces Training Center at Camp Claiborne, Louisiana, and the Engineer Unit Training Center at Camp Ellis, Illinois.[84]

By the end of summer 1943, the manpower crisis stabilized, which allowed the Engineer School to expand the ERTCs from twelve to seventeen weeks, just like the EOCS. The new curriculum contained three blocks: six weeks on basic training, eight weeks on specialist or engineering training, and finally three weeks of large-team training that simulated the combat zone. In April 1944, the ERTCs changed names to Army Service Forces Training Centers, which reflected an Army reorganization of all training activities under the Army Service Forces.[85]

Volunteers and draftees in non-combat specialties went to the Army Service Forces Training Center. First they received six weeks of training in basic military and combat engineering subjects. Then, they focused for eight weeks on learning their particular skills as surveyors, quarrymen, carpenters, welders, bricklayers, crane hoist operators, millwrights, and the like. This list only scratched the surface of the several hundred engineering specialties. The trainees also learned the critical aspect of teamwork because so many projects required individuals to function among diverse groups of specialists. Following the end of the fourteen weeks, the new engineer soldiers augmented existing units or joined newly formed units.[86]

The Engineer General Service Regiment was the most prominent type of unit coming out of Camp Claiborne. According to the Corps of Engineers' directives, these units performed "the construction, repair, and maintenance of all structures of every character throughout the theater" from permanent bridging to airfields.[87] Yet, many other non-combat units of all sizes came out of Camp Claiborne, including Heavy Shop Companies, Petroleum Distribution Companies, and Fire Fighting Platoons.

Some 236,000 engineers served in 1,060 units like these during the Second World War. Although typically working behind the front lines, the non-combat engineer units could take up arms as easily as they could lay mines and breach obstacles.[88]

The other new post at Camp Ellis in Illinois helped prepare entire units in the engineer, quartermaster, signal, and medical branches for deployment overseas. Training resembled that of Camp Claiborne, because both posts allocated the first six weeks to basic military training for units, as opposed to individual soldiers. The units spent the following ten weeks on tactical training in their respective branches and, finally, on field exercises. The unit training at Camp Ellis lasted a total of sixteen weeks, with an additional two weeks spent as units in the field.[89]

Examples of Engineer Training Put into Practice during the Second World War

The US Army Corps of Engineers mobilized 89 divisional combat battalions, 204 non-divisional combat battalions, 124 aviation battalions, 79 general service regiments, and 36 construction battalions during the Second World War. Many of these ostensibly non-combat units did come under enemy fire and deployed as infantry when needed.[90]

Nevertheless, many examples highlighted how training helped prepare engineers to perform mobility, countermobility, general engineering, and topographical engineering functions. All these factors call to mind the farsighted article "Engineers in Combat" written by Lt. Col. Donald B. Adams back in early 1940. By synthesizing lessons from the First World War with observations about the fighting in Europe earlier that year, Adams laid the foundation for successful engineering operations during the Second World War. His article reflected the doctrine being developed and the training offered at the Engineer School at Fort Belvoir. Adams's prewar perspective can likewise be used as a lens for analyzing the combat operations in the Second World War.[91]

The mechanization of ground forces made movement on battlefields in the Second World War more rapid than any major conflict to date. The race across France in August 1944 is one such example when XII Corps advanced 250 miles in a sixteen-day period, an unthinkable distance in previous conflicts.[92] Again, just as Adams predicted in 1940, the new operational reality magnified the role of the US Army's engineers provision of mobility to combat arms units in every campaign of the war. The resulting mobility afforded those combat units ever greater freedom of movement, thus the rapid advance across France toward the heart of Nazi Germany.[93]

Although engineers mainly supported the race across France with much needed mobility during offensive operations, the engineer's countermobility function saw impressive use during Germany's counterattack during the Battle of the Bulge in December 1944. On 16 December, more than 200,000 German soldiers and some 970 tanks and armored assault guns launched a surprise attack against a thinly defended American sector in the Ardennes Forest in Belgium. The fast-moving Germans overwhelmed the US Army units spread along a sixty-mile front and drove quickly westward. The Germans' greatest depth of penetration was achieved on the tenth day of the attack when German troops reached their culmination point about sixty air-line miles deep in the American lines.[94]

Across the entire operational area of this bulge, several thousand engineers quickly transitioned from the offensive mobility function they had used during the previous months to the defensive countermobility function. The 35th and 158th Engineer Combat Battalions held the tiny village of Bastogne against initial German attacks until they were relieved by the 101st Airborne Division on 19 December.[95] Elsewhere, engineer units laid mine fields, erected abatises, defended roadblocks, and destroyed bridges that diverted, disrupted, delayed, or even stopped the German advance. They relied on their training and put existing doctrine into practice. Although the officers in 1944 may have not read Lt. Col. Donald Adams's article from 1940, they instinctively followed his recommendations that had been ingrained in their training: "Bridges, not to be used during the advance, will be mined with TNT ready for instant demolition," and roads "will be prepared for defense by mining, by road blocks of large trees felled across the roads, by cable blocks, by earth barricades, and in some cases by concrete or steel tank blocks."[96]

In one of the more dramatic engagements during the Battle of the Bulge, German Lt. Col. Joachim Peiper and his elite *Waffen SS* armor had to cross several bridges in Belgium as they pushed westward through the American lines. They ran into elements of the US Army's 291st and 51st Engineer Combat Battalions that, although heavily outnumbered, thwarted the German advance by blowing up or defending several bridges in their path. Those small American units had received guidance from senior commanders to hold the bridges until the last possible moment and destroy them only if forced to do so in order to keep them from falling into German hands. Finally, on 18 December 1944, Peiper made one last desperate attempt to cross a stone bridge in the village of Habiemont. Before he could succeed, however, a platoon from the 291st blew the bridge just as Peiper's tanks rolled up. The engineers had wired the bridge with more than 2,000

pounds of TNT to make certain it would be completely destroyed.[97] After the explosion a badly irritated Joachim Peiper "could only sit with a leaden heart and face the fact that time and his luck had entirely run out on him," according to one source.[98] "And he could only sit helplessly, pound his knee and swear, 'The damned engineers! The damned engineers!'"[99]

Figure 6.4. During the Battle of the Bulge in December 1944, engineers of the 146th Engineer Combat Battalion wired trees with dynamite charges. When detonated, the trees fell across the road and formed an abatis. Courtesy of US Army Engineer School History Office Archives.

Ultimately, the tactical successes of blowing up these bridges contributed to the Americans' decisive obstruction of the German advance in the Bulge. The engineers put the countermobility function, which they had studied at the ERTCs and EOCS, into effective practice. Lieutenant Colonel Adams's prophetic words from 1940, that the "engineers are equipped and able to construct the blocks which are intended to bring the mechanized vehicles to a halt" and in fact that "against mechanized forces, it is the job of the engineers to halt them so that they can be destroyed by the covering fire of the infantry and artillery" can be clearly seen in the above example.[100]

The bridge demolitions on 18 December 1944 did not, however, mark the end of engineer contributions in the Bulge. Peiper's tactical retreat a few days later opened up the possibility for American forces along the north of the Bulge to launch their own counterattack. The United States advanced southward with the objective of cutting off the Germans within the Bulge from reaching their own friendly lines. "Mines aside, the road conditions all but stopped our modern wheeled and tracked army. Lateral roads that might have been used to skirt or bypass tough [German] defensive cordons were often rendered impassable by snow too deep for our vehicles," recalled Lt. Col. David Pergrin.[101] His soldiers used "all their bulldozers to cut fresh attack and supply routes through the heavy snow. Often, bulldozers with their make-shift armored cabs had to precede the infantry assaulting snow-bound German blocking positions" which once again is proof that the renewed American offensive operations would have been bogged down if not for the combat engineers of the 291st.[102] By mid-January 1945, the American forces had reclaimed the ground taken by the Germans during the Battle of Bulge and the push into the heart of Nazi Germany continued.

Figure 6.5. A bulldozer from the 307th Engineer Combat Battalion pushes a destroyed German armored vehicle off the snow-covered road during the Battle of the Bulge in early January 1945. This mobility function supported the American counterattack that drove the Germans back to the original front lines. Courtesy of US Army Engineer School History Office Archives.

The bulldozers of the 291st represented yet another example of this battle harkening back to Adams's 1940 article. He referred to bulldozers when he predicted: "It is quite possible that more of these will be needed in actual warfare, bearing in mind that, to make speed, the motorized forces must keep to roads. . . . For this the bulldozer is admirably suited. New roads, bypasses, cutoffs, earth barricades can all be easily constructed by this machine."[103] Adams's foresight once again proved to be very accurate.

Training in General Engineering and Topographical Engineering Put into Practice

Although the general engineering function rarely received the attention given to combat engineering in the Second World War, the contributions of engineers working on herculean construction projects should not be ignored. Projecting American forces numbering in the millions required supply lines running over thousands of miles. In terms of land transportation, the Corps of Engineers took the lead in building and maintaining railroads, roads, and bridges in some of the most inhospitable environments on earth. The successes enjoyed by the engineers would not have been possible without effective training received at ERTCs, EOCS, and other specialized programs offered by the US Army Engineer School. These programs gave engineers of all ranks the knowledge base necessary to plan, direct, and complete construction projects no matter how small or large.

General engineering projects such as the 6.5-million-square-foot Pentagon in Washington, DC (1941–43), or the Ledo Road which connected Ledo, India, to Kunming, China (1942–45) all have the signature of the US Army Corps of Engineers.[104] Perhaps the most extraordinary feat of general engineering in the Second World War was the Alaska Canadian (ALCAN) Highway which ran some 1,500 miles from Dawson Creek in British Columbia northwest to Big Delta, about ninety miles southeast of Fairbanks, Alaska. The War Department directed the chief of engineers to proceed with the project on 14 February 1942. The so-called ALCAN Highway was built under the direction of Brig. Gen. William H. Hoge. In addition to being a combat veteran of the First World War, he brought extensive civil works experience to the project. More than 10,000 engineers worked on the road all the while contending with wintry weather, spring flooding, and extreme summer heat. They crossed countless rivers and streams, first with pontoon bridges, which were then replaced with wooden trestle bridges. The engineers cut a path for the ALCAN Highway through unmapped wilderness using everything from axes and saws to bulldozers. Hoge's command included the 18th and 35th Engineer Combat Regiments, the 340th and 341st Engineer General Service Regiments, and the African Americans in the 93rd, 95th, and 97th Engineer General Service Regiments (Colored). Together, these units completed the project barely eight months later on 28 October 1942. The highway then became a major artery for transporting supplies to American troops stationed in Alaska. It also carried supplies that found their way from Alaska across the Bering Sea and then through Siberia to the Soviet Union's forces fighting in Europe.[105]

The best roads and bridges and the most effective mobility and countermobility efforts in the field cannot guarantee battlefield successes. These activities do not do commanders much good if they do not know the terrain features of their operating environments. Topographical engineers—geospatial engineers in twenty-first century terms—provided this much-needed information. High quality maps give commanders decisive advantages or crushing disadvantages. Creating accurate maps requires reconnaissance and analysis of terrain features, waterways, foliage, natural obstacles, manmade obstacles, and conditions and locations of roads. These accurate assessments can affect decisions by commanders regarding tactical movement or logistical support. The information collected during this war was sent to topographical engineer units at higher echelons to help create maps and models of the operational environment. At the beginning of the war, engineer applicants who wanted to train in this specialty were required to have two years of college mathematics and a minimum score of 100 in the Army General Classification Test (AGCT). In March 1943, the qualifications for the Topographical courses were revised downward and only required a high school diploma and an AGCT score of 90. The additional training beyond the normal twelve weeks required for this career field fluctuated between taking a variety of surveying and topographic computing courses at civilian institution such as the University of Kentucky or the 528-hour Topographic Drafting or Topographic Computing Course at Fort Belvoir.[106]

Before the topographical engineers could create maps, let alone models, they needed to examine existing maps and aerial photography. They also needed to conduct their own visual reconnaissance of the ground, often drawing very close to enemy positions while attempting to avoid detection. Once the topographical engineers gathered as much data as possible, they could create maps and build a three-dimensional model, inclusive of as many terrain features as possible. Such attention to detail and accuracy could enable commanders to make decisions that won battles and saved lives. Conversely, if mistakes were made, American soldiers could be killed or wounded in a possible defeat. Thus, despite the inglorious task of painstakingly creating maps or building such as models, the topographical engineers' finished products could determine life and death, victory and defeat.

Figure 6.6. Using a detailed three-dimensional model of one of the German-occupied forts in the November 1944 Metz ring of fortifications, Maj. Gen. S. Leroy Irwin, 5th Infantry Division, briefs high-ranking visitors. Among the visitors are Army Deputy Chief of Staff Lt. Gen. Thomas T. Handy (left), Lt. Gen. George S. Patton Jr. (second from left), and Army Chief of Staff General George C. Marshall (right). Courtesy of US Army Engineer School History Office Archives.

Engineering Lessons Learned in the Second World War

Many lessons regarding engineer training and its operational applications can be gleaned from the Second World War. Never before 1941 and never since 1945 have so many engineers served at one time all over the world. The same goes of the magnitude of the Engineer School's activities in the ERTCs and EOCS.

The engineering lessons from the Second World War are intertwined between the Engineer School and the Corps of Engineers and include:

• Prioritized development of leadership in all engineers. Development of this intangible trait started at EOCS and the ERTCs, and needed to continue in active service with units, continual training, senior commander mentorship, and consultation with senior noncommissioned officers.

• Developed engineering training for all ranks that contained realistic scenarios in field exercises, feedback loops from the front, and agile evaluations and revisions of doctrine.

• Reinforced the need for mobilization planning and processes that can match manpower needs with sufficient infrastructure and equipment to make training relevant.

• Balanced the number of competent engineer officers and noncommissioned assigned to units in the field vice the number of these teaching in the Engineer School's various program.

• Validated efforts by the Corps of Engineers and the Engineer School to identify and recruit future officers with professional and/or educational background in technical fields.

• Highlighted the need for engineers with specialized training in general and topographical engineering functions to keep pace with technological advances. Centralized schools teaching these specialists to one location, rather than scattering them across several posts.

• Confirmed the primacies of mobility and speed on modern battlefields.

• Verified the lessons from the First World War that combat engineer units needed to be organic to divisions, as well as have engineer support attached to higher echelons such as corps. This gave the senior commanders more flexibility to place the engineer units where and when they were needed.

Conclusion

When the Second World War broke out in Europe in September 1939, the Engineer School's student body numbered less than 100 officers. The entire Corps of Engineers stood at just over 6,500 officers and men in a dozen units. The next six years of mobilization for war and maintenance in war saw a 100-fold growth in manpower. Although sometimes haphazard or inadequate, the Engineer School's programs like the ERTCs and EOCS trained nearly enough soldiers to expand the Corps of Engineers to 688,888 men in 2,125 units at its peak in 1945. This mobilization process drew some lessons from First World War, which helped the Engineer School and Corps of Engineers reach these incredible figures. Mobilization was not, however, the only challenge facing the school as it supported engineering operations overseas. The various training programs needed to adapt curricula and doctrine to solve problems in combat and construction engineering alike. Despite being deficient in qualified instructors and manpower numbers, the Engineer School succeeded admirably in training competent engineers to perform any number of missions and improvise in missions not covered in training. This is not to say that engineers never failed. They did. Nevertheless, evidence of effective training can be seen in countless operations in every theater of operation, campaign, and battle. World War II is termed an "Engineer's War" for good reasons.

Notes

1. David M. Kennedy, *Freedom from Fear: The American People in Depression and War, 1929–1945* (New York: Oxford University Press, 1999), 381–464.

2. Paul K. Walker, "The Engineer Replacement Training Center, Fort Belvoir, Virginia," in *Builders and Fighters: U.S. Army Engineers in World War II*, ed. Barry W. Fowle (Fort Belvoir, VA: US Army Corps of Engineers Office of History, 1992), 65; Blanche D. Coll, Jean E. Keith, and Herbert H. Rosenthal, *The Corps of Engineers: Troops and Equipment* (1958; repr., Washington, DC: US Army Center of Military History, 2002), 14–15; and US Army Corps of Engineers, *History and Traditions of the Corps of Engineers* (Fort Belvoir, VA: US Army, 1953), 57–58.

3. Coll, Keith, and Rosenthal, 198.

4. Walker, "The Engineer Replacement Training Center," 65.

5. See Crawford's entry in R. Manning Ancell with Christine Miller, *The Biographical Dictionary of World War II Generals and Flag Officers: The U.S. Armed Forces* (Westport, CT: Greenwood, 1996), 70.

6. Commandant, Engineer School, Memorandum for Adjutant General, Subject: Report of Operations of the Engineer School for the School Year 1940, 5 July 1940, and Appendices I and II, US Army Engineer School History Office Archives.

7. War Department, Bureau of Public Relations, Press Branch, "The Engineer School," press release, 19 August 1941, US Army Engineer School History Office Archives.

8. John J. Kingman, Memorandum through the Adjutant General for Major General Commandant, US Marine Corps, Subject: Lecturer on Landing Operations, 6 January 1941, US Army Engineer School History Office Archives.

9. Kingman, Memorandum through the Adjutant General to the Chief of Naval Operations.

10. Commandant, Engineer School, Memorandum for Adjutant General, Subject: Report of Operations of the Engineer School for the School Year 1940, 5 July 1940, Appendices I and II, US Army Engineer School History Office Archives.

11. Gustav Person, "Fort Belvoir's Engineer Replacement Training Center," *The Military Engineer* 103 (September–December 2011): 36–39; Walker, "The Engineer Replacement Training Center," 66; and Coll, Keith, and Rosenthal, *The Corps of Engineers*, 160–65.

12. "A Short History of the Engineer Training Center," 3; Capt. Ralph Johansen, "Training a Selectee to Be an Engineer," *The Military Engineer* 33 (March–April 1941): 104; Walker, "The Engineer Replacement Training Center," 66; and General William M. Hoge, *Engineer Memoirs* (Washington, DC: US Army Corps of Engineers Office of History, 1993), 75–82.

13. Lt. Col. Donald B. Adams, "Engineers in Combat," *The Military Engineer* 32, no. 186 (November–December 1940): 429–35.

14. Maj. P. S. Bond, "Duty, Organization, Training, and Equipment of the Engineer Troops for Field Service," *Professional Memoirs* 7, no. 36 (November–December 1915): 691–718.

15. Adams, "Engineers in Combat," 429.

16. Adams, 431

17. Adams, 434.

18. Adams, 434.

19. Adams, 434.

20. Adams, 433.

21. Adams, 433.

22. Adams, 435.

23. Adams, 433.

24. Adams, 433.

25. For example, see *Field Manual (Vol. II) Military Engineering (Tentative) Part II: Defensive Measures* (Washington, DC: Government Printing Office, 1932). This manual and many other primary sources are available in the "Documents" section of *VI Corps Combat Engineers of WWII*, accessed 25 June 2016, http://www.6thcorpscombatengineers.com/.

26. Hoge, *Engineer Memoirs*, 75.

27. Walker, "The Engineer Replacement Training Center," 66.

28. Walker, 67.

29. Walker, 67–68.

30. David C. Pergrin with Eric Hammel, *First Across the Rhine: The 291st Engineer Combat Battalion in France, Belgium, and Germany* (New York: Macmillan Publishing, 1989), 2–3

31. Pergrin with Hammel, 3.

32. Walker, "The Engineer Replacement Training Center," 70.

33. The Public Relations Office, E.T.C., "A Short History of the Engineer Training Center" (Fort Belvoir, VA: US Army publication, n.d.), 5–6.

34. Paul W. Bass, *The History of Fort Leonard Wood*, *Missouri* (Morley, MO: Acclaim Press, 2016), 35–47.

35. Fred W. Hansen, "Fort Leonard Wood, Missouri," *The Military Engineer* 33 (March–April 1941): 108–9; and Larry Roberts, "The Engineer Replacement Training Center, Fort Leonard Wood, Missouri," in *Builders and Fighters: U.S. Army Engineers in World War II*, 79.

36. Hansen, 110; Bass, *The History of Fort Leonard Wood*, 17–30; and Roberts, 84.

37. Roberts, 87–88; and Bass, 48–50.

38. Commanding General, Memorandum for Chief of Engineers, 20 December 1944, US Army Engineer School History Office Archives; Larry D. Roberts, "A School for Officers: A History of the Engineer Officer Candidate School" (unpublished manuscript, US Army Engineer School, n.d.), chap. 2, 3–4, US Army Engineer School History Office Archives; and Coll, Keith, and Rosenthal, *The Corps of Engineers*, 157–59.

39. Roberts, chap. 2, 4.
40. Roberts, chap. 2, 4.
41. Roberts, chap. 2, 4.
42. Roberts, chap. 2, 4.
43. War Department, The Adjutant General's Office, Memorandum to Chief of Staff, Commanding Generals, Commandants, Superintendent, et al., Subject: War Department Training Directive, 1941–1942, 19 August 1941, US Army Engineer School History Office Archives.
44. War Department, 3.
45. War Department, 3.
46. War Department, 3.
47. Roberts, "A School for Officers," chap. 2, 5.
48. Coll, Keith, and Rosenthal, *The Corps of Engineers*, 149; Roberts, chap. 2, 4–6; and Whipple, "Engineer Officer Candidate School," 421.
49. National World War II Museum, "By the Numbers: The US Military," accessed 6 July 2016, http://www.nationalww2museum.org/learn/education/for-students/ww2-history/ww2-by-the-numbers/us-military.html.
50. Coll, Keith, and Rosenthal, *The Corps of Engineers*, 149; and Roberts, "A School for Officers," chap. 2, 5–6.
51. Chief of Engineers, Memorandum for Adjutant General, War Department, Subject: Expansion of the Engineer School, 18 December 1941, US Army Engineer School History Office.
52. Chief of Engineers.
53. McPherson, *Ninety Day Wonders*, 115–18; Roberts, "A School for Officers," chap. 2, 5–15; and Coll, Keith, and Rosenthal, *The Corps of Engineers,* 146–60.
54. Coll, Keith, and Rosenthal, 150.
55. Coll, Keith, and Rosenthal, 150–51.
56. Roberts, "A School for Officers," chap. 2, 13–15.
57. Edwin W. Zoller, "The Instructional Guidance Program at the Engineer School," *The Military Engineer* 38, no. 252 (October 1946): 424.
58. Zoller, 421–24; and Coll, Keith, and Rosenthal, *The Corps of Engineers*, 153.
59. Roberts, "A School for Officers," chap. 2, 9.
60. Roberts, chap. 2, 15–16.
61. Roberts, chap. 2, 10.
62. Roberts, chap. 2, 10–12.
63. Coll, Keith, and Rosenthal, *The Corps of Engineers*, 128–30; for details, see Woody McMillan, *In the Presence of Soldiers: The 2nd Army Maneuvers and Other World War II Activity* (Nashville, TN: Horton Heights Press, 2010).
64. Coll, Keith, and Rosenthal, 153–54.
65. Thomas A. Pederson, "The Engineer School," *The Military Engineer* 38, no. 247 (May 1946): 184.
66. Roberts, "A School for Officers," 20.

67. "Annual Report of the Chief of Engineers, 1943," section V.A (Washington, DC: US Government Printing Office, 1943); and "Annual Report of the Military Activities the Office of the Chief of Engineers to the Commanding General, Army Service Forces, 1 July 1943 to 30 June 1944" (Washington, DC: US Government Printing Office, 1944), 22. Both reports can be found in the US Army Engineer School History Office Archives. The US Army Engineer School History Office holds some 17,000 manuals, including those from the Second World War. Selected manuals are available at "U.S. Army Field Manuals–World War II," accessed 15 July 2016, http://www.ibiblio.org/hyperwar/USA/ref/FM/.
68. Roberts, "A School for Officers," chap. 2, 15–17.
69. Roberts, chap. 2, 17–19.
70. Roberts, chap. 2, 20.
71. David M. Dunne, "The Engineer School—Past and Present," *The Military Engineer* 41, no. 284 (November–December 1949): 415; and Commandant of the Engineer School, Memorandum for the Adjutant General, Subject: Army Register Data, 13 February 1943, US Army Engineer School History Office Archives.
72. Dunne, 415; Roberts, "A School for Officers," chap. 2, 19; and Pederson, "The Engineer School," 184.
73. Coll, Keith, and Rosenthal, *The Corps of Engineers*, 159.
74. Roberts, "A School for Officers," chap. 2, 21–22.
75. Coll, Keith, and Rosenthal, *The Corps of the Engineers*, 166; and Person, "Fort Belvoir's Engineer Replacement Training Center," 39.
76. The Public Relations Office, E.T.C., "A Short History of the Engineer Training Center," 10–12; and Walker, "The Engineer Replacement Training Center," 71–73.
77. Person, "Fort Belvoir's Engineer Replacement Training Center," 39.
78. Roger O. Austin, *One Man's War: Through the Lens of a Combat Engineer* (self-pub., Austin Books, 2009), ix–4.
79. Austin, 12.
80. Austin, 12.
81. Austin, 12–13, 15, 17.
82. Austin, 48, 168.
83. Coll, Keith, and Rosenthal, *The Corps of Engineers*, 257–59.
84. Coll, Keith, and Rosenthal, 296.
85. Walker, "The Engineer Replacement Training Center," 74–75.
86. Theodore C. Combs, "Engineer Training at Camp Claiborne," *The Military Engineer* 36 (August 1944): 265–67; and Report, "Geodetic Computing Course," n.d.; and Headquarters, ERTC, Report, List of Engineer Jobs, 8 August 1941, both in US Army Engineer School History Office Archives.
87. Cited in Combs, "Engineer Training at Camp Claiborne," 266.
88. Karl C. Dod, *The Corps of Engineers: The War against Japan* (Washington, DC: US Army Center of Military History, 1987) 685–90; Coll, Keith, and Rosenthal, *The Corps of Engineers*, 239; and Combs, 264–67.

89. Joseph C. Fitzharris, ed., *Patton's Fighting Bridge Builders: Company B, 1303rd Engineer GeneCral Service Regiment* (College Station, TX: A&M University Press, 2007), 4–16.

90. Coll, Keith, and Rosenthal, *The Corps of Engineers,* 239.

91. Adams, "Engineers in Combat," 429–35.

92. Hugh M. Cole, *The Lorraine Campaign: U.S. Army in World War II, European Theater of Operations* (Washington, DC: Government Printing Office, 1950), 57.

93. Adams, "Engineers in Combat," 429–35.

94. Hugh M. Cole, *The Ardennes: Battle of the Bulge, U.S. Army in World War II, European Theater of Operations* (Washington, DC: Government Printing Office, 1965), 71, 650–51.

95. William C. Baldwin, "Engineers in the Battle of the Bulge," in *Builders and Fighters: U.S. Army Engineers in World War II*, 457.

96. Adams, "Engineers in Combat," 433.

97. Pergrin, *First Across the Rhine*, 122–34; and Janice Holt Giles, *The Damned Engineers* (Washington, DC: Historical Division, Office of Administrative Services, Office of the Chief of Engineers, 1987), 250–62.

98. Cited in Giles, 261.

99. Cited in Giles, 261.

100. Adams, "Engineers in Combat," 431. See also Baldwin, "Engineers in the Battle of the Bulge," 460.

101. Pergrin, *First Across the Rhine,* 191

102. Pergrin, 191.

103. Adams, "Engineers in Combat," 433.

104. Lenore Fine and Jesse A. Remington, *The Corps of Engineers: Construction in the United States* (Washington, DC: US Army Center of Military History, 1989), 431–39; and Dod, *The Corps of Engineers*, 474–75.

105. Dod, 299–317.

106. Coll, Keith, and Rosenthal, *The Corps of the Engineers*, 246; and Report, "Geodetic Computing Courses," 4–5.

Chapter 7
The Engineer School during the Korean War and the Cold War: From Conventional to Nuclear and Back to Conventional Battlefields, 1945–65

After World War II ended in August 1945, the US military demobilized within five years to less than one-tenth of its peak wartime strength. Like the rest of the military, the Engineer School's downsized staff tried to leverage past experiences into preparations for future conventional conflicts. Then, in a surprise attack, North Korea invaded South Korea in June 1950, and the US military was engaged in combat once again. The Engineer School answered the call once more and expanded to meet the great demand for personnel. After the conflict ended, the Engineer School reoriented its efforts to train engineers to serve in the Army's "pentomic" divisions on a new nuclear battlefield. In 1962, however, the Army and the Engineers reverted to preparing for another conventional fight against the Soviet Union's army threatening American allies in Western Europe. This focus lasted until 1965, when the United States became heavily involved in Vietnam.

The Effects of Demobilization on the Engineer School

At the end of each war in American history, the US military demobilized to a fraction of its wartime strength. The post-World War II years were no different. The US Army alone downsized more than 90 percent from over 8.2 million men in May 1945 to under 640,000 by the end of 1949.[1] The American public and Congress could not justify maintaining a total war commitment any longer. The post-war honeymoon lasted about two years before a state of political hostility between the United States and the Soviet Union began the Cold War. Countering Soviet geopolitical expansion fueled by the communist ideology, the Truman doctrine of 1947 became the foundation of US foreign policy over the next four decades. Short of open warfare, the two countries and their allies confronted one another in a series of struggles that resulted in a nuclear arms race and several proxy wars. Unending fear and suspicion persisted from 1947 to the 1991 dissolution of the Soviet Union, which officially marked the end of the Cold War.

During American demobilization after 1945, the Engineer School saw a dramatic reduction in the numbers of courses and size of classes for every rank. The Engineer School's curricula changed slightly between 1945 and 1947. The weekly training routine dropped from forty-eight to forty hours and from six to five days. Some realistic yet hazardous training, such as throwing live hand grenades and certain portions of the rifle range, was removed by the direction of the War Department due to the associated risks.[2] By the end of March 1946, all training activities at Fort Leonard Wood, Missouri ended; the post was inactivated and only served National Guard units during their summer training. It wasn't until 1950 that the post was reactivated and engineer training returned to Fort Leonard Wood.[3] The Army Service Forces Training Center at Fort Belvoir, Virginia underwent similar reductions. In early 1947, the Army Service Forces Training Center at Fort Belvoir was discontinued altogether because the responsibility for basic military training of new recruits in branches, including engineers, transferred to the Army Ground Forces command.[4]

The changing circumstances in the immediate post-war years deflated morale at the Engineer School. The situation stabilized over time thanks in part to the curricular foundation published in early 1946 by the War Department's Military Education Board, better known as the Gerow Board named after its chairman, Lt. Gen. Leonard T. Gerow. Gerow was the commandant of the US Army Command and General Staff College at Fort Leavenworth, Kansas, from 1945 to 1948, and he exerted enormous influence on all training activities in the Army. His previous thirty-five years of service included tours as an efficient staff officer with the Signal Corps in the First World War, a superb student at every level of the Army's professional military education system, and a successful division and later corps commanding general in World War II.[5]

The Gerow Board's purpose was to study and submit recommendations for the Army's post-war educational system. The board proposed five joint colleges that would collectively form a National Security University, but only portions of the board's recommendations were adopted. The National War College, the Industrial College of the Armed Forces, and the Armed Forces Staff College were the accepted and implemented institutions at the Joint Chiefs of Staff level. Each was devoted to the joint training of officers. The board's recommendations in regards to the level of training for junior officers up to the intermediate field grade officers did not see any major changes from pre-war years. The officer education system would still be a progressive and sequential education in which the officers advanced through their branch-specific basic and advanced schools followed by the ground college as intermediate field grade officers at the Command and General Staff College. This progressive and sequential officer education system is still in use today.[6]

As a result, the Engineer School created four different officer courses: the Basic Engineer Officer Course and the Advanced Engineer Officer Course for active component officers, and the Associate Basic Engineer Officers Course and the Advanced Associate Engineer Officer Course for reserve component officers.[7] This structure mirrored the courses of the early 1920s, which were designed for newly commissioned lieutenants and subsequent company-level courses for captains, whether in the active or reserve components. The Engineer School also expanded its enlisted courses. These activities required greater numbers of instructors and better post facilities. The development and implementation of the new curricula, as well as the construction of new buildings, fell to a pair of senior engineer officers. One was Maj. Gen. William M. Hoge, who served simultaneously as commanding general of the Engineer Center, commandant of the Engineer School, and commanding general of Fort Belvoir proper. The other officer, Col. David M. Dunne, served as assistant commandant of the Engineer School. Hoge and Dunne's collaborative efforts followed a set pattern for commandants and assistant commandants. The commandant was almost always a general officer who liaised with other US military and government agencies to secure resources for the school. The assistant commandant, for his part, served as the *de facto* executive officer to the commandant and directed the daily activities of the school.[8]

With the Gerow Board's mandate and Hoge and Dunne's leadership in place, the Engineer School conducted its first five-month Basic Engineer Officers Course at Fort Belvoir from November 1946 to April 1947. Aimed at training recently commissioned active component engineers, the 800-hour-long curriculum devoted one third of its time to soldiering and pioneering (i.e., combat engineering), skills in small unit tactics, mines, explosives, demolitions, obstacles, and field fortifications; and the other two thirds to general engineering skills in job management, soils, airfield construction, bridge construction, and engineer equipment. Most of the sixty students had previously graduated from the US Military Academy or Reserve Officer Training Corps (ROTC) programs. Two others came from the Marine Corps, two from Nationalist China, two from the Philippines, and one from Guatemala. A few marines, sailors, and foreign students frequently enrolled in courses at the Engineer School.[9]

The Advanced Engineer Officers Course ran for ten months at Fort Belvoir and provided instruction to first lieutenants and captains with three to ten years of active service. The 1,600-hour program of instruction (POI) consisted of general subjects, tactics, engineer subjects, mechanical equipment, and mapping. The first Advanced Engineer Officers Course started with twenty officers in September 1946. The course prepared its graduates for service as unit commanders, division engineers, staff officers on group through Army levels, and staff officers in Corps of Engineers regional districts or divisions.[10]

The Associate Basic Engineer and the Advanced Associate Engineer Officers Courses were tailored to Reserve and National Guard officers, as well as to recent Officer Candidate School graduates. The first Associate Basic Engineer Course did not start until March 1947. The thirteen US engineer officers and four Chinese officers covered the same subjects as the active Basic Engineer Officers Course over a condensed twelve weeks of instruction. The Advanced Associate Engineer Officers Course was inactive during the academic year of 1 July 1946 to 30 June 1947.[11]

In addition to the above courses, the Engineer School offered several shorter yet more specialized courses for engineers; most enrolled less than twenty students. The twelve-week Post Engineer Course trained officers to perform duties relating to construction, maintenance, and administration on Army posts. The Officers Mechanical Equipment Course helped prepare engineer officers to command engineer units tasked with operating and maintaining equipment. The Instructor's Guidance Course encompassed two weeks of intensive study on skills and technical subject matter needed for effective instruction. At the enlisted and noncommissioned officer ranks, the Engineer School offered numerous Enlisted Specialist Courses in military occupational specialties (MOSs) such as Special Electrical Device Repair, Topographical Computing, General Surveying, Water Supply Technician, Construction Foreman, Power Shovel Operator, Demolition Specialist, and Refrigeration Mechanics. These lasted anywhere from three days to several months. All the above-mentioned courses fell into one of the four academic departments: Military Art, Engineering, Topography, and Mechanical and Technical Equipment.[12]

The Department of Military Art instructed students about Army organization, military law, sanitation, first aid, administration, mess management, leadership, terrain studies, atomic energy, and other branch-generic subjects. The Department of Engineering focused on mobility and combat skills relating to mines, demolitions, booby traps, obstacles, field fortifications, camouflage, bridges, reconnaissance, tools, rigging, roads, airfields, quarrying, mathematics, drawings, and river and harbor duties. This coursework prepared officers not only to serve in line units, but also gave them the necessary background to transition into civil works projects in the Corps of Engineers. The Department of Topography and the Department of Mechanical and Technical Equipment were principally concerned with the conduct

of the enlisted specialist courses. The Department of Mechanical and Technical Equipment instructed the students in maintenance and operation of engineer heavy equipment, motor vehicle maintenance; electricity, refrigeration, and water supply. The Department of Topography concentrated on topics such as map and aerial photograph reading, engineer and topographic drawing, surveying, photolithography, and geodetic computing.[13]

The Department of Extension administered non-resident courses for engineers of all ranks in the active and reserve components. It also developed teaching aids for unit-level professional development and distributed school lesson plans to Reserve and National Guard elements. As of 1949, this department enrolled almost 7,000 students in the United States and overseas, as opposed to the combined enrollments of just over 2,000 students in resident courses at Fort Belvoir.[14]

Lastly, the Department of Training Publications printed field manuals and training materials for the Engineer School and the Corps of Engineers. It also served as the conduit for formulating tactics, techniques, procedures, policies, and operating standards proposed by the War Department and reviewed by the Departments of Military Art and Engineering. Committees of veteran officers frequently drew on their past experiences of World War II as they compiled their publications. Indeed, one short history of the school argued that lessons from a conflict needed to be captured and preserved "while they are fresh in our minds but properly evaluated in the light of the probable changes in the nature of future warfare."[15] The downsizing of the Army by 90 percent made it all the more important to preserve this institutional memory and knowledge before it would be lost forever. The departmental and course curricula at the Engineer School remained fairly consistent during the five years immediately following the end of World War II.

Effects of Rapid Mobilization on the Engineer School during the Korean War

On 25 June 1950, North Korean ground forces launched a surprise attack across the 38th parallel and invaded South Korea. The rapid advance overwhelmed the unprepared South Korean Army and and its small contingent of American advisors. The chaotic retreat south lasted several weeks and the American and South Korean forces ended up holding a small area on the southeastern corner of the Korean peninsula where the last defensive line, known as the Pusan Perimeter, was established. Meanwhile, the United Nations (UN) Security Council condemned the actions of North Korea and authorized a coalition force to be dispatched to liberate South Korea. The UN force eventually consisted of twenty-one countries but the US provided close to 90 percent of military personnel. In mid-September, General Douglas MacArthur launched an amphibious assault on Inchon far behind enemy lines along the western coast of the Korean peninsula to relieve the Pusan Perimeter. Following the successful amphibious landing at Inchon, the Eighth Army began its breakout from the Pusan Perimeter. For the next two months, MacArthur scored victory after victory as his forces advanced north to the Yalu River along North Korea's border with China. MacArthur was successful in not only retaking the South, but also liberating most of the North. In late November, China staged its full-scale intervention in the Korean War; with the advantage of numerical superiority, the troops stormed across the Yalu, striking US and UN forces. The Chinese Second Phase Offensive sent the forces fleeing southward through the mountainous terrain of North Korea. The American and UN forces retreated all the way back into South Korea and the Chinese seemed unstoppable until they experienced their first defeat in mid-February of 1951 at Chipyong-ni. After several more months of fighting along the 38th parallel, the lines solidified near the original border between the Koreas. For the next two years, each side dug trenches and built fortifications reminiscent of the Western Front in the First World War. The Korean War dragged on interminably while negotiations stagnated. Finally, after newly inaugurated President Dwight D. Eisenhower pushed the North Koreans and the Chinese for a resolution, the belligerent nations finally signed an armistice in July 1953.[16]

During the Korean War, the US Army almost tripled in manpower from around 593,000 soldiers in 1950 to over 1.5 million soldiers in 1951.[17] The rapid expansion of this wartime mobilization caused problems that affected the entire Army and filtered down to the Engineer School, just as the school experienced during earlier conflicts. Maj. Gen. Douglas L. Weart was the commandant of the Engineer School and the commanding general of the Engineer Center and Fort Belvoir at the beginning of the Korean War. The school's *Annual Report* covering July 1950 to June 1951 outlined the effects of the Korean War on training:

> The Korean hostilities and the subsequent increase in the armed forces greatly affected the resident courses. The addition of new courses of instruction, the revision and expansion of existing courses, and the preparation of mobilization courses placed a heavy planning and writing burden on all departments and staff divisions. Changes dictated by the fluctuating international situation added to this burden.[18]

The demand for personnel prompted the Engineer School in August 1950 to reactivate the Engineer Replacement Training Centers (ERTCs) at

Fort Belvoir, Virginia, and Fort Leonard Wood, Missouri. The first courses started in September 1950. The trainees underwent only six weeks of preparation, albeit intensive, to become combat engineers. Two months later in November 1950, the Engineer School's leadership decided to lengthen the ERTCs. The expansion gave much more time for students to learn more necessary skills and competencies.[19]

The new longer fourteen-week version of ERTC was divided into two blocks. Soldiers who received their basic six-week infantry training at other Army posts prior to arrival at the ERTCs went straight into the second block in advanced engineering training, which lasted eight weeks. Recruits with no previous military training, however, spent the first six weeks learning the usual basic infantry soldiering skills such as physical training, weapons training, and defense against gas. Once they completed their basic six weeks of training at the ERTC, the ensuing eight weeks covered advanced individual training and consisted of engineer techniques such as mines, explosives, fixed and floating bridges, and map and aerial photo reading. Following the twelve-week course, the top performers had the chance to take the new Engineer Leaders Course.[20]

Figure 7.1. Bridging exercise at Fort Belvoir, circa 1951. Courtesy of US Army Engineer School History Office Archives.

The first eight-week Engineer Leaders Course started at Fort Belvoir on 13 November 1950. The first three-week section was on leadership and soldiering skills; then a three-week section on combat and general engineering skills; and, finally, two weeks of applied leadership when the trainees were afforded the temporary duty status as acting non-commissioned officers in the training companies. For many soldiers, this was their first time in command or had their first feel of command. Out of an initial enrollment of 1,134 soldiers, only 816 completed the eight-week course. The successful graduates received promotions to private first class; the suffix "L" for "Leader" was added to their MOS, and they attained the rating of "Pioneer–Combat Engineer." Thereafter, several successful graduates entered the Officer Candidate School at Fort Riley, Kansas, while others remained on staff at Fort Belvoir, transferred to the ERTC staff at Fort Leonard Wood, or joined engineer units in the United States and in overseas areas such as Korea.[21]

In all, the ERTC at Fort Belvoir trained more than 37,000 engineers between September 1950 and its closure in December 1953. In addition, the need for engineer specialists arose just as it had done during World War II. Fort Belvoir offered five specialist courses in masonry, carpentry, plumbing, electricity, and air compressor operation. Some 2,000 trainees took these courses during the Korean War.[22] By the end of the first year of the Korean War, the size of the instructional load for enlisted students reached proportions equal to twice the size of the peak load of World War II.[23]

Beyond enlisted training, the Engineer School expanded its officer courses in size and frequency of training cycles to meet manpower demands following the start of the Korean War. From July 1949 to June 1950, a combined 698 officers graduated from basic and advanced courses. Then in the succeeding twelve months through June 1951, 1,109 graduated, including 148 US Marine Corps officers, one Navy officer, four Air Force officers, and several foreign officers who received "cross-service training" at the Engineer School.[24]

The Engineer School reactivated its Engineer Officers Candidate School (EOCS) at Fort Belvoir from September 1951 until July 1954 due to the acute need for junior officers during the Korean War expansion.[25] Two major changes occurred to the EOCS curriculum between World War II and the Korean War. First, the curriculum saw a significant increase from 816 hours over seventeen weeks during 1943–45 to 1,081 hours over twenty-two weeks during 1951–54.[26] About 450 hours of training were devoted to common subjects prescribed by the Office of the Chief, Army Field Forces, which ensured that all officers could serve as infantry

platoon leaders with minimum additional training, regardless of branch. Much of the rest of the EOCS content mirrored or paralleled that of the Engineer School's Basic Officers Course. The remaining hours concentrated on technical training in engineering subjects, including the application and maintenance of engineer equipment, field fortifications, bridging, construction planning, mines, and demolitions.[27]

The last two subjects, mines and demolitions, grew increasingly important in the program of instruction because the Chinese and North Koreans made very effective use of land mines. US Army engineers needed to learn how to detect those devices and, conversely, to lay their own mine fields and use demolitions to destroy bridges and roads, impeding enemy mobility. Indeed, the grading system weighted these subjects at 9 percent of the course.[28]

The second major EOCS change was in the class system established during the Korean War. The new system helped maintain high discipline standards and offered more leadership opportunities for candidates. In order to provide an organizational framework for the class system, which operated in almost every respect like West Point, classes were scheduled so that each candidate company consisted of three classes eight weeks apart in training. This meant that each company consisted of a plebe, a junior, and a senior class; this made the class system effective at self-policing with minor involvement of the cadre. During the first eight weeks of the twenty-two-week-long EOCS, candidates were designated as "plebes" or underclassmen. They needed to obey strict conduct rules and maintain proper military bearings and proper study habits. They did not enjoy many privileges in this class; they could not leave post without special permission or vary their daily regimens. Candidates who performed well enough academically and demonstrated leadership potential advanced into the junior class from the ninth week through the fifteenth of EOCS. As upperclassmen, the juniors began taking on responsibilities, such as monitoring plebe behavior or intermediate duties as corporals of the guard and assistant squad leaders. Juniors also enjoyed more freedom of movement on and off post. Finally, upon the sixteenth week and through graduation, the candidates were seniors. In taking on still more responsibilities, they in-processed new candidates, served in leadership roles within their companies, and instructed the plebes or juniors.[29] These extra activities required the battalion's cadre to spend less time on administrative activities, and more time on instruction and evaluation, which better prepared officers for their first duty station.

Figure 7.2. Candidates at EOCS build a single-lane trestle bridge at Fort Leonard Wood in 1952. Courtesy of US Army Engineer School History Office Archives.

Examples of Engineering Operations in the War of Movement in Korea, 1950–51

Engineers used every skill instructed at the Engineer School to conduct countermobility operations against the North Korean invaders at the onset of the Korean War. As commander of the 3rd Engineer Combat Battalion, Lt. Col. Peter C. Hyzer recalled that his unit spent most of its time blowing bridges and planting mines. "That was about all we had time to do," he recalled.[30] Hyzer also mentioned that his unit repaired or upgraded roads to help American and South Korean forces move southward more quickly. In fact, these retreating forces were so hard-pressed that the construction engineering units were also thrown into the front line to stall the North Korean rapid advance. Once the Americans and South Koreans were entrenched along the Pusan Perimeter in August 1950, engineers helped construct defensive emplacements against continued enemy assaults.[31]

Following the Inchon amphibious landing on 15 September, engineers shifted back to mobility efforts during the northward counterattack by US and UN forces. The engineers needed to repair or fully rebuild many bridges and railroads previously destroyed by the North Koreans or Americans. They repaired damaged bridges or constructed new ones, as

well as roads and railroads. Lieutenant Colonel Hyzer explained how one particular bridging operation allowed him to "use some of [his] engineering education . . . very technically."[32] Hyzer, who had decided to build a bridge across a river running through Pakch'on, suggested using some old Japanese trusses that his unit had found nearby:

> I didn't know how strong the steel was because it was Japanese steel. I got an old field manual and my slide rule out. I designed that bridge by myself because I couldn't find anybody else at battalion headquarters who knew how to do the structure work. . . . So, I designed that bridge and we put it together. We built several trusses and we also built a causeway . . . that eventually carried all the tanks and trucks for the division.[33]

Hundreds of engineers like Hyzer and his men worked miracles by giving combat unit commanders the needed mobility to maneuver their units through the austere Korean Peninsula terrain. As the US and UN forces pushed northward to the Yalu River, their lengthening supply lines required engineering construction units to do continuous maintenance on bridges, railroads, and roads.[34]

On 25 October 1950, around 300,000 People's Liberation Army troops launched a surprise offensive against the US and UN forces. The Chinese soldiers crossed the Yalu River and overwhelmed the units; by the beginning of December 1950 after the Battle of the Ch'ongch'on River, the US Army would find itself on the longest retreat in US military history. During the retreat, casualties mounted and the engineers yet again reverted to countermobility operations. To slow or stop the Chinese offensive, engineers destroyed the bridges and railroads that they had completed weeks or days prior.[35]

Then engineers helped the retreating US and UN forces by constructing or repairing roads and bridges leading south. "We reconnoitered roads to the rear," remembered then-Col. Emerson C. Itschner from his perspective as the I Corps Engineer. "We had to bridge several river crossings by improvising. We also had to leapfrog our bridging by taking it up as we left each river and moving it forward" to reach the next river before the combat units arrived. Itschner praised his fellow engineers for their work throughout the ordeal: "The engineers were magnificent, really magnificent. They weren't afraid to be right up at the front. They did their work extremely well. They worked infinitely long hours, without sleep, getting two meals a day, part of the time."[36] This "can-do" spirit paid dividends; hundreds of lives were saved by securing the much-needed mobility of US and UN forces and successfully slowing the Chinese advance. Following the retreat south of the 38th parallel, fighting seesawed during early 1951; by June, the front lines stabilized near the 38th parallel, not far from the pre-war border that divided the two Koreas.[37]

Engineer Operations in the War of Attrition in Korea, 1951–53

The Korean War transformed from a war of movement into a war of attrition that ran from the summer of 1951 through the summer of 1953. At the beginning of this two-year period, the belligerents deployed along defensive lines and heavy fighting mainly occurred for key outpost positions. Both sides took advantage of the rugged terrain and constructed fortifications on opposing hills or mountains, with the valleys between becoming no man's land. Both forces sent out numerous patrols and raids to probe for weaknesses in the enemy's defenses. Each side also tried to get control of the high ground in battles with colorful names like Heartbreak Ridge, Bloody Ridge, Pork Chop Hill, and Old Baldy. None of these engagements, bloody as they were, turned into strategically decisive battles that ended the conflict. Neither side could break through enemy defensive lines. To deal with the stalemate, US Army engineers supported combat units with survivability, countermobility, mobility, and general engineering capabilities.[38]

During the offensives conducted by coalition forces, American engineers provided mobility for combat units on the assault. Once beyond enemy positions, they returned to general engineering functions to maintain supply lines in order to support their position. The US Army's Operation Touchdown to secure Heartbreak Ridge in October 1951 offers a sampling of the gamut of engineering contributions.[39] The commander of the 2nd Engineer Combat Battalion, Lt. Col. W. Love, listed his unit's various missions during this offensive:

> The engineers located and removed or destroyed enemy antitank and antipersonnel mines; reduced natural and man-made obstacles; constructed, repaired, maintained, and worked roads and trails; constructed fords, fixed bridges and culverts; constructed and assisted in the improvement of command posts, artillery positions, and other installations; repaired and maintained landing strips; provided engineer supply service; procured and distributed maps; collected and disseminated engineer intelligence; and prepared and executed the engineer plan for the operation.[40]

Not only does this list provide the full spectrum of general engineering and mobility support for combat operations; it also reveals how countermobility and topographical capabilities could be leveraged by combat units. Ultimately, this list mirrored the contents of courses instructed at Fort Belvoir and Fort Leonard Wood. Only with such relevant and diverse training were engineer combat battalions successful once deployed to Korea's fluid operating environments.

Examples of survivability and countermobility were many times intertwined functions in the Korean War. The former referred to planned, hardened, permanent fortifications; and the latter to tactical, temporary defenses. Both functions tried to disrupt, turn, or halt enemy mobility and assault operations, while sheltering friendly forces from enemy attacks. On countless occasions, engineers strung barbed wire, dug bunkers, created obstacles, and laid land mines along trenches or camp perimeters. Lt. Col. Harry D. Hoskins Jr., commander of the 10th Engineer Combat Battalion, explained the American defensive mindset in 1952: "At that time the North Koreans didn't have tanks. They were just waves, and waves, and waves of manpower. You had to have mines, especially antipersonnel mines, to stop the manpower."[41] In addition to land mines, engineers used other improvised solutions such as "fougasse," drums of napalm com-

Figure 7.3. A US Army tank lost one tread after it hit an anti-vehicle mine. Once this happened, the disabled tank became a tactical liability for US soldiers. Courtesy of US Army Engineer School History Office Archives.

bined with 81-mm mortar shells and other explosives that were detonated electronically during these human wave assaults.[42] Enemy mines presented frustrating challenges to American ground forces and especially to engineers during the Korean War. Engineers were, after all, responsible to clear and maintain lines of communication and supply for combat units.[43]

A little over three years after the Korean War started, the belligerent nations signed an armistice that ended organized combat on 27 July 1953.[44] The experiences of the individual engineer soldier during the Korean War varied considerably. Engineers were seen as "force multipliers" due to their skills in mobility, countermobility, survivability, topographical engineering, and general engineering functions as well as their ability to adapt to the current environment.[45]

The Engineer School during Demobilization and the Pentomic Era, 1953–62

After the armistice was signed in Korea, the US military once again began demobilizing. The downsizing was not nearly as dramatic, however, in the post-war 1950s as it had been during the post-world war years. US Army manpower decreased from its wartime strength of about 1.5 million soldiers in 1953 to just under 900,000 soldiers in 1958.[46] A number of factors contributed to these less severe personnel cuts between 1953 and 1958. The Cold War had become firmly ensconced in the American strategic and collective psyches. Anxieties persisted that the Soviet Union, its allies, and its communist ideology constituted immediate threats to the American way of life. The United States had managed to contain these threats in the Korean War. China had already fallen to communism in 1949, and other nations like Iran, Vietnam, and Guatemala might share the same fate unless the United States remained a superpower with sufficient military forces to protect its anti-communist allies. Then President Dwight D. Eisenhower implemented his New Look defense policy in 1954. Eisenhower believed the Cold War would be a protracted struggle that would last over decades. He knew that the only way the United States could prevail was with a stronger economy. Eisenhower believed deterring war, protecting US security, and defending its allies were essential but, at the same time, could not come at the price of a weakening US economy. The new policy devoted resources to research and developing new weapons, vehicles, and equipment for the US military; at the same time, Eisenhower attempted to rein in enormous military expenditures. He believed that improving American military technology would be less expensive than maintaining so many service personnel on active duty, especially overseas deployments. Nuclear weapons became the centerpiece of the United

States military strategy, which relied on the threat of massive nuclear retaliation to deter future Soviet aggression. The US military was able to shift from costly conventional ground forces to a smaller but modernized and nuclear-capable force. At the end, this policy was purely driven by fiscal and economic considerations.[47]

Eisenhower initiated several strategic and structural changes in the US military as part of his New Look policy. For example, the US Army replaced the Office of the Chief of Army Field Forces with the Continental Army Command in 1955. This new command was responsible for all active units and armies in the continental United States as well as training centers, schools, and doctrine development.[48] Eisenhower's New Look called for ongoing reductions in military manpower, which caused new problems like inadequate training and materiel shortages. The Engineer School at Fort Belvoir endured these adversities all through the 1950s. Unlike demobilization after World War II, however, the end of the Korean War did not prompt the closure of Fort Leonard Wood. The permanent post's role as an additional training center for engineer and infantry recruits continued from 1950 through today.[49]

By the mid-1950s, the US Army's major combat units went through a major transformation that trickled down to the engineers and other branches. The American divisions proved themselves more than capable of fighting conventional conflicts like the Korean War, but a perceived need to shift the Army to a force capable of fighting on an atomic battlefield prompted a major Army force structure change to drop the number of divisions from twenty down to fourteen by 1961. The Army's recently promoted chief of staff, General Maxwell Taylor, started to modernize the force structure to more easily fight and survive on nuclear battlefields.[50] His reorganization converted the triangular infantry division with its three regimental combat teams into the new Reorganization of the Current Infantry Division (ROCID) force structure. These new units were nicknamed pentomic divisions, which combined the prefix "penta," meaning "five," with the term "atomic.[51]

This new force structure carried with it an equally new operational concept. In combat, each battle group would ride in fast-moving armored vehicles; they needed to be nimble enough to disperse across battlefields to avoid complete destruction by a single enemy nuclear attack yet agile enough to coordinate movements to strike those enemy forces. The battle groups, for instance, could use their own tactical nuclear projectiles fired from artillery or rocket launchers. They would only achieve such an unprecedented level of mobility thanks to the efforts of engineer units.[52]

The Engineer School partnered with the Engineer Research and Development Laboratories (ERDL) to develop vehicles and equipment to support engineering functions in this new nuclear battlespace. Engineer units could only provide mobility if their bridges kept pace with the quick movements of the battle groups. One example was the development of the 60-foot aluminum alloy "scissor bridge" mounted on a modified tank.

The ERDL conducted research and developed other equipment for this new atomic battlefield, such as a remote-controlled tractor for use in radioactive areas and infrared devices for night-time or low-light operations. And, because land mines caused so much damage in the Korean War, engineers designed new devices to increase the effectiveness of mine warfare and mine detection. To help impede enemy movement via countermobility, the ERDL experimented with towed machines capable of laying and arming land mines. Facilitating mobility for the pentomic battle groups also required engineer units to test rollers invulnerable to mine detonation. These were mounted on tanks as of 1958.[53]

The Engineer School's "Orientation for Assistant Commandant" brochure from July 1958 mentioned that the "most significant revision" was the complete integration of the division of instruction into a "fundamentals phase" and an "applicatory phase" in the Engineer Officer Advanced Course. The document further stated that "nuclear weapons implications will be integrated into all fields of instruction" and that Engineer School faculty recently completed a two-week course on Nuclear Weapons Effects in order to enhance their classroom competence in regard to these topics.[54] This revision paralleled the entire Army's major force structures and operational concepts shift toward training for nuclear warfare.

Going into the 1961 fiscal year, the Engineer Officer Advanced Course's POI contained two blocks on Nuclear Weapons Effects and Nuclear Weapons Employment. The first block devoted seventy-four hours to the "effects of nuclear weapons on engineer unit capabilities; influence on engineer tactical and logical operations at battalion, group, and division levels; and recommended employment nuclear weapons in support of engineer operations."[55] In the second block on New Weapons Employment, students spent seventy-five additional hours learning about the "duties and responsibilities of the nuclear weapons deployment officer; capabilities and limitations of various means of delivery; staff planning concepts and procedures; and targets and methods of analysis."[56] Practical exercises entailed employing nuclear weapons systems in countermobility operations. This could require students to determine the best placements and proper yields of tactical nuclear mines to impede Soviet movements during a potential invasion of Western Europe. Officers with this knowledge base and skill set could eventually serve in units tasked with the atomic demolition munition mission in Europe.[57]

The combined 149 hours of training on nuclear subjects amounted to almost 20 percent of the 773-hour-long Advanced Course. The rest of the POI was divided among traditional subjects for officers with five to ten years of previous service. The students received instruction in the roles of the Corps of Engineers, combined arms operations, logistical operations, equipment maintenance, military engineering, and command and staff functions.[58]

Figure 7.4. Engineers learning about operating heavy equipment in 1959. Courtesy of US Army Engineer School History Office Archives.

The Engineer Officers Advanced Course was one of six engineer career courses for officers in the 1959 fiscal year. Besides the career courses, the Engineer School offered shorter specialist courses for officers that ranged from two to ten weeks in length. The Engineer School's officer enrollment numbered more than 2,900 students for that year; around 1,750 of those students attended one of seventeen sessions of the twelve-week Engineer Officers Basic Course. This course continued to run year-round in continuous cycles. The second largest enrollment was the seventeen-week Associate Engineer Officers Advanced Course, which was offered seven times that year and had a student attendance of 420 officers, of which fifty were allied students. The other three career courses—Engineer Company

Grade Officer Refresher, Engineer Field Grade Officer Refresher, and the Engineer Officer Basic Course (Allied)—had limited enrollments of only a few dozen students and less than three classes per year. In 1958, one Engineer Officer Basic Course (Allied) consisted entirely of Vietnamese officers; the Engineer School used interpreters to train these officers in their native language.[59]

Beyond the large regular career courses, several short specialist courses prepared a limited number of officers to serve in Airbase Construction, Specialist Demolition, Engineer Supply & Spare Parts, or Disaster Recovery, just to name a few.[60] Meanwhile, the Engineer School offered enlisted specialist courses to almost 6,000 students that year. The twenty-five courses ranged between five and twenty weeks in length and included topics such as Liquid Oxygen Plant Operation, Topographical Surveyor, and Electrical Device Repairmen.[61]

To ensure instructional competence and student learning, the Engineer School employed course evaluation programs. Objective and subjective data from class supervisor reports, grading curves, student surveys, and follow-up surveys with students and their future unit commanders helped the school adjust course objectives and standards to real-world needs. The relevance of the POIs was further enhanced by continuous communication with other service schools, the Corps of Engineers, the Continental Army Command, the Combat Developments System, the Engineer Research and Development Laboratories (ERDL), and industry. These contacts also helped ensure that doctrine, tactics, techniques, and procedures would be incorporated into dozens of technical manuals, field manuals, and other training materials being revised or written every year. An annual Engineer Instructors Conference as well as an Educators Conference were conducted for the engineer officers instructing at the Engineer School as well as the other service schools to keep all instructors abreast of the latest developments in the engineer community in regards to doctrine, tactics, techniques, instructional policies, and procedures in effect at the Engineer School.[62]

Engineer Training for Conventional War in the ROAD Era, 1962–65

By 1960, the Army had reorganized most of its divisions; the new pentomic division's force structure proved to be impractical in organization as well as in functionality. Newly elected President John F. Kennedy called for the US Army to turn away from Eisenhower's New Look and toward his own Flexible Response strategy. Kennedy wanted Army divisions that could fight conventional battles, presumably against the Soviet Union in Western Europe. He also wanted the new units to be adaptable enough to operate as divisions or break into smaller brigade-sized units capable of stand-alone maneuver and combat. The pentomic division could not meet Kennedy's expectations.[63]

With this mandate in hand, the US Army began shifting in 1962 to the new force structure dubbed the Reorganization Objective Army Division (ROAD). Numbered at around 15,000 men, the unit contained three combat arms brigades, each of which possessed three combat battalions. The ROAD concept mixed combat arms battalions according to tactical or situational needs. The first two Army divisions converted from the ROCID to the ROAD force structure in late 1962. Army Chief of Staff General George H. Decker enumerated the advantages in a report to the secretary of the Army: "ROAD provides substantial improvements in command structure, organization flexibility, capability for sustained combat, tactical mobility (ground and air), balanced firepower (nuclear and nonnuclear), logistical support, and compatibility with Allied forces (particularly NATO)."[64] With the exception of re-designating regiments at brigades, the ROAD force structure looked much like the Army triangular divisions from World War II and the Korean War.

Meanwhile at Fort Belvoir, the Engineer School's mission remained constant during the early 1960s. The Engineer School's 1963 and 1964 mission statements both included the development, administration, and support of a progressive program of resident and non-resident education and the training of officers and warrant officers of the Corps of Engineers as well as civilians of all components of the Army establishment in Corps of Engineers functions, tactics, and techniques and in Corps of Engineers relationships with other agencies.[65] They also included the mission of instruction and training of selected enlisted Department of Defense personnel in engineering skills; development of extension courses as well as engineer doctrine, techniques, and functions; preparation and review of training aids; information dissemination; and several other identical tasks.[66]

Five main departments executed the Engineer School's mission during 1964. The Department of Engineering and Military Science was the centerpiece of training. It contained the divisions of Combat Engineering, Combined Arms, and Construction Engineering, each of which included several branches. The three divisions retained emphases on nuclear warfare. As of 1964, for instance, atomic demolition munition and nuclear weapons became independent branches in the Combat Engineering and Combined Arms Divisions, respectively. Even the Construction Engineering Division offered classes relating to nuclear warfare, such as "fallout shelter analysis and protective construction" in its General Engineering Branch. The other three teaching departments had self-explanatory names like Topography, Logistics, and Mechanical and Technical Equipment. They taught narrowly focused courses to engineers from enlisted specialists up to junior officers.[67] The above-named four teaching departments also offered unique training or demonstrations to the US Military Academy's cadets, the US Marine Corps Senior School, the Canadian Army Staff College, the US Army 8th Special Forces Group, and even the Internal Revenue Service. Instructors from all four departments traveled to other posts and public universities to give presentations and teach mini-courses.[68]

Lastly, the Department of Doctrine Review and Literature completed 735 review and analysis projects during 1964. Among the significant new publications were Field Manual (FM) 5-13, *Engineer Soldiers Handbook*; the 790-page Special Text (ST) 5-188, *Structures and Utilities: Theater of Operations Construction*; *Guide for Engineer Leaders*, which was requested by the assistant commandant as a handbook for Engineer Officer Basic Course students; and other field manuals, graphic aids, and instructional material.[69]

The Engineer School's accomplishments in number of graduates and volume of publications looked impressive in absolute numbers. They were even more impressive given that the school suffered from a chronic shortage of qualified instructors and from rapid instructor turnover with engineering field units. In fact, only 1,646 of the authorized 1,973 slots were filled, which amounted to an almost 17 percent shortfall in the school's manpower.[70]

In some ways, the Engineer School kept pace with the reorientation of the US Army. Yet despite the significant restructuring in the ROAD era and the move away from emphasizing nuclear capabilities, the Engineer School continued to maintain conspicuous nuclear components in its branch POIs. Some might see this as a struggle of the Engineer School to adapt to the Army's changing needs.

Retired Maj. Gen. Richard S. Kem captured the mood and context in observations about the 1965 Engineer Officer Advanced Course at the Engineer School:

> The course was not overly rigorous, but the course was very good, I thought. I learned some things. . . . The course at that time included a lot of engineering—I mean drainage, how you design things for drainage. Now it would be TO&E [table of organization and equipment] kind of construction, you know, construction for the theater of operations and that kind of thing. It had bridge design. It was really preparing you for the theater of operations kind of construction. It was a lot more engineering than what our course evolved to later, which was the engineers' contribution to combined arms and the overall theater. We had some of both in the more recent designed course.[71]

Kem's memories revealed the attitudes of a thirty-one-year-old captain, just on the cusp of the major American commitment of ground troops to South Vietnam. As it turned out, the ability to "design things for drainage" and knowledge of "construction for the theater of operations" proved to be just as valuable to engineers in the Vietnam War as the combined arms and combat components of the POI.

Conclusion

After World War II ended in 1945, the US Engineer School experienced the dramatic effects of a 90-percent manpower demobilization. Over the next five years, the Engineer School struggled not merely to survive, but also to improve training. Commandants Maj. Gen. William M. Hoge and Maj. Gen. Douglas L. Weart applied lessons from World War II to the Engineer School's courses. They wanted graduates to be professionals, both as engineers and as soldiers. In 1950, the Korean War erupted with North Korea's surprise invasion of South Korea. Two phases of this conflict—movement and attrition—tested pre-war and wartime training at the Engineer School. For the most part, graduating engineers performed well in their function. After the Korean War ended in 1953, the US Army demobilized but not as much as after 1945. The Army shifted its force structure from the triangle division for conventional battlefields to the pentomic division for the nuclear battlefield. This change required the Engineer School to adapt to new training to prepare engineers to serve in these new units. The pentomic division, however, proved to be short-lived because the Army reverted back to the more traditional triangular division model by 1965. The Engineer School had not yet achieved an equilibrium vis-à-vis conventional operations when the United States was drawn into a new conflict in South Vietnam.

Notes

1. James F. Schnabel, *The Joint Chiefs of Staff and National Policy 1945–1947*, History of the Joint Chiefs of Staff, vol. I (Washington, DC: Office of Joint History, Office of the Chairman of the Joint Chiefs of Staff, 1996), 91; and Kenneth W. Condit, *The Joint Chiefs of Staff and National Policy 1947–1949*, History of the Joint Chiefs of Staff, vol. II (Washington, DC: Office of Joint History, 1996), 301.

2. Larry D. Roberts, “A School for Officers: A History of the Engineer Officer Candidate School” (unpublished manuscript, n.d.), chap. 2, 23, US Army Engineer School History Office Archives.

3. Larry Roberts, “The Engineer Replacement Training Center, Fort Leonard Wood, Missouri,” in *Builders and Fighters: U.S. Army Engineers in World War II*, ed. Barry W. Fowle (Fort Belvoir, VA: US Army Engineer School Office of History, 1992), 93.

4. Paul K. Walker, “The Engineer Replacement Training Center, Fort Belvoir, Virginia,” in *Builders and Fighters: U.S. Army Engineers in World War II,* 75; and “A Short History of the Engineer Training Center,” Engineer Training Center Public Relations Office, 22, 25.

5. *Report of the War Department Military Education Board on Educational System for Officers of the Army* [Gerow Board] (Washington, DC: War Department, 1946); and Marquis Who’s Who, *Who Was Who in American History, the Military* (Chicago, IL: Marquis Who’s Who, 1975), 199.

6. *Report of the War Department Military Education Board*, 27–40, 51–54.

7. *Report of the Engineer School for Academic Year Ending 30 June 1947* (Fort Belvoir, VA: Headquarters, The Engineer Center), 5.

8. General William M. Hoge, *Engineer Memoirs* (Washington, DC: US Army Corps of Engineers Office of History, 1993), 164–65; and *Report of the Engineer School for Academic Year Ending 30 June 1947,* 13 and Exhibit A.

9. *Report of the Engineer School for Academic Year Ending 30 June 1947*, 5 and Exhibit D; and David M. Dunne, “The Engineer School—Past and Present” (booklet, n.d., The Engineer School), 21, US Army Engineer School History Office Archives.

10. *Report of the Engineer School for Academic Year Ending 30 June 1947*, 5 and Exhibit B.

11. *Report of the Engineer School for Academic Year Ending 30 June 1947*, 5 and Exhibit G.

12. *Report of the Engineer School for Academic Year Ending 30 June 1947*, 5–11 and Exhibits H, I, L, and M; and Dunne, “The Engineer School,” 21, 23.

13. Dunne, 18–19.

14. Dunne, 23, 416.

15. Dunne, 23.

16. For books and pamphlets on the Korean War published by the US Army Center of Military History, see http://www.history.army.mil/html/bookshelves/resmat/KW.html; and T. R. Fehrenbach, *This Kind of War* (New York: Macmillan, 1963).

17. Garry L. Thompson, “Army Downsizing following World War I, World War II, Vietnam, and a Comparison to Recent Army Downsizing” (MMAS thesis, US Army Command and General Staff College, Fort Leavenworth, KS, 2002), referenced in Russell F. Weigley, *History of the United States Army*, enlarged ed. (Bloomington, IN: Indiana University Press, 1984), 596–97.

18. US Army Engineer School, *Annual Report: The Engineer School, 1 July 1950 to 30 June 1951* (Fort Belvoir, VA: The Engineer Center, US Army Engineer School History Office Archives), 4–5.

19. Gustav Person, “Fort Belvoir’s Engineer Replacement Training Center,” *Engineer–The Professional Bulletin of Army Engineers* (September–December 2011): 40.

20. Capt. Lanham L. Boteler, “Individual Engineer Training,” *The Military Engineer* 44 (May–June 1951): 172–74.

21. Editorial, “Engineer Leaders’ Course,” *The Military Engineer* 44 (January–February 1952): 64; and Boteler, 174.

22. Gustav Person, “Fort Belvoir’s Engineer Replacement Training Center,” 40.

23. US Army Engineer School, *Annual Report*, 5.

24. US Army Engineer School, 10.

25. *Final Report on Engineer Officers Candidate School (1951–54)* (Fort Belvoir, VA: Headquarters, The Engineer Officers Candidate School, c. 1955), 3, 6.

26. Roberts, “A School for Officers,” chap. 2, 18.

27. *Final Report on Engineer Officers Candidate School (1951–54),* 4, 70–71.

28. *Final Report on Engineer Officers Candidate School (1951–54),* 4, 77.

29. Col. P. Y. Browning, “Little West Point,” *The Military Engineer* 44 (November–December 1952): 440; *Final Report on Engineer Officers Candidate School (1951–54),* 109–11.

30. Barry W. Fowle and John C. Lonnquest, eds., *Remembering the “Forgotten War”: U.S. Army Engineer Officers in Korea* (Alexandria, VA: Office of History, Headquarters, US Army Corps of Engineers, February 2005), 17–18.

31. Fowle and Lonnquest, 16, 18, 20.

32. Fowle and Lonnquest, 132.

33. Fowle and Lonnquest, 132–33.

34. Fowle and Lonnquest, 132.

35. Billy C. Mossman, *Ebb and Flow, November 1950–July 1951* (Washington, DC: US Army Center of Military History, 1990), 60–83.

36. Fowle and Lonnquest, *Remembering the “Forgotten War,”* 169.

37. Fowle and Lonnquest, 257–59.

38. Fowle and Lonnquest, 331–33.

39. Fowle and Lonnquest, 336.

40. Fowle and Lonnquest, 337.
41. Fowle and Lonnquest, 375.
42. Fowle and Lonnquest, 376.
43. Fowle and Lonnquest, 300–2.
44. Fowle and Lonnquest, 420.
45. Fowle and Lonnquest, 437.
46. Thompson, "Army Downsizing."
47. Ingo Trauschweizer, *The Cold War U.S. Army: Building Deterrence for Limited War* (Lawrence, KS: University Press of Kansas, 2008), 28–29.
48. Trauschweizer, 51–58, 95.
49. Paul W. Bass, *The History of Fort Leonard Wood, Missouri* (Morley, MO: Acclaim Press, 2016), 101–3.
50. Richard Kedzior, *Evolution and Endurance: The U.S. Army Division in the Twentieth Century* (Santa Monica, CA: RAND Corporation, 2000), 23–24.
51. John J. McGrath, *The Brigade: A History, Its Organization and Employment in the U.S. Army* (Fort Leavenworth, KS: Combat Studies Institute, 2004), 59–61; and Richard Kedzior, *Evolution and Endurance: The U.S. Army Division in the Twentieth Century* (Santa Monica, CA: RAND Corporation, 2000), 24, accessed 20 July 2016, http://www.rand.org/pubs/monograph_reports/MR1211.html.
52. Kedzior, 23–28.
53. Col. A. H. Anderson Jr., "Preparation for the Engineer Role," *The Military Engineer* 50 (November–December 1958): 417–19.
54. *Orientation for Assistant Commandant 10–25 July 1958* (Fort Belvoir, VA: US Army Engineer School, US Army Engineer School History Office Archives), 16.
55. US Army Engineer School, *Guidelines for the Preparation of Programs of Instruction at the USAES* (Fort Belvoir, VA: US Army Engineer School, April 1960), Annex A, 36.
56. US Army Engineer School, Annex A, 37.
57. For a sample POI of the Advanced Course in 1960, see US Army Engineer School, Annex A, 37–38. For the instructional lesson plan for Nuclear Weapons Effects, see Annex C, 45–50; and Maj. Gen. Richard S. Kem, *Engineer Memoirs* (Alexandria, VA: US Army Corps of Engineers Office of History, 2002): 32.
58. US Army Engineer School, *Guidelines for the Preparation of Programs of Instruction*, Annex A, 33–38.
59. US Army Engineer School, *Orientation for Assistant Commandant 10–25 July 1958* (Fort Belvoir, VA: US Army Engineer School, n.d.), 11, 15, US Army Engineer School History Office Archives.
60. US Army Engineer School, 11.
61. US Army Engineer School, 12. For a sample POI in 1960, the Electrical Devise Repairman, see US Army Engineer School, *Guidelines for the Preparation of Programs of Instruction*, Annex B, 39–44.

62. US Army Engineer School, *Orientation for Assistant Commandant*, 16–17.
63. Trauschweizer, *The Cold War U.S. Army*; 2–3, 114
64. Cited in Trauschweizer, 117.
65. US Army Engineer School, *Annual History Report, 1 January 1963 to 31 December 1963*, Tab A, and US Army Engineer School, *Annual History Report, 1 January 1964 to 31 December 1964*, 1, both in US Army Engineer School History Office Archives.
66. US Army Engineer School, *Annual History Report, 1 January 1963 to 31 December 1963*, Tab A, and US Army Engineer School, *Annual History Report, 1 January 1964 to 31 December 1964*, 1.
67. US Army Engineer School, *Annual History Report, 1 January 1964 to 31 December 1964*, 3.
68. US Army Engineer School, 25–26.
69. US Army Engineer School, 29–32.
70. US Army Engineer School, 8.
71. Kem, *Engineer Memoirs*, 89–90.

Chapter 8
The Engineer School: Training for Unconventional War in Vietnam, 1965–73

The Engineer School began the 1960s with the goal to continue development of training on a Soviet-oriented conflict. Strategic thinking during this time focused on the possibility of a conventional large-scale invasion of Western Europe by the Soviet Union and its Warsaw Pact allies. Even after the United States was drawn into the ever-expanding and lengthy war in Vietnam, American policymakers and military leaders stayed determined to support the defense of Western Europe and NATO allies.

Very little conventional fighting occurred between American forces and the opposing Viet Cong insurgents and North Vietnamese troops. Consequently, the US military and the engineers in particular tried to adapt to counterinsurgency tactics to stop the enemy from overthrowing the government of South Vietnam. The engineers played a major role in the buildup of American military forces, improvement of the South Vietnamese infrastructure, and the fight to keep the lines of communication open through mine detection and road improvements. The Engineer School strove to absorb combat lessons, update doctrine, revise course content, and thus better prepare newly produced soldiers for deployments to Vietnam.

Engineer Experience in Vietnam

The United States grew more involved in the conflict in Vietnam in the early 1960s. US policymakers had embraced the idea of the domino theory since the 1950s, believing that if South Vietnam fell to communism, then the rest of Southeast Asia would quickly follow. The conflict, part civil war and part revolution, pitted Soviet-supported communist North Vietnam against American-supported anticommunist South Vietnam. Escalating hostilities evolved into the seminal example of a Cold War proxy conflict between the United States and the Soviet Union which would be fought with guerrilla tactics in the jungles and rice paddies of South Vietnam. During John F. Kennedy's presidency, support to South Vietnam increased significantly; the number of advisers grew rapidly from 3,205 men in 1961 to more than 9,000 by the end of 1962. These American advisors were officially not participating in direct combat. Under the newly enlarged and reorganized Military Assistance Command, Vietnam, advisors performed a large variety of ever-widening tasks ranging from Civic Action programs conducted by US Army Special Forces Detachments to training programs for the Army of the Republic of Vietnam (ARVN) and the Civil Guard. The Kennedy administration deceived the American public on the extent and nature of its involvement in Vietnam.[1]

A typical example of advisor experience can be seen in Capt. Richard S. Kem, who was sent by the Corps of Engineers to advise the 201st Engineer Battalion of the ARVN for a year beginning in March 1962.[2] The battalion performed the usual construction and maintenance tasks, but as the only fully trained engineer officer in the battalion, Kem was expected to perform the design work for various projects. He recalled one bridge construction project that presented challenges:

> How to fix a bridge? I mean, I got out my old engineering handbook from West Point and tried to figure out . . . what needed to be done—that bridge needs to be fixed; figuring out how many rails we'd need; giving them the design; scrounging the welding rods; and then matching their welder with the steel with the rest to get the job done.[3]

After drawing the plans, Kem provided the ARVN engineers with much-needed guidance on the construction of fixed bridges.[4]

In addition to general engineering efforts, Kem found himself involved in advising the ARVN in clear and hold operations. He noted how "we would move into an area, first clear and then put in a security structure and a civil affairs structure to hold it. Like an oil blot . . . start the blot and then as it moves outward you bring under control more and more of the population" and drive the Viet Cong from the area.[5] Kem saw villagers respond well to added security and improved infrastructure, but his evaluation of success occurred prior to US increase in commitment and personnel.[6]

Following reported North Vietnamese torpedo boat attacks on the USS Maddox and the USS Turner Joy on 2 and 4 August 1964, the US Congress passed the Gulf of Tonkin Resolution on 7 August 1964. The resolution authorized President Lyndon B. Johnson to take "all necessary measures to repel any armed attacks against the forces of the United States and to prevent further aggression."[7] This resulted in an escalation of force, beginning with the Rolling Thunder bombing campaign in early 1965, along with the deployment of US ground troops to Vietnam. The year 1965 marked the beginning of the switch from advising the South Vietnamese Armed Forces to the enclave strategy. This broad and far-reaching new strategy allowed US military personnel to undertake missions within fifty miles of their bases in South Vietnam as well as perform outright large-scale search and destroy combat operations. The numbers of US military personnel in Vietnam grew exponentially from around 23,300 in December 1964 to 184,300 in December 1965.[8]

The conflict was not like the conventional force on force engagements the US military experienced during World War II and the Korean War, yet the instructors at the Engineer School and most of the officers in engineer units gained their extensive conventional combat experience in World War II or the Korean War. Instructors who were not combat veterans grew accustomed to nuclear applications on the battlefield in the late 1950s or early 1960s. The Engineer School did not focus on teaching counterinsurgency/counterguerrilla operations during the years prior to the US Army's involvement in Vietnam. In fact, the first mention of the unconventional warfare can be seen in 1960 when a proposed fiscal year 1961 program of instruction (POI) for the Engineer Officer Advanced Career Course (EOAC) covered material for "procedures capabilities for combating guerrilla action, enemy infiltration and airborne attack" as one of three parts totaling eleven hours on "engineer troop organizations in a theater of operations." These hours fit into a block of eighty-eight hours on providing terrain intelligence, engineer operations in public works activities, engineer troop organizations, and logistical functions relating to the Corps of Engineers; this represented a small fraction of the total 773 hours for the EOAC.[9]

The fast influx of such an immense amount of American service personnel in South Vietnam from 23,300 on 31 December 1964 to the peak of 543,400 on 30 April 1969 overwhelmed South Vietnam's already shaky infrastructure.[10] Providing support to those American units required the deployment of engineers by the thousands. Tanks and trucks soon bogged down on dirt roads made for carts, leaving deep ruts in the soft soil. Electricity, running water, and other conveniences did not exist in most of South Vietnam. All of these had to be created by the engineers out of nothing. The Americans needed to build their own massive bases, airfields, and supply facilities.[11] During the early phases of the construction program in Vietnam, materials and equipment were in short supply; the logistical situation improved in 1966 as base and port development projects neared completion.[12]

One of the most impressive construction efforts began in 1965 in Cam Ranh Bay.[13] This bay offered a protected harbor capable of accommodating deep-draft American ships. When advance elements of the 35th Engineer Group arrived at the bay in early May 1965, they found limited berthing spots for deep-draft ships. Much work needed to be done.

The 864th and 84th Engineer Battalions, together with several specialized companies, joined the 35th Engineer Group at Cam Ranh Bay by month's end.[14] They set about designing and developing the port facilities. The engineers' best asset proved to be the so-called DeLong Pier. The pier—in all actuality a barge—measured 90 by 300 feet and rested atop eighteen tubular steel caissons six feet in diameter and anchored to the harbor's bottom.[15] The first DeLong Pier was completed in December 1965 under the direction of the 497th Port Construction Company; three more DeLong piers were eventually added to the Cam Ranh Bay facilities.[16] These allowed supplies to be offloaded directly from the transport ships and moved to the shore via the pier.

As of December 1965, total US troop strength reached 184,300 personnel. The 18th Engineer Brigade alone consisted of more than 9,500 men divided into three engineer groups, ten battalions, and an assortment of separate engineer companies which all worked on establishing and constructing bases, airfields, and ports. Expansion of the operational, logistical, and support facilities in South Vietnam was also supported by other engineer assets from the US Navy, the US Marine Corps, as well as US Air Force civil engineering teams and civilian contractors.[17]

Brig. Gen. Robert R. Ploger, commander of the 18th Engineer Brigade, possessed significant experience in combat and civil works operations, as well as command and staff positions. Following graduation from the US Military Academy in 1939, he took a commission in the Corps of Engineers. In 1944, then-Major Ploger served as the staff engineer for the 29th Infantry Division that made the amphibious assault on Omaha Beach on D-Day. Next, he commanded the 121st Engineer Combat Battalion in the drive across France to Germany. During the post-war years, Ploger served as a project manager in Okinawa and later as commander of the New England Division of the Corps of Engineers.[18] Taken as a whole, Ploger's previous experiences qualified him for key roles in Vietnam, first as the commanding general of the 18th Engineer Brigade, and then as the major general and commander of the US Army Engineer Command, Vietnam (Provisional).[19]

Under the leadership of Ploger and his successors, the 18th Engineer Brigade assumed responsibility for engineer staff planning from the small engineer section of the 1st Logistical Command. Ploger acted as both the engineer troop commander and the army engineer until December 1966 when the US Army Engineer Command was formed. The brigade numbered more than 6,200 engineers; its subordinate groups and battalions performed

tasks across South Vietnam until 1967 when the 18th Engineer Brigade settled into the I and II Corps areas in the northern half of South Vietnam.[20]

In April and May 1966, a significant proportion of engineers in Vietnam were nearing the end of their twelve-month tours. An instantaneous loss of such a large quantity of experienced engineers threatened the needed operational expertise of many units. The already deployed engineer group headquarters and the 45th Engineer Group enacted several measures to prevent one month's rotation from exceeding 25 percent of any one battalion's strength. First, an over strength of 10 percent was authorized for the battalions; next in order to spread the administrative load to at least two months, some individual tours of duty were shortened by as much as one month while about 10 percent of individual's tours were voluntarily or involuntarily extended for one month; and lastly some engineers were interchanged with counterparts in other battalions who had less Vietnam service in order to lessen the impact of the loss on any specific battalion. General Ploger also agreed to allow soldiers with no engineer military occupational specialties to be used as fillers in order to maintain the manpower resources needed to sustain operational support.[21]

As the number of engineers in country grew, exercising command and control for all units extended beyond what the 18th Engineer Brigade could handle. To alleviate the pressure, the 20th Engineer Brigade deployed to South Vietnam in August 1967. It assumed responsibility for all non-division engineering missions in the III and IV Corps areas in the southern part of the nation.[22] In this region, subordinate units supported US Army forces around the capital city of Saigon and the Mekong Delta.

As of 1967, both the 18th and 20th Engineer Brigades fell under direct control of the higher headquarters of the US Army Engineer Command, Vietnam.[23] The peak of deployed engineer soldiers was reached in mid-1968 when thirty-five engineer battalions, forty-two separate companies, along with several other teams and detachments were deployed to Vietnam. Army engineer strength in Vietnam approximated 40,000 officers and enlisted.[24] In 1971, the newly promoted Major General Ploger believed the Engineer Command's "real accomplishment is measured in the statement of many tactical commanders over there who said that no operation, tactical or otherwise, suffered or failed to be performed because of any shortcoming on the part of engineering input."[25] Even allowing for some exceptions of poor engineering performances, Ploger's sweeping statement encapsulated the level of success achieved by engineer units in South Vietnam.

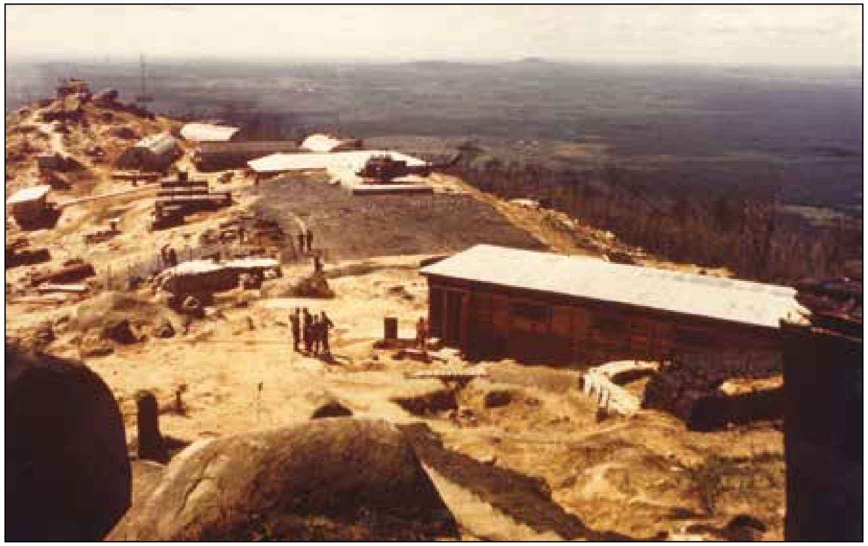


Figure 8.1. Soldiers of the 31st Engineer Battalion construct living and firing bunkers at a base in Vietnam in 1968. Source: US Army Engineer School History Office Archives.

Overall from 1965 to 1973, more than 200,000 engineers served at least one tour of duty in Vietnam.[26] They undertook many general engineering tasks such as building roads, bridges, hospitals, bases, ammunition dumps, and port facilities. This short list hardly covered the extent of their activities. The engineers also constructed fire bases and other fortifications, bulldozed great swaths of jungle near roads, destroyed Viet Cong tunnel systems, and searched for enemy mines and booby traps on roads, in rice paddies and village huts, and alongside jungle paths.

Effects of War on Mobilization and Training at the Engineer School, 1965–73

In mobilizing for Vietnam from 1965 through 1968, the US Army and the Engineer School drew on past lessons from the World Wars and the Korean War. Nevertheless, several problems arose in the late 1960s that also plagued those past mobilization efforts: building sufficient housing and other facilities, obtaining and training the cadre of instructors, and meeting the expanding demands for competent engineers at platoon and company levels. According to commandant and then-Maj. Gen. Frederick J. Clarke:

> The expansion of the military to support Vietnam came through the training system and the school system. And this hit heavily at Belvoir during the time I was there. We started instruction twenty-four hours a day. We had limited facilities, and it was easier

> to get the people in than it was to expand the facilities. We had problems of bedding people down, finding enough space for them. The combination of opening the officer candidate school and increasing the capacity of all the courses was probably the major problem there at that time.[27]

Despite these circumstances, Clarke set mobilization in motion while commandant and commanding general of the Engineer Center and of Fort Belvoir during 1965 and 1966.[28] The assistant commandant and deputy assistant commandant directed the daily activities of the Engineer School. The director of instruction supervised three training departments: Engineering and Military Science, Mechanical and Technical Equipment, and Topography.[29] These three large organizations worked closely with the Engineer School's training units at Fort Belvoir to provide instruction at all levels and ranks. The departments helped train battalions and companies before sending them off to Vietnam.[30] The school likewise retained the Department of Doctrine Review and Literature to supervise continual revisions to manuals and other publications. The one major addition to the Engineer School occurred in September 1965 with the establishment of Engineer Officer Candidate School (EOCS) under the auspices of the US Army Engineer Officer Candidate Regiment.[31]

The Engineer School's "Annual Historical Summary" for fiscal year 1965 affirmed Clarke's observations. During mobilization, "all areas of the school felt the impact of urgent requirements and additional workloads. No activity remained untouched: fiscal, administration, materiel and supply, personnel, training literature, building and maintenance needs."[32] The personnel assigned as faculty and staff at the Engineer School doubled between July 1965 and June 1966, with the total reaching 3,860 assigned and 3,822 authorized positions.[33] As of June 1967, those figures rose to 4,400 and 4,336 respectively.[34] The strength levels hovered close to 4,000 faculty and staff until 1970.[35] Even with these increased numbers and additional assigned personnel, the Engineer School could not keep pace with the Army's 1966 and 1967 wartime support for increasing deployments to Vietnam. The buildup during the Tet Offensive in early 1968 further exacerbated manpower shortages. Then during the slow withdrawal of American forces from Vietnam between July 1969 and March 1973, the Engineer School's personnel decreased proportionately from 1,753 slots in fiscal year 1972 to 1,527 slots in fiscal year 1973. During the Vietnam War, the Engineer School retained much the same structure from the previous ten years or more. Given the necessary commitment of instructors to supply the specialized training, the Engineer

School and the Corps of Engineers felt the negative effects of the annual deployments to Vietnam.[36] The Engineer Training Centers at Fort Belvoir and Fort Leonard Wood needed to increase their incoming student numbers and update or expand their facilities.[37]

During mobilization and in the war years thereafter, the Engineer School trained students to perform a tremendous variety of tasks, including the top fifty-five priorities shown in Figure 8.2. Many of these tasks required the Engineer School to offer specialized training for the enlisted, noncommissioned, warrant, and officer ranks. This specialized training was often lost when soldiers took their Army-developed skills and experience with them to civilian life at the conclusion of their draft service.[38]

Engineer Officer Candidate School during the Vietnam Years

The shortage of engineer officers during the early years of the Vietnam War was especially apparent at the company-level ranks. In January 1968, for example, only 278 captains served in Vietnam out of the authorized total of 755 captains. Less severe shortages existed from major up to colonel.[39] Newly commissioned officers from Reserve Officer Training Corps programs and the US Military Academy could not fill all the vacancies in 1965, let alone during the later war years. As in previous conflicts, the EOCS Regiment was reactivated in the fall of 1965 at Fort Belvoir. "This was to take promising people from the enlisted ranks and prepare them to be platoon leaders, largely for Vietnam," said retired Lt. Gen. Frederick J. Clarke about his time as commandant. "It was one of our major activities at the time."[40] By June 1966, 1,132 soldiers completed the program and received their commissions in the Corps of Engineers. That total grew to around 4,000 graduates in 1968 before reaching nearly 5,900 when the Engineer School deactivated EOCS in 1971. In addition to the almost 5,900 engineer officers, another 4,000 or so graduates were assigned to other Army branches.[41]

According to its mission statement, the EOCS put premiums on developing "practical leadership, with special emphasis . . . on building physical stamina, and the mastery of tactics and weapons. The rigorous program of training and discipline furnishes the means of confirming whether a candidate possesses the potential ability to become a competent leader."[42] To fill EOCS enrollment, the engineers tried to identify noncommissioned officers and college-educated civilians who would be able to successfully complete EOCS and make effective junior officers.

During the twenty-three weeks in EOCS at Fort Belvoir, candidates took all the usual Army-generic subjects like discipline and military cour-

Engineer Priorities in Vietnam

- Clearing and grubbing of troop areas
- Field fortifications
- Clearing of fields of fire
- Water supply points
- LST ramps and bollards
- Materials for pit latrines
- Flight strips with access roads
- Roads and hardstands at ports
- Hospitals
- Ammunition storage areas and access roads
- Communications facilities
- Storage facilities for petroleum products (tank farms)
- Ramps and parking areas for flight strips
- Jetties at ports
- Dispensaries for tactical units
- Internal axial roads
- Distribution systems (depots) for petroleum products
- Maintenance buildings for flight strips
- Administration buildings such as headquarters
- Kitchen pads
- Mess halls
- Dispensaries
- Warehousing space and open storage area depots
- Maintenance facilities for weapons
- Maintenance facilities for communications equipment
- Road improvement
- Off-loading and feeder pipelines for petroleum products
- Piers at ports
- Bridge strengthening
- Field maintenance facilities for vehicles
- Fire protection sumps
- Covered storage space
- Internal tributary roads
- Shop maintenance facilities for vehicles
- Shower points
- Warehousing space
- Post offices and post exchanges
- Bakeries
- Laundries
- Service clubs
- Wharves at ports
- Enlisted billets for combat elements capable of only intermittent self-help because of engagement with the enemy
- Unit maintenance facilities for vehicles
- Enlisted billets for combat support units
- Stabilized access roads
- Enlisted billets for general support units (including engineers)
- Road surface treatment through villages
- Bridge replacement
- Stabilized parking areas for vehicles
- Bermed ammunition storage areas with stabilized pads
- Officer billets for combat units
- Officer billets for combat support units
- Officer billets for general support units
- Chapels

Source: Maj. Gen. Robert R. Ploger, *Vietnam Studies–U.S. Army Engineers, 1965–1970* (Washington, DC: Department of the Army, 2000), 229–30.

Figure 8.2. Engineer Priorities in Vietnam. Created by Army University Press.

tesy along with engineer-specific subjects such as bridging, mine warfare, and construction. The EOCS followed the class system introduced during the Korean War. Candidates started out as "SMEACs" (derived from the five-paragraph field order of Situation, Mission, Execution, Administration & Logistics, and Command & Signal and pronounced "smacks") because they had not mastered any of the rudimentary requirements to meet even the basic standards of officer candidate school. This stage culminated in the ninth week with a visit to Fort A. P. Hill in Virginia, where candidates lived as infantrymen during a weeklong field exercise, learned about infantry tactics with a focus on squad and platoon operations, and practiced with M-14 rifles, 3.5-inch rocket launchers, M-60 light machine guns, M-79 grenade launchers, and .45-caliber pistols. All these weapons were standard issue for soldiers in platoons led by successful EOCS graduates commissioned as second lieutenants. If successful in the field and during an additional two weeks of academic examinations at Fort Belvoir, the candidates progressed to the junior officer candidate stage where most of the engineer-specific tasks and lessons were instructed. Finally, as senior officer candidates, they took over some instruction of SMEACs as well as some administrative duties in their training units. As the seniors neared the end of the twenty-three-week EOCS, they participated in a simulated combat exercise that emphasized command, control, and communications, and tested leadership abilities.[43] One about-to-be-graduated candidate reflected on his experiences:

> Officer Candidate School *has* done something for us because it was a . . . succession of constant challenges that made us look closely at ourselves and others [and it] has given us a confidence in ourselves and . . . has taught us to roll with the punches, to handle crises, to control men, to command respect—all necessary abilities of a platoon leader. . . . Of course we're not perfectly qualified; no program can profess to accomplish that mission. But at least we're the product[s] of a system designed to eliminate the totally unqualified and, more importantly, to develop the potential of the qualified.[44]

This description shows that EOCS was a carefully constructed process to shape raw candidates into potentially effective platoon leaders. It is interesting to note that during the Vietnam War years, EOCS was constantly refined and the type of candidates evolved from career-type enlisted men with prior service in 1965 to fresh-to-the-ranks college graduates in 1968. With this change in candidates, EOCS changed to produce the number of junior officers needed in Vietnam and throughout the Army.[45] The EOCS mission was expanded in fiscal year 1968 to include commissioning offi-

cers in different branches.[46] Those efforts increased in the coming years; in 1970, a year before the EOCS Regiment deactivation, EOCS commissioned more lieutenants in Military Intelligence than in the Corps of Engineers itself. Class instruction transitioned from engineer-specific training to general branch training.[47]

Figure 8.3. Engineer Officers Basic Course class participates in a 1965 raft training exercise at Fort Belvoir. Source: US Army Engineer School History Office Archives.

Wartime Curriculum Changes and Adaptations

The wartime necessity for additional personnel put stress on training efforts across the US Army, including on the Engineer Center and Fort Belvoir. Furthermore, the requirements of sufficient land to use for marksmanship training and field exercises during these increased training efforts surpassed the available space of the relatively small post at Fort Belvoir. Training a few hundred officers and noncommissioned officers (NCOs) at any given time could be easily accomplished at Fort Belvoir. However, training thousands of draftees and volunteers presented an insurmountable problem. The best solution was to expand the engineering instruction already offered at Fort Leonard Wood in Missouri. In 1968, Fort Leonard Wood's expansion made it "the nation's largest US Army Training Center."[48] An average of 94,000 men a year completed training at Fort Leonard Wood during the 1960s; the highest numbers were in 1966 and 1967, when almost a quarter of a million men completed basic military and engineer or combat support specialty training there.[49] Despite efforts to build new facilities to support this increase of trainees and support staff, several thousand recruits on the base were housed in tents, even though the US government spent more than $86 million for construction of permanent facilities from 1956 to 1968.[50]

Several specific additions of courses and POIs in 1969 illustrated the Engineer School's efforts to leverage some lessons learned in Vietnam and increase training relevance. By 1969, the construction of a DeLong Pier at Cam Ranh Bay was added as a case study in a two-hour segment on Port and Harbor Construction in the Engineer Officers Advanced Course. In 1970, this same content was slated to be part of the revised POI for the Construction Planning and Operations Course. The Engineer School also started developing a two-week course on Procurement Management of Construction Contracts, because engineer officers needed better knowledge of legal and other factors related to the contracting process. This short course was undergoing the approval process in 1969 with the expectation that it would start the following year.[51] In response to significant land-clearing and counter-tunneling operations in Vietnam, the Engineer School added classes on these topics to officer advanced courses. It was believed that any future jungle operations would require these skill sets.[52] To help engineer junior officers prepare to coordinate artillery support from fire bases in Vietnam, the school added a three-hour lesson on Requesting and Adjusting Artillery Fire, which included a two-hour practical exercise on use of the M31 Artillery Trainer.[53]

Other lessons from Vietnam, such as the enemy's abundant use of mines and booby traps, were incorporated in various courses and during updated field training exercises. A replicated Viet Cong campsite at Fort Leonard Wood was used during basic training and some pre-deployment training with hopes to give more realistic training before soldiers deployed to Vietnam.[54] Recent Vietnam returnees serving as instructors at the Engineer School also made training more realistic. In fiscal year 1969, there were 242 Vietnam returnees assigned to the Department of Mechanical and Technical Equipment, of which 93 became new instructors.[55] In fiscal year 1970, 83 of the 288 Vietnam returnees assigned to the Department of Mechanical and Technical Equipment became instructors.[56] Regardless of how long it took for changes in tactics, techniques, or procedures to filter into new doctrine or new manuals, these instructors provided immediate perspectives on combat and construction missions undertaken in Vietnam.

Engineer training teams conducted one- to five-day training courses on demolitions and mine warfare for units at other posts. Much of the content was drawn from case studies, practical experiences in Vietnam, and the newly developed 1969 version of Training Circular (TC) 5-31, *Viet Cong Boobytraps, Mine and Mine Warfare Techniques,* produced by the Department of the Army Training Literature of the Engineer School.[57] Mines and booby traps laid by the enemy resulted in about one-third of personnel casualties and two-thirds of all combat losses of armored personnel carriers and tanks. Enemy use of mines and booby traps led to the establishment of the US Army's Mine Warfare Center in Vietnam. The newly established center collected and distributed reports on enemy techniques and tactics while at the same time introducing countermeasures.[58] Even though mine-related casualties remained serious throughout the war, the analysis by the Mine Warfare Center improved the ratio of mines detected. Use of mine-detecting dogs and improved models of metallic and nonmetallic mine detectors debuted in Vietnam. Regardless of countermeasures, mine warfare still favored the force that placed the mines.[59]

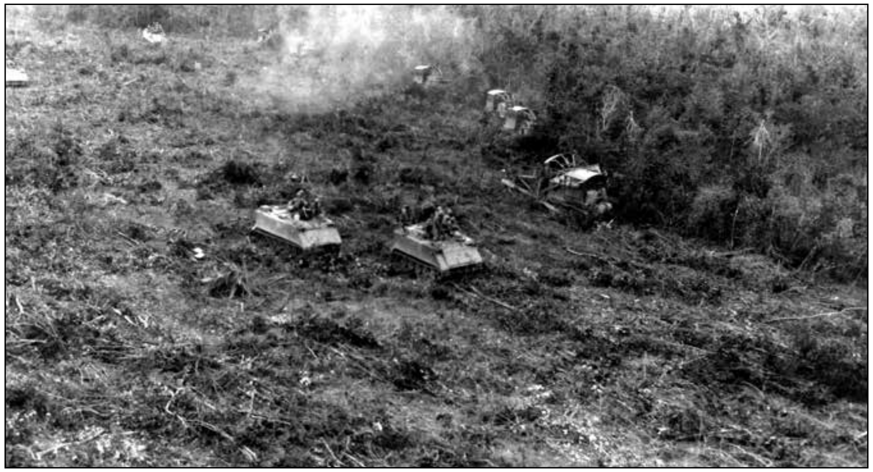


Figure 8.4. The 27th Land Clearing Team, 168th Engineer Battalion, uses Rome Plows to push back the jungle from a road. Meanwhile, armored personnel carriers with infantry provide security. Source: US Army Engineer School History Office Archives.

NCO Leadership Development Changes

The Engineer School did not limit its focus on leadership development to officers. POIs evolved to better train the noncommissioned officer rank, embracing the Whole Man Concept in which the students received not only professional military education but also opportunities to broaden their civilian education. Such opportunities ranged from high school equivalency programs for soldiers without a high school diploma to the chance to work on a baccalaureate degree. The POIs were designed to become progressively more rigorous and, just as important, more professional. When combined with ten to fifteen years of practical experience, the courses ultimately prepared sergeants, staff sergeants, and sergeants first class for more senior command and staff positions later in their careers. The level of sophistication in the Advanced Course would approximate their officer counterparts at the Command and General Staff College at Fort Leavenworth, Kansas.[60] The push for professionalism at the NCO level would, as one late 1972 article stated, be increasingly important in the coming era of the all-volunteer force.[61]

The Engineer School implemented its first twelve-week Basic Course for engineers in July 1970, and the twelve-week Advanced Course for engineers followed in May 1971. The Basic Course illuminated the enlisted ranks and sergeants to their responsibilities in squads, sections, and platoons. The Advanced Course focused on supervisory and managerial roles at the company and battalion levels for sergeants, staff sergeants, and sergeants first-class. The two courses, in turn, were divided into four phases that covered Army-generic, as well as branch-specific content. Phase I used lecture and discussion formats to teach students about universal leadership topics such as professional ethics and military resource management. Phase II started to individualize the training within five career fields: Combat Engineer, Engineer Equipment, Mechanical Maintenance, Topography, and Construction and Utilities. These five main fields covered every engineering military occupational specialty (MOS). Phase III further customized training to increase the skill level within the soldier's MOS. Finally, Phase IV included "specialized group and individual projects where the student is required to make practical application of the skills and knowledge" gained from the previous three phases and career experiences. [62] Students were assigned real-world problems to solve relative to their MOSs. This more structured and progressive pairing of POIs marked a departure from previous courses for noncommissioned officers. Both the Basic and Advanced Courses helped reinforce the notion that noncommissioned officers were subject matter experts and professionals.[63]

An experimental concept called the Modern Volunteer Army Program emerged in 1970 as a possible solution to both quantitative and qualitative challenges facing the Army and engineer recruitment and training efforts. Several posts, including Fort Leonard Wood and Fort Benning, Georgia, participated between 1970 and 1972. The Modern Volunteer Army Program tried to attract and enlist volunteers with more education and better skill sets. To make the basic training experience less distasteful, the Army eliminated unnecessary formations, daily reveille, and routine bed checks. There was even a proposal to stop using trainees for KP duty (kitchen

police) and instead hire civilian kitchen attendants. The Army also started serving short-order meals in mess halls on weekends and adopted five-day work weeks unless trainees were on field exercises. The Modern Volunteer Army Program tried to raise levels of professionalism and motivation. Program supporters believed traditional basic training regimens and rituals hurt, rather than helped, the Army achieve these goals.

The Modern Volunteer Army Program experiment yielded mixed results because the levels of professionalism and motivation, or lack thereof, too often depended on the education and intelligence of incoming volunteers. Other variables, like the relative quality of training cadre or living conditions, also limited the conclusions made. The ongoing draft certainly did not help the experiment; even when better educated, the draftees were not necessarily motivated to serve in the Army, especially during the last few years of Vietnam.[64] In 1972, Robert W. Elkey, command sergeant major at the US Army Engineer Center and Fort Belvoir, bluntly conceded, "This Vietnam thing—as no other in our history—has been unpopular."[65] The negative, or at best ambivalent, feelings of many Americans regarding the conflict impaired the US Army's recruitment, training, and retention efforts.

Engineering Lessons Learned during the Vietnam War

Many engineering lessons can be taken away from the Vietnam War. Some must be understood in the context of that time and place, and the global realities of the Cold War. The following lessons appeared during the conflict or shortly after its end:

- Exposed the need for advanced planning of the initial US forces buildup and the needed supply channels to accomplish the mission.
- Established the need for engineer units to be effective builders of bases of all types, particularly in areas with limited existing infrastructure.
- Highlighted the need to use every man, machine, and moment to advantage no matter the climate, geography, or existing infrastructure.
- Exposed the need for greater competence in construction among engineer combat units, and of construction units in combat competencies. These were especially necessary in the climate and geography of an underdeveloped nation like South Vietnam.
- Revealed the importance of civilian contractors in near-combat situations when engineers were not prepared to replace.
- Revealed that enemy mines and booby traps were effective as force multipliers.

• Exposed the inadequacy of a single engineer battalion organic to combat divisions.

• Called for engineer units to adapt force structures and tables of organization and equipment to the tasks at hand.

• Highlighted the need for combat arms unit commanders to be educated about the best employment of engineer skills and resources.

• Reinforced the importance of effective engineering functions of survivability such as building or fortifying fire bases.

• Prioritized the engineering function of mobility during road clearing, land clearing, crater repair, and mine and booby trap detection, as well as construction and maintenance of lines of communication.

• Validated the need for engineers to be able to fight as infantry.

• Highlighted the importance of mapmaking and topographic information provided by engineers to successful operations planning, especially in regard to artillery fire placement.

• Established the advantages of having senior engineer officers on staff at corps and echelon above corps.[66]

Conclusion

The US Army Engineer School entered the Vietnam War with its training focus squarely on conventional large-scale combat and support operations before shifting to counterinsurgency/counterguerrilla operations. The Engineer School's training in general and sustainment engineering missions proved invaluable in Vietnam. Whether engineering units were combat- or construction-based, they inevitably had to perform outside of their traditional tasks. Engineer accomplishments were significant and ranged from establishing the first large port facilities and airfields, to erecting logistical facilities and housing, to improving and securing the various lines of communication throughout South Vietnam. The Vietnam experience once again exposed that no matter how effective the Engineer School training, a student's true proficiency only came with time and experience—something most conscripted soldiers did not have in the US Army of the late 1960s and early 1970s.

Notes

1. George C Herring, *America's Longest War: The United States and Vietnam, 1950–1975,* 4th ed. (New York: McGraw-Hill, 2002), 20, 85, 104, 144–46.
2. Maj. Gen. Richard S. Kem, *Engineer Memoirs* (Alexandria, VA: Office of History, Headquarters, US Army Corps of Engineers, 2002), 55.
3. Kem, 63.
4. Kem, 63.
5. Kem, 63.
6. Kem, 71.
7. Herring, *America's Longest War*, 144.
8. Herring, 141–47, 151–58, 173–74, 179–82.
9. US Army Engineer School, *Guidelines for the Preparation of Programs of Instruction at the US Army Engineer School* (Fort Belvoir, VA: US Army Engineer School, April 1960), Annex A, 35.
10. Herring, *America's Longest War*, 182; and Adrian G. Traas, *Engineers at War* (Washington, DC: Center of Military History, US Army, 2010), 397.
11. Traas, 26–28.
12. Maj. Gen. Robert R. Ploger, *Vietnam Studies–U.S. Army Engineers; 1965–1970* (Washington, DC: US Army, 2000), 130.
13. Ploger, 106.
14. Traas, *Engineers at War*, 20–22.
15. Ploger, *U.S. Army Engineers,* 106.
16. Traas, *Engineers at War*, 29; and Ploger, 106.
17. Traas, 48.
18. Bob McClintic, "Engineer Interview with Major General Robert R. Ploger," *The Engineer* (Fall 1971): 5.
19. Ploger, *U.S. Army Engineers*, 63, 135.
20. Ploger, 65–66, 136.
21. Ploger, 130–31.
22. Traas, *Engineers at War*, 279.
23. Traas, 279.
24. Lt. Gen. Carroll H. Dunn, *Vietnam Studies–Base Development in South Vietnam; 1965–1970* (Washington, DC: Department of the Army, 1991): 26
25. McClintic, "Engineer Interview," 5.
26. Traas, *Engineers at War*, 579.
27. Lt. Gen. Frederick J. Clarke, *Engineer Memoirs* (Washington, DC: US Army Corps of Engineers Office of History, 1979), 179.
28. US Army Engineer School, "Annual Historical Summary: 1 July 1965 to 30 June 1966," 1, 4, 7, US Army Engineer School History Office Archives.
29. US Army Engineer School, "Annual Historical Summary: 1 July 1965 to 30 June 1966," Tab A.
30. Clarke, *Engineer Memoirs*, 180–81.
31. US Army Engineer School, "Annual Historical Summary: 1 July 1965 to 30 June 1966," 49.

32. US Army Engineer School, 1.
33. US Army Engineer School, 7, Tab C.
34. US Army Engineer School, “Annual Historical Summary: 1 July 1966 to 30 June 1967,” Tab D, US Army Engineer School History Office Archives.
35. US Army Engineer School, “Annual Historical Summary: 1 July 1969 to 30 June 1970,” US Army Engineer School History Office Archives.
36. US Army Engineer School, “Annual Historical Summary: 1 July 1972 to 30 June 1973,” 11, US Army Engineer School History Office Archives.
37. Ploger *U.S. Army Engineers*, 8, 16–22.
38. Ploger, 17, 22.
39. Ploger, 18.
40. Clarke, *Engineer Memoirs*, 177.
41. Traas, *Engineers at War*, 187.
42. Department of the Army Pamphlet 601-1, *The OCS Story*, cited in Capt. John J. Connor, “Engineer OCS: Another Perspective!” *The Engineer* (Spring 1972): 42.
43. “From Enlisted Soldier to Engineer Second Lieutenant,” *The Army Engineer* (September–October 2006): 46–49.
44. Cited in Connor, “Engineer OCS,” 43.
45. Connor, 42–43.
46. US Army Engineer School, “Annual Historical Summary: 1 July 1968 to 30 June 1969,” 87, US Army Engineer School History Office Archives.
47. US Army Engineer School, “Annual Historical Summary: 1 July 1969 to 30 June 1970,” 92.
48. Paul W. Bass, *The History of Fort Leonard Wood, Missouri* (Morley, MO: Acclaim Press, 2016), 113.
49. Bass, 113.
50. Bass, 113.
51. US Army Engineer School, “Annual Historical Summary: 1 July 1968 to 30 June 1969,” 40.
52. Traas, *Engineers at War*, 583.
53. US Army Engineer School, “Annual Historical Summary: 1968–1969,” 35.
54. Bass, *The History of Fort Leonard Wood,* 107.
55. US Army Engineer School, “Annual Historical Summary: 1 July 1968 to 30 June 1969,” 17.
56. US Army Engineer School, “Annual Historical Summary: 1 July 1969 to 30 June 1970,” 20.
57. “Annual Historical Summary: 1969–1970,” 68, 70.
58. William Gardner Bell, comp. and ed., *Department of the Army History Summary, Fiscal Year 1969* (Washington DC: US Army Center of Military History, 1973), 92.
59. Traas, *Engineers at War*, 583.
60. Maj. Robert E. Harper, “ENCOES: A Revolutionary Formula for Enlisted Career Development,” *The Engineer* (Winter 1972): 26–29.

61. “Engineer Interview: With Command Sergeant Major Robert W. Elkey,” *The Engineer* (Spring 1972): 6.
62. Harper, “ENCOES,” 28.
63. Harper, 28–29.
64. Capt. Dennis F. Pierman, “Rated ‘P’ for Professionals,” *The Engineer* (Spring 1972): 20.
65. “Engineer Interview with CSM Elkey,” 7.
66. Lessons learned are drawn from “Engineer Interview with Ploger,” 6–8; Ploger, *U.S. Army Engineers*, 105, 178–96; Dunn, *Base Development*, 132–47; and Traas, *Engineers at War*, 583–87. See also the Schneck Mine/Countermine Collection, and several boxes of reports and documents from the “Study and Evaluation of Countermine Activities” compiled by the Army Concept Team, which are all held at the US Army Engineer School History Office.

Chapter 9

The Engineer School's Final Years at Fort Belvoir: Training Engineers for Conventional Warfare, 1973–88

Following the Vietnam War, the US military once again focused on conventional warfare and its move away from a draft-based manpower pool to an all-volunteer force. This would bring several challenges and opportunities to the US Army. The adoption of the Active Defense and later AirLand Battle doctrine attempted to stem the tide of a possible Soviet invasion of Europe. A new organization—the Training and Doctrine Command (TRADOC)—emerged to drive the application of the two doctrines and to take control of the Army's training, doctrine writing, and combat developments efforts. The Engineer School survived the rocky 1970s and maintained its training posture vis-à-vis conventional operations. The 1980s saw a renewed push to relocate the school from Fort Belvoir to Fort Leonard Wood and with General Order 31, the relocation would finally be effective on 1 June 1988.

Effects of Demobilization on the Engineer School: Personnel Reductions and the All-Volunteer Force

During the Vietnam War, the active US Army expanded to over 1.5 million soldiers in 1968 and 1969, and then dropped slightly to just over 1.3 million soldiers in 1970. Manpower levels dropped after the Vietnam War to around 770,000 soldiers by 1974, and these numbers would hold steady for the most part until 1989.[1] The elimination of the draft and the creation of the all-volunteer force went into effect in 1973. Army planners could no longer depend on an influx of draftees; therefore, recruiting efforts had to be ramped up to make the all-volunteer force sustainable. The post-Vietnam downsizing of the Army, the shrinking defense budgets of the 1970s, and the move to the all-volunteer force forced the Army to overhaul how it approached training in order be more efficient and cost effective. Required Army manpower strengths were difficult to sustain and, therefore, the Army saw a dramatic increase of women enlistees which was necessary to meet the all-volunteer force manpower requirements.[2] The Department of the Army and the Continental Army Command developed and established the Noncommissioned Officer Education System (NCOES). By January 1973, the Sergeant Majors Academy opened its doors at Fort Bliss, Texas, as the capstone of professional educational development for the noncommissioned officer.[3]

Between 1970 and 1974, the US Army Engineer School also experienced significant changes due to demobilization and the move to an all-volunteer force. The numbers of students of all ranks shrank from 23,461 in fiscal year 1970 to 7,868 in fiscal year 1974. The school's faculty and staff decreased just as dramatically, dipping from 4,100 personnel in January 1970 to 1,405 personnel in June 1974.[4] The Engineer School instituted a pilot program in July 1970 specifically for engineer noncommissioned officers. After several changes in curriculum, the Engineer School implemented the Engineer Noncommissioned Officer Education System (ENCOES) in February 1972. The ENCOES consisted of a twelve-week Engineer Noncommissioned Officer Basic Course for E-4s and E-5s, and a twelve-week Engineer Officer Advanced Course for E-6s and E-7s.[5] The school also put forward a proposal in 1974 that trainees in certain courses (e.g., the Engineer Equipment Repairman course) could gain civilian labor organization recognition as apprentices and later journeymen. In fact, the Engineer School's elements at Fort Leonard Wood had started aligning some programs of instruction (POIs) for training in these military occupational specialties (MOSs) with industry standards so that operators and mechanics could gain either official certification or transfer credits toward certification. This proposed Military Apprenticeship Program thus added value to the military experience by meeting the civilian professional standards of those trades and was a great way to support the recruiting effort for the new all-volunteer force.[6]

Figure 9.1. Heavy equipment training at the Engineer School in the post-Vietnam years. Courtesy of US Army Engineer School History Office Archives.

Looking to the Next War: TRADOC, Engineer School Reorganization, and the Pivot toward Europe

In addition to modifications in personnel policies and professionalism, the Engineer School made major organizational reforms to consolidate control of the key training functions and force structure. Dating back to 1955 and 1962 respectively, two administrative entities existed in the Army. Continental Army Command (CONARC) was responsible for maintaining the readiness of all active duty units in the continental United States. It also developed some doctrine and controlled training under the auspices of the branch schools and training centers. Meanwhile, the Combat Developments Command (CDC) integrated some doctrine with tactics, force structure, and research and development. Problems occurred between the two commands when their respective staffs tried to match doctrine with tactics, training, and force structure. Following the recommendation of Operation Steadfast, both CONARC and CDC were inactivated; then on 1 July 1973, US Army Forces Command (FORSCOM) and US Army Training and Doctrine Command (TRADOC) were activated. The new entities combined the functions and responsibilities of their predecessors in more rational ways. FORSCOM assumed control of all active units stationed in the United States and prepared units for potential deployment. However, FORSCOM relinquished CONARC's control of tactics and doctrine components to the new TRADOC. This meant that all basic and advanced individual training for enlisted soldiers, Army branch schools and Army colleges as well as the Reserve Officer Training Corps (ROTC), along with doctrine development, and combat developments were now under one single headquarters. The advent of TRADOC, therefore, affected the Engineer School and other branch schools in far-reaching and significant ways.[7]

The restructuring and consolidation of roles under FORSCOM and TRADOC made sense on practical levels. There could be more agility and efficiency at the branch schools, for example, because the branch schools now exercised combat developments functions and was responsible for research and development of equipment as well as unit tables of organization and equipment. In fact, the establishment of TRADOC and FORSCOM was considered the "most far-reaching reorganization of the US Army since 1962," a change that strengthened the military engineer role in the structure of the Senior Service.[8]

The significance of the Army's new TRADOC organization and mission was discussed in a 1973 issue of the *Engineer–The Magazine for Army*

Engineers, which claimed: "While the current Army structure proved to be excellent in support of the war in Vietnam, the streamlining will enable the new organization to refocus and more easily handle its normal peacetime war-deterrent role."[9] In addition to the efficiency gained by creating TRADOC and FORSCOM, these new commands were part of a larger pivot that looked toward deterring the Soviet Union's threat to Western Europe.

As TRADOC's first commander, General William E. DePuy recognized that Army doctrine and capabilities had to be enhanced in order to successfully fight the next conventional battle. General DePuy was heavily influenced by the 1973 Yom Kippur War due to its increased lethality, especially in armored warfare. Lengthy campaigns of attrition were no longer feasible, and DePuy adjusted the emphasis from training the Army to win battles to specifically winning the first battle of the next war. He knew that the US Army must decisively win its first major battle after a Soviet invasion of Western Europe, or risk never recovering for a second battle. DePuy's work culminated in the formulation of the Active Defense doctrine between 1973 and 1976. The US Army would remain on the defensive in Western Europe but had to win that first battle by destroying the numerically superior Soviet invasion force as it advanced into West Germany through the Fulda Gap. The Soviets, which had an inefficient logistical system, would never recover from such a counterattack. The creation of Field Manual (FM) 100-5, *Operations*, became the capstone document that defined Army doctrine and influenced the combat developments commands at every branch school where branch-specific tactics, techniques, procedures, and doctrines were produced. [10]

Collaboration between two branches and the sharing of ideas across branch lines sometimes resulted in new doctrine development. This can be seen at the Engineer School's newly established Office of Combat and Training Developments collaborative project with the Infantry School at Fort Benning, Georgia, which resulted in the writing of a new anti-armor manual. A mine warfare action officer commented that he traveled to Fort Benning for three days:

> To assist in writing what may ultimately be titled the first "Battle Manual." This particular test showed, using informal language, the integration of mines in all phases of a tactical scenario. The use of mines as a target acquisition tool in conjunction with AT [Anti-Tank] weapons was emphasized.[11]

The 1975 designation of engineers as a combat arm and part of the Combined Arms Team, along with the collaboration with other combat arms

branch schools, may have helped engineers attain greater visibility; by 1979, they played a critical role as members of the Combat Arms Team.[12]

The educational concept used at the Engineer School in 1975 was "systems orientation" and it required "(1) that all training and education be based on a valid job analysis, associated conditions, and standards; (2) that the appropriate instructional tactics be selected to best accomplish the training objectives derived from the job analysis; and (3) that instruction be modified as dictated by the valid quality control feedback."[13] The Engineer School faculty and staff were required to draw lesson plans within POIs that correlated with the overall objectives of a given course. The objectives in turn needed to be synchronized with engineering doctrine. Each lesson plan had to build on past lessons, establish standards for performance, and set up successful students to undertake future lessons. All activities, exercises, discussions, or briefings needed to fit into the sequenced lessons of the POI.[14]

Entire course packages went to TRADOC for approval and then implementation. The School's Curriculum Branch and Task Analysis Division collected data throughout the course instruction (i.e., examinations, after-action reports, questionnaires, performance checklists, and instructor observations). Each branch and division used these data sets to assess whether the course met the stated objectives, both at the macro-level in POIs and at the micro-level in individual lessons. If all the components of a given course were deemed to be properly harmonized, completing it to standard meant that students attained the level of competency required to perform tasks associated with that course.[15]

More courses (Engineer Equipment Repair, Mobile Assault Bridge Maintenance, Engineer Equipment Officers Course, Engineer Equipment Repair Technician Warrant Officer Course, and the Basic Maintenance Track Course) were relocated from Fort Belvoir to Fort Leonard Wood in 1976. This meant that the support staff of these courses, which numbered sixty-one military and nineteen civilian positions, were also transferred to Fort Leonard Wood.[16]

The Engineer School and AirLand Battle as the New Strategy in Europe

After DePuy retired in 1977, General Donn A. Starry assumed command of TRADOC and served until 1981. Starry had experience as a corps commander in Germany between 1976 and 1977. The idea of NATO forces facing the heavily armored Warsaw Pact forces in a structured central battle and having to fight them methodically and aggressively, therefore, influenced his decision-making while serving as the TRADOC commander. He also adhered to the Army's continued emphasis on conventional warfare. Starry transformed DePuy's Active Defense into the new AirLand Battle doctrine that culminated in the revised FM 100-5 in 1982.[17]

Starry envisioned an extended battlefield and believed that the commander's view of the battlefield had to be wider and deeper than previously designated by the Active Defense doctrine. Starry gained a new appreciation of Soviet doctrine and capabilities while he was the V Corps commander in Germany. This experience, as well as a study at the Field Artillery School at Fort Sill, Oklahoma, informed the need to disrupt the enemy's follow-on echelon during the enemy's assault. AirLand Battle became a fundamental conceptual change as well as doctrinal change which used the principles of war and called for depth, agility, synchronization, and decentralized execution of mission orders at all levels of command.[18]

The need for mobility, countermobility, and survivability were key to AirLand Battle requirements. Even before the official publication of the revised FM 100-5 in 1982, engineers recognized how critical their capabilities would be for successful operations in this new scheme. In the *Engineer–The Magazine for Army Engineers* Summer 1981 issue, then-Commandant and Maj. Gen. Max W. Noah examined engineering roles in an article titled "Mobility, Countermobility, and Survivability in the Airland Battle." He laid out the argument that the engineers provided the capabilities and expert skill sets for the combat arms units to perform in their missions. Noah began by bluntly stating, "More than ever before, our success in the first and succeeding battles in the next war will hinge on the battle commander's use of time and terrain."[19] He noted several engineering functions among the requirements for combined arms operations:

> Without mobility on that battlefield, we cannot move or maneuver our forces with sufficient speed to destroy the overwhelming numbers facing us. And we must block, disrupt, and slow the enemy—hence the countermobility need. Lastly, to meet the first blow and survive to win, we need to dig in to protect our high value resources. Each of these hinges upon altering the terrain to our benefit, and so basic to all is the need for continuous and accurate terrain analysis.[20]

Major General Noah also mentioned some equipment shortcomings for engineer units in 1981. He explicitly named the need for the new M9 Armored Combat Earthmover (ACE) since the current D7 bulldozers and JD410 backhoes had neither the mobility nor survivability to successfully accomplish missions in the main battle area during future operations.[21] Furthermore, Noah used the "Clear the Way" section in the same issue of the magazine to inform engineers of "the need to start working and training now to support the new doctrine."[22] He hinted that with the arrival of the new M1 tanks in the force, engineers as "members of the Combined Arms Team will have to provide the best way . . . to use their speed and agility;" in other words, engineer equipment needed updating in order to match the new equipment of the rest of the Combined Arms Team.[23]

The next commandant of the US Army Engineer School from 1982 to 1984, Maj. Gen. James N. Ellis, continued to tout the engineering roles in AirLand Battle and in FM 100-5. Like commandants before and after him, Ellis used his regular "Clear the Way" column in the *Engineer–The Magazine for Army Engineers* to provide the Engineer School perspective to the rest of the engineer force. His first column in the summer 1982 issue identified "three critical areas" which he personally supported. First, he explained the Mission Area Analysis (MAA) which began with a mobility- and countermobility-survivability Systems Program Review (SPR) in 1981. He explained that from a mission standpoint, Mission Area Analysis would be "the most important project" the school would undertake in the decade because the results of the analysis and the follow-on review would drive structure, doctrine, and curricula changes as well as shape the character of the engineer mission of the future.[24]

Ellis next pointed to the school's second critical need to synchronize engineering doctrine, training, and equipment with the expectations of AirLand Battle and FM 100-5. He explained how all branch schools started the process of writing their respective field manuals to complement FM 100-5, just as the engineers were compiling their draft of Field Manual (FM) 5-100, *Engineer Combat Operations*. Once completed, Ellis would turn to writing specialized manuals to supplement those two primary field manuals. This process thus moved from general to specific topics.[25]

Lastly, Ellis expressed concern about the ongoing lack of career development proponency of engineer soldiers. As of 1982, this role had only recently been given to the school. The commandant wanted to establish structure in career development, as well as professional development, educational requirements, additional specialties, gender policies, and accession and retention.[26]

Given Ellis's inaugural article identifying three critical areas, it should come as no surprise that the Engineer School reorganized its structure and revised its curricula during his tenure. Impetus for reorganization also came from TRADOC's "School Model '83," which called for instructor roles to expand to doctrine writing, thereby unifying training with doctrine. The changes in the Engineer School's structures included:

• Consolidating the Engineer Training Brigade and the Engineer Center Brigade into one School Brigade.

• Establishing a third training department—the Department of Maintenance.

• Establishing a school secretary to centrally manage the three training departments and provide logistical support.

• Establishing a Directorate of Evaluation and Standardization.

• Establishing a Proponency Office.[27]

The Engineer School's effort to expand its number of branch-specific manuals bore fruit in 1984, when FM 5-100 was published as the keystone doctrine manual. The school also started work on narrower topics such as Field Manual (FM) 5-101, *Mobility*; Field Manual (FM) 5-102, *Countermobility*; Field Manual (FM) 5-103, *Survivability*; Field Manual (FM) 5-104, *General Engineering*; and Field Manual (FM) 5-205, *Topographic Operations*. As Major General Ellis readied to move to his next assignment, he expected these to be published by 1986. All of these manuals supplemented FM 5-100, as well as the Army-wide FM 100-5.[28]

The Army-wide emphasis on conventional, mobile warfare in AirLand Battle filtered down to the Engineer School's curricula. The new Engineer Officer Advanced Course for captains that launched in late 1984 stood out as a representative example of these changes. The POI began with fourteen weeks of common "core courses" on combat engineering. An *Engineer–The Magazine for Army Engineers* article outlining the Advanced Course indicated that the principles of AirLand Battle doctrine and combined Arms employment were "integrated" into every component of the POI.[29]

Then, during the final six weeks of functional courses, students took one of four tracks: Engineer Unit Staff Officer, Facilities/Contract Construction Management Engineer, Engineer Studies Program, or Topographic Engineer. These experiences helped students attain better levels of competence in their respective tracks. The functional courses prepared the graduating captains to take on the responsibilities of future duties.

Any who did not yet have company command also attended a Company Pre-Command Course.[30]

The same *Engineer–The Magazine for Army Engineers* article claimed that the new Advanced Course had a "combination of features unlike anything the Army has seen before."[31] Related lessons were divided into two-week blocks that included scenario-based problems for each small group of students to find solutions using doctrine as a guide. Emphasis was placed on experiential learning and teamwork, rather than on rote memory. Each small group of ten to twelve students had a team leader who served as mentor, coach, facilitator, and role model. In addition to activities, the revised POI for the Advanced Course covered issues of diet, time management, and control of substance abuse under the auspices of "Wellness." The new course also encouraged captains to leverage computers and networks in their projects.[32]

The first cycles of the Advanced Course started after Maj. Gen. Richard S. Kem became the commanding general (commandant) of the US Army Engineer Center and Fort Belvoir in the summer of 1984. He remained at Fort Belvoir until 1987.[33] Several major objectives affected how he ran the Engineer School. The first two—AirLand Battle-oriented training and the commandant as engineer proponent—came from the TRADOC guidance. As Kem recalled:

> I met with my two major bosses. General [Carl] Vuono, who was the commander of the Combined Arms Center, wanted me to be proactive, wanted me to absolutely ensure the integration of engineers into the combined arms team, told me if he was the Corps commander, I was his Corps engineer and we ought to make things fit that way. He wanted me to focus on AirLand Battle doctrine and ensure we embedded the tenets of AirLand Battle doctrine in all things we do.[34]

Kem also shared details about meeting with the TRADOC commander:

> General [William] Richardson actually was probably more specific describing the proponent's role. He specifically laid that out in the terms that I used for the last question. He expected me, as the engineer proponent, to take charge, make sure we did everything possible to improve the effectiveness of engineers. He told me he didn't think we engineers were very effective and we were badly broken and we needed a lot of work to be repaired. He said, "Your job is to go out and do that, and that means working

> not only at Belvoir." The way he put it was, "You're not responsible for just engineers and how combat engineers are taught at Fort Belvoir. You're responsible for engineers in the total force and how the commandant of the Armored School instructs in the use of engineers at Knox and the same at the Infantry School at Fort Benning and at the Combined Arms Center at Fort Leavenworth and so forth."[35]

Aside from the AirLand Battle and proponency objectives established by TRADOC, Kem wanted the Engineer School to offer the best training possible. His training philosophy can be understood in his own passionate words: "You want to make [training] tough, you want to make it realistic, and you ought not to let somebody assume the problem away or simulate the problem away because certain things aren't available. Make those things available. Make training realistic."[36] Kem likewise believed training did not end when soldiers graduated from the Engineer School and joined their new units. Instead, he asserted that "Ranger School taught me that you don't need to compromise with training. You can make it realistic and then you get full value from it. So, don't compromise; keep your standards high for training, and then the unit will benefit from that."[37] Not all engineers would have the chance to attend Ranger School, hence the inception of the Sapper Leader Course in 1985. The course design began in 1982 and the first eighteen sapper leaders graduated on 14 June 1985. The course was designed to train light engineer leaders in airborne, air assault, mountain, and light infantry tactics to form a more cohesive maneuver element. The twenty-eight-day course, which is still taught today, is extremely fast-paced and challenging. The course culminates in an intense field training exercise that reinforces the battle drills and specialized engineer techniques learned throughout the course. Graduating soldiers earn the right to wear the Sapper tab, which was authorized for permanent wear on 28 June 2004. It is only one of four permanent individual skills tabs authorized by the Army—the others being the President's Hundred, the Special Forces, and the Ranger tabs.[38]

But Major General Kem was not happy about some progress he hoped to accomplish as the commandant; he was frustrated that the Engineer School did not have an adequate number of staff working in the Directorate of Combat Developments. The Engineer School ranked ninth in this area among the TRADOC branch schools, even though the engineers faced more complex challenges than did most branches. Kem acknowledged that an "engineer carries a bunch of different tools in today's battlefield so

that others don't have to carry them."[39] Among these were acquiring the best bridging and breaching vehicles and mine detection equipment. Yet, engineer units still used the 1960s-era M60 Armored Vehicle Launched Bridge (AVLB) and the M728 Combat Engineer Vehicle (CEV) that could not keep pace with much more modern Abrams and Bradleys used by other branches. Thus, when developing new vehicles, the operational requirements and capabilities of engineers proper as well as those of the armor and infantry had to be taken into account. A vehicle might work for engineer purposes, but not for the armor or infantry. The limited staffing in Combat Developments compounded these challenges.[40]

Figure 9.2. Combat engineer vehicle (CEV) pushing through a road block as part of a 194th Armor Brigade mobility exercise at Fort Knox, Kentucky. Courtesy of US Army Engineer School History Office Archives.

It should, therefore, be no surprise that Kem lamented how the Engineer School was always:

> Playing catch-up across a lot more different kinds of systems, a lot more different kinds of units, more different sets, kits, and outfits than anybody else, and yet we're ninth in combat developments staffing. . . . What we're talking about are turning out the documents, the operational and organizational plans, the requirements documents, all that staffing stuff that gets you into the game to get one of these improvements. So, my most frustrating thing is I have not been able to solve the combat development staffing problem, although I've gone directly at it.[41]

The lack of Combat Developments personnel had a ripple effect that spread into force structure and other areas. Kem wanted to create engineer units—the term "E-Force" was his moniker for the conceptualized units—that could match combat arms' need for mobility and speed. An E-Force would also be agile and capable of meeting the operational demands of AirLand Battle.[42] Kem, however, was hamstrung with too little or obsolete equipment. No amount of relevant doctrine or excellence could fix this type of problem. One of his presentation slides stated that "today's combat engineers are the 'weakest link' in the battlefield combined arms team!" due to having a 1960s engineer force.[43] Kem left the Engineer School in 1987 without having found any solutions for these issues.

The Engineer School's Slow Road to Fort Leonard Wood from 1975–88

While the Engineer School's curricula, organization, and doctrines were evolving, the mid-1980s marked the coming of another major change for the Engineer School—realignment from Fort Belvoir in Virginia to Fort Leonard Wood in Missouri. The term "realignment" referred to relocations or consolidations of units, schools, commands, or other military organizations to different bases or posts, either to consolidate similar functions in one place, or to save money by cutting the overhead of duplicated administration.[44] The Engineer School's move to Fort Leonard Wood eventually occurred in June 1988 after many years of debate and planning. This resulted in the consolidation of most engineering training, combat developments, and doctrine writing efforts. In the years after Vietnam and during the Army's demobilization, several posts were slated to be closed outright. Other posts, however, would expand to accommodate additional units, organizations, and command realignments displaced by base closures. Among the many factors that required consideration were

the positive and negative effects on communities and environments near closed or expanded installations; short- and long-term costs versus savings for closures or expansions; mission requirements of the existing tenants on bases relative to relocating to new installations; the physical ability of existing installations to accommodate additional tenants; and the condition of facilities, surrounding land, and airspace at all installations.[45]

As early as 1975, the vice chief of staff of the Army approved the relocation of five Engineer School courses from Fort Belvoir to Fort Leonard Wood, Missouri. The courses were Engineer Equipment Repair; Mobile Assault Bridge, Maintenance; Engineer Equipment Officers Course; Engineer Equipment Repair Technician, Warrant Officer; and Noncommissioned Officer Education System, Basic (Maintenance Track). While some personnel slots at Fort Belvoir were cut with the move, most shifted to Fort Leonard Wood. The relocation of these five courses constituted Phase I in the Engineer School Case Study and Justification Folder. The TRADOC Headquarters completed this study by September 1974, and the courses moved during the 1976 fiscal year, with new training cycles set to commence in 1977.[46] Phase II would not occur for several years.

In an 8 July 1976 letter to General William E. DePuy, Maj. Gen. John C. Waggener declared that noncommissioned officers and junior officers enrolled in courses at Fort Belvoir could not "really learn or understand combat engineering as performed in the field" or "be trained and prepared psychologically to fight as infantry."[47] Waggener, who was commanding general of the US Army Training Center Engineer and Fort Leonard Wood, explained to DePuy, who was commanding general of TRADOC, that the Engineer School's courses should be moved as soon as possible "from the Washington metropolitan area (Fort Belvoir) to the open, wooded, and rolling training area of mid-Missouri (Fort Leonard Wood) where the environment is more conducive to realistic, combat-oriented training."[48] Waggener knew that the move would not be completed until the mid-1980s. He argued that the school ultimately needed "to train our combat engineers in an environment which will enhance their total preparedness to fight and win the first battle as members of the combined arms team" and advocated transferring the Engineer Officer Basic Course and the NCOES engineer advance course to Fort Leonard Wood as fast as possible.[49]

Waggener also sent a copy of his 8 July letter to Maj. Gen. James A. Johnson, then-commanding general of the US Army Engineer Center and Fort Belvoir. Less than a week later, on 14 July, Johnson sent his own letter to DePuy. "We have done an exhaustive training analysis of our courses of instruction and no task was altered nor dropped because the terrain or environment of Fort Belvoir precluded the task from being presented in a dynamic performance oriented manner," retorted Johnson.[50] "Although training areas are adequate, I consider the real Combined Arms environment at Fort Belvoir not measured in hills, valleys, or other terrain features, but rather in the expertise of our Infantry, Armor, Artillery, and Engineer members of our staff and faculty."[51] According to a letter from Johnson to General E. C. Meyer, DePuy let the two posts maintain their independent missions and courses until Fort Leonard Wood's facilities were expanded enough to receive the additional staff, faculty and students.[52]

Even though the relocation of all engineer courses from Fort Belvoir to Fort Leonard Wood was halted in 1976, the idea of placing all engineer training at Fort Leonard Wood did not go away. TRADOC conducted another feasibility study in 1979 which explored four alternatives, each with its own detailed finances and statistics. The study stated that "consolidation of Engineer training has long been a TRADOC goal" and the consolidation would have several organizational benefits such as the improvement of "training effectiveness through closer integration of combat development, training development, and training activities in the Engineering field."[53] Furthermore, the study mentioned that the consolidation would not only provide better training facilities but also align the Engineer Officers Basic Course with other engineer training.[54] Besides improving training effectiveness, the move was projected to save $7.4 million and 458 manpower spaces annually; this was considered significant enough to warrant a detailed study concerning the consolidation of engineer training even though the one-time relocation expenses were estimated to be around $78.8 million.[55]

Even in retirement, Major General Johnson continued to oppose consolidation. In 1981, the former commandant sent a letter to the Army Chief of Staff, General E. C. Meyer, in which he claimed a more realistic figure of $100 million would be needed to move the school to Fort Leonard Wood. Johnson disagreed that officers and enlisted engineers should be trained together. He also stressed to Meyer that consolidation of the engineer schools at Fort Leonard Wood would deprive officers of professional and educational opportunities unique to the Washington area.[56] That same year, Johnson used still stronger language in a letter to then-Engineer School commandant, Maj. Gen. Max W. Noah; he wrote that no one can "predict the erosion of engineer professionalism" that might be associated with moving the Engineer School to the "institutional oasis of Leonard Wood."[57]

Meyer replied to Johnson's appeal with a short note thanking Johnson for his opinions and assuring him that this input would receive due consideration.[58] For his part, Noah also responded to Johnson, but Noah did not tip his hand about the move other than to state cryptically: "There are a variety of views in the Engineer community and the TRADOC community, at least one of which—my boss—is to try to move EOBC [the Engineer Officers Basic Course]" to Fort Leonard Wood.[59]

In addition to disagreements inside the Army, opposition came from US Representative Stan Parris (R-VA). Fort Belvoir sat squarely in his Congressional district, so he had vested political interests in keeping the post at full capacity. "I thought this snake had been killed two years ago," remarked Parris, adding that the proposal "totally and completely ignores" concerns of civilian and uniformed personnel who would not want to move to Missouri.[60]

Not all members of Congress opposed the school's move. One representative in particular—Ike Skelton (D-MO)—provided unwavering support for the proposed relocation and for Fort Leonard Wood as a whole since his district included it. As Paul Bass quoted in his history of Fort Leonard Wood, Skelton characterized the opposition from within the Army as "old generals, old colonel types, who had gone to the engineer school [at Belvoir], didn't want it moved and they just weren't for it. It had always been done that way."[61] Skelton played a critical role not only in advocating for the Engineer School's eventual move to Missouri in 1988, but also for the subsequent relocations of the US Army Military Police School and the US Army CBRN School to Fort Leonard Wood.[62]

In November 1983, yet another "Case Study and Justification Folder for Engineer Training and INSCOM [Installation Command] Realignment" was completed. It contained intricately detailed finances and statistics. This study found that, in reality, Fort Belvoir did not contain adequate training facilities after all, because engineer students needed to travel fifty miles south to Fort A. P. Hill and occasionally other training locations to conduct some of their critical training. Moreover, TRADOC's staff worried that, if need arose, Fort Belvoir could not expand to meet mobilization requirements because of the sprawling northern Virginia suburban areas, whereas Fort Leonard Wood contained ample space to grow as needed.[63]

Substantial savings could be achieved by the move, according to the 1983 case study. The updated fiscal estimates of consolidating engineer training at Fort Leonard Wood presumed annual savings of more than $36 million, including around $3.4 million through use of unused bachelor officer quarters. This would mean that the process would take only two years to offset the one-time relocation expense, which was estimated at a little over $63 million. The case study likewise proposed that the respective Installation Command and Corps of Engineers headquarter nodes could occupy the facilities at Fort Belvoir vacated by the Engineer School.[64] Major General Kem also mentioned that Representative Parris's opposition "died down" after mentioning that there would be, in fact, a net gain with the proposed relocation of the Engineer School and the two headquarters with all of its personnel occupying the same facilities.[65]

Figure 9.3. Trainee being instructed at the hand grenade range in the 1980s. Courtesy of US Army Engineer School History Office Archives.

After at least a decade of debate, enough compelling reasons finally prompted the decision to relocate the Engineer School to Fort Leonard Wood. This official announcement came in February 1985. According to Major General Kem's oral history interview, he immediately encountered naysayers who believed the school's relocation "was the wrong decision, a terrible thing, and so forth."[66] However, the new commandant was of a different mind regarding the value of the school's relocation. Ken voiced his support in an oral history interview:

> I don't feel that way. I think that from the standpoint of training and keeping the engineer part of the force effective, that Fort Belvoir's just too tight. It's certainly a wonderful place and it's got a lot of tradition, but the fact is it's just going to be better when we get officer training and soldier and noncommissioned officer training all out at the same place so we all start from the same focal point. We're going to be able to do a lot of things out there we can't do right now here.[67]

Later in the interview, Major General Kem continued:

> That's what we see when we talk about Fort Leonard Wood. When I talk about it being the Army prototype training facility for combined arms, we're going to have a school that's wired for all of our automation and any other kind of way we want to present instruction, plus this Battlefield Command Training Center, plus all of the good terrain at Fort Leonard Wood to practice "hands on" in the field. That's what's going to be the great benefit there.[68]

In 1987, Kem relinquished the commandancy to Maj. Gen. William H. Reno, who continued to plan the US Army Engineer Center and school's multi-phase move to Fort Leonard Wood.

In General Orders No. 31 on 26 May 1988, the Headquarters Department of the Army made the relocation of the US Army Engineer School to Fort Leonard Wood official as of 1 June 1988. The same general orders redesignated the US Army Engineer School and the post as the "United States Army Training Center Engineer and Fort Leonard Wood" effective 2 October 1988.[69]

Conclusion

Despite the period of flux between 1973 and 1988, the US Army Engineer School remained remarkably agile in adapting to the political and budgetary Army environment. The Engineer School benefitted from the formulations of the Active Defense and the AirLand Battle doctrines, as well as from the newly created Training and Doctrine Command. These undertakings gave the school not only some concrete goals for its training efforts, combat developments, and doctrine writing but also provided integral roles for engineers on the Army's combined arms team. The 1980s marked the branch's greater visibility and, thus, increased its importance. The decade also saw the slow and often-contentious process of relocating the Engineer School from Fort Belvoir to its new home at Fort Leonard Wood.

Notes

1. Garry L. Thompson, “Army Downsizing following World War I, World War II, Vietnam, and a Comparison to Recent Army Downsizing” (MMAS thesis, US Army Command and General Staff College, Fort Leavenworth, KS, 2002), referenced in Russell F. Weigley, *History of the United States Army*, enlarged ed. (Bloomington, IN: Indiana University Press, 1984), 596–97.

2. Benjamin King, *Victory Starts Here: A 40-Year History of the US Army Training and Doctrine Command* (Fort Leavenworth, KS: Combat Studies Institute Press, 2013), 39, 48.

3. Robert R. Froude, “Training Tomorrow’s Leaders Today,” *Engineer–The Magazine for Army Engineers* (Spring 1973): 25.

4. US Army Engineer School, “Annual Historical Summary, 1969–70,” 22, 39, US Army Engineer School History Office Archives; and US Army Engineer School, “Annual Historical Summary, 31 July 1973–June 1974,” 18, 31, US Army Engineer School History Office Archives.

5. Froude, “Training Tomorrow’s Leaders Today,” 25–27.

6. Col. W. R. Hylander Jr. and Maj. Kenneth D. Jobe, “Apprentice Training for Engineer Soldiers: Union Recognition,” *Engineer–The Magazine for Army Engineers* (Spring 1973): 12–17; and Maj. Hugh T. Stevenson, “Apprentice to Journeymen,” *Engineer–The Magazine for Army Engineers* (Summer 1974): 33–35.

7. King, *Victory Starts Here*, 1–2.

8. Staff, “U.S. Army Reorganization: Engineering Bonanza,” *Engineer–The Magazine for Army Engineers* (Spring 1973): 5.

9. Staff, 7.

10. King, *Victory Starts Here*, 5–6; and Paul H. Herbert, *Deciding What Has to Be Done: General William E. DePuy and the 1976 Edition of FM-105,* Operations, Leavenworth Paper No. 16 (Fort Leavenworth, KS: Combat Studies Institute, 1988), 29–37.

11. US Army Engineer School, “Annual Historical Summary, FY74,” 50–51, US Army Engineer School History Office Archives.

12. Staff, “An Interview with CSM Cowart,” *Engineer–The Magazine for Army Engineers* (Spring 1979): 8–9.

13. US Army Engineer School, “Accreditation Self-Study Report,” 1975, Standard I, 1–2, US Army Engineer School History Office Archives.

14. US Army Engineer School, “Accreditation Self-Study Report,” 1975, Standard III, 4–5.

15. US Army Engineer School, 5–7.

16. Department of the Army, Office of the Chief of Staff, Memorandum for Deputy Chief of Staff for Personnel, 12 May 1975, signed by Maj. Gen. James J. Ursano, US Army Engineer School History Office Archives.

17. Donn A. Starry, “Extending the Battlefield,” *Military Review* (March 1981): 31–50; Douglas W. Skinner, “AirLand Battle Doctrine,” Professional Paper 463 (Alexandria, VA: Center for Naval Analyses, September 1988), 1–29; and John L. Romjue, “The Evolution of the AirLand Battle Concept,” *Air University Review* (May–June 1984): 6–8.

18. Del Stewart, *Victory Starts Here: A Short 45-Year History of the US Army Training and Doctrine Command* (Fort Leavenworth, KS: Combat Studies Institute Press, 2018), 48–49; Skinner, 5–11; and Romjue, 5–8.

19. Maj. Gen. Max W. Noah, “Mobility, Countermobility, and Survivability in the Airland Battle,” *Engineer–The Magazine for Army Engineers* (Summer 1981): 18.

20. Noah, 19.

21. Noah, 21.

22. Maj. Gen. Max W. Noah, “Clear the Way,” *Engineer–The Magazine for Army Engineers* (Summer 1981): 3.

23. Noah, 3.

24. Maj. Gen. James N. Ellis, “Clear the Way: Three Key Activities,” *Engineer–The Magazine for Army Engineers* (Summer 1982): 2.

25. Ellis, 2.

26. Ellis, 2–3.

27. Unsigned editorial, “The Engineer School is Reorganizing,” *Engineer–The Magazine for Army Engineers* (Fall 1983): 12.

28. Maj. Gen. James N. Ellis, “Clear the Way: Goals Achieved, Challenges Ahead,” *Engineer–The Magazine for Army Engineers* (Summer 1984): 6.

29. Capt. Ralph H. Graves, “Captains’ Training Strategy,” *Engineer–The Magazine for Army Engineers* (Winter 1983–84): 33–34.

30. Graves, 33–34.

31. Graves, 32.

32. Graves, 32–34.

33. Maj. Gen. Richard S. Kem, *Engineer Memoirs* (Washington, DC: US Army Corps of Engineers Office of History, 2002), 327.

34. Kem, 329.

35. Kem, 329–30.

36. Kem, 23.

37. Kem, 24. See also Maj. Gen. Richard S. Kem, “Clear the Way: Engineer Commandant Stresses Training for Excellence,” *Engineer–The Magazine for Army Engineers* (Fall 1984): 4.

38. “Sappers Lead the Way! Earn the Right!,” Sapper Leader Course History, US Army Fort Leonard Wood website, accessed 5 May 2020, https://home.army.mil/wood/index.php/units-tenants/USAES/Sapper/Sapper/history.

39. Kem, *Engineer Memoirs*, 374.

40. Kem, 374.

41. Kem, 374–75.

42. Kem, Annex C.

43. Kem, Annex C-2.

44. Gustav Person, *BRAC at Fort Belvoir 1988–2011* (Alexandria, VA: Global Printing Company, 2012), 1.

45. Person, 1–3.

46. Director of Management, Memorandum for the Deputy Chief of Staff for Personnel, Subject: Realignment of U.S. Army Engineer School (USAES) Courses, 12 May 1975, US Army Engineer School History Office Archives.

47. Maj. Gen. John G. Waggener, letter to Gen. William E. DePuy, 8 July 1976, US Army Engineer School History Office Archives.

48. Waggener.

49. Waggener.

50. Waggener.

51. Maj. Gen. James A. Johnson, letter to Gen. DePuy, 14 July 1976, US Army Engineer School History Office Archives.

52. Maj. Gen. (Ret.) James A. Johnson, letter to Gen. E. C. Meyer, Chief of Staff, US Army, 17 March 1981, US Army Engineer School History Office Archives.

53. TRADOC Memorandum, Subj: Realignment Feasibility Study—Engineer Training Consolidation, 18 December 1979, 1, US Army Engineer School History Office Archives; and TRADOC, "Realignment Feasibility Study—Engineer Training Consolidation," 18 December 1979, 3, US Army Engineer School History Office Archives.

54. TRADOC Memorandum; and TRADOC.

55. TRADOC Memorandum, 2, ii.

56. Maj. Gen. (Ret.) Johnson, letter to Gen. E. C. Meyer, 17 March 1981.

57. Maj. Gen. (Ret.) Johnson, letter to Maj. Gen. Max Noah, 24 March 1981, US Army Engineer School History Office Archives.

58. Gen. E. C. Meyer, letter to Maj. Gen. (Ret.) Johnson, 4 April 1981, US Army Engineer School History Office Archives.

59. Maj. Gen. Max W. Noah, letter to Maj. Gen. (Ret.) Johnson 30 March 1981, US Army Engineer School History Office Archives.

60. Cited in Karlyn Barker, "Army Studying Proposals to Move Combat Engineers from Fort Belvoir," *The Washington Post* (3 February 1983): B3, US Army Engineer School History Office Archives.

61. Cited in Bass, *History of Fort Leonard Wood*, 127.

62. Cited in Bass, 127–28, 162, 173–76.

63. TRADOC, "Case Study and Justification Folder for Engineer Training and INSCOM (Installation Command) Realignment, CSJF #234 Volume 1 Realignment Summary," 1 November 1983, section 1, 91, 164.

64. TRADOC, section 1, 16–17, 33, 88–91.

65. Kem, *Engineer Memoirs*, 366.

66. Kem, 354.

67. Kem, 354.

68. Kem, 357.

69. "General Orders No. 31, 26 May 1988," Headquarters Department of the Army, Washington, DC, US Army Engineer School History Office Archives.

Chapter 10

The Move to Fort Leonard Wood: From Engineer Center to Maneuver Support Center, 1988–2000

In a period of just eleven years, the Engineer School moved halfway across the continental United States of America while continuing to give first class instruction to its students, only to find itself once again tested by conflict during the Persian Gulf War. The budgetary challenges of the 1990s left marks on many programs of the Engineer Center and the Engineer School. The reorganization and activation of the Maneuver Support Center (MANSCEN) in 1999 marked the end of an era when the Engineer Center at Fort Leonard Wood, Missouri, ceased to exist but at the same time marked the expansion of military training and operations at Fort Leonard Wood for decades to come.

Establishing the Engineer Center and Engineer School at Fort Leonard Wood

The Engineer Center and the Engineer School experienced many substantial and dynamic changes in 1988. The merging of these two entities into "a single center for Engineer training, doctrine, force development and design, and modernization of major systems" at Fort Leonard Wood marked the first time that engineers had a single home in fifty years.[1] The Engineer School resided for nearly seven decades at Fort Belvoir, Virginia. By year's end, it had relocated halfway across the continent and began merging with the Engineer Training Center already at Fort Leonard Wood.[2]

The task of moving and merging two training centers over two years took place in several stages. Relocating officer basic and advanced courses was contingent upon the completion of the headquarters and academic buildings; hence, officer education courses were not transferred to Fort Leonard Wood until the fall of 1989. The last officer courses at Fort Belvoir graduated in December 1989. In fiscal year 1987, the Basic Noncommissioned Officers course was the first course relocated to Fort Leonard Wood and was followed by the Advanced Noncommissioned Officers Course. By the end of fiscal year 1988, the Noncommissioned Officers Academy (NCOA) was fully established at Fort Leonard Wood. Training and combat development functions also began to transfer gradually in fiscal year 1987. The majority of the advanced individual training (AIT) courses, personnel, equipment, and vehicles made the cross-country move in 1988 and 1989, as did the main elements of the school's directorates and departments.[3] In March 1989, the Engineer School's Command Sergeant Major Acie R. Gardner expressed his optimism in the *Engineer–The Professional Bulletin for Army Engineers* about the school's move: "Now that the school has moved to Fort Leonard Wood, the opportunity for our soldiers to expand those skills is greatly increased. We can increase the hands-on, 'get out of the classroom and into the field' training that best provides realism" along with many other opportunities to integrate training at Fort Leonard Wood.[4]

The relocation from Fort Belvoir to Fort Leonard Wood eventually involved changes to three major dimensions. First, new facilities of all kinds needed to be designed, contracted, and constructed. This process began several years before the 1988 arrival of the Engineer School. The new major projects included buildings for headquarters, academic classrooms, training aide support, a technical library, and four bachelor officers' quarters. Several firms bid and received the awards for each of the projects, totaling some $56.5 million. This figure did not include furniture for any of the buildings, which ran $2.3 million for the headquarters and academic buildings and $1.3 million for the library. No money was allotted for additional family housing. Incoming students were expected to live in what already existed on Fort Leonard Wood. Next came the physical transfer of organizations and equipment to Fort Leonard Wood, which included everything from typewriters to major end items of equipment. And finally, the movement of people—both military and civilian along with their families—would be a challenge. The Engineer School's military personnel who had two or more years at Fort Belvoir were not allowed to PCS to Fort Leonard Wood. Vacancies were filled and assigned to Fort Leonard Wood even before some of these courses were taught at Fort Leonard Wood, which meant that these instructors were then sent on TDY orders to Fort Belvoir to teach the courses that had not yet been transferred. Similarly, some of the instructors assigned to Fort Belvoir were not allowed to PCS to Fort Leonard Wood. Those instructors were sent on TDY orders to Fort Leonard Wood to teach already transferred courses. The school, therefore, had a substantial TDY expense trying to maintain quality training at both locations. By December 1988, only about 25 percent of the school's authorized uniformed personnel strength reported to Fort Leonard Wood. Of the 223 civilian employees at Fort Belvoir, only seventy-one chose to transfer with the Engineer School to Fort Leonard Wood; 128 found employment with other agencies, and twenty-three retired or resigned. Replacements for these newly vacated positions needed to be recruited, interviewed, hired, and trained at Leonard Wood amid the transition. It took until the end of 1989 before the Engineer School again employed 220 of the authorized 240 civilians.[5]

In the interim, the Engineer School's directorates, divisions, and departments needed to set up operations and begin training, doctrine writing, and combat developments with understrength staffs. The Department of Military Engineering (DME) Combat Operations Division, for example, had only twelve civilian instructors who moved from Fort Belvoir to Fort Leonard Wood. The Department of Topographic Engineering (DTE) reached a total of thirty-two personnel by adding twenty-one new employees, most of whom did not come from Belvoir. The Department of Combined Arms (DCA) was in no better shape. This personnel shortage meant that on-site instructors carried a heavier teaching load to make up the difference. As new instructors joined a department, they underwent intensive training to ensure a level of competency. Everyone, civilian and military alike, coped with setting up and preparing the new offices, establishing new work procedures, and handling many other tasks taken for granted back at Fort Belvoir.[6]

The Engineer School's move also caused proportional changes to units associated to the two posts. The 4th Engineer Brigade at Fort Belvoir was deactivated in August 1988, while the 554th Engineer Battalion shifted assignment from the 4th Engineer Brigade to the 136th Engineer Brigade at Fort Leonard Wood. Elements of the 554th Engineer Battalion moved to Fort Leonard Wood to administer some of the already transitioning officer courses, while others remained at Fort Belvoir to finish the last training cycles in 1989. Furthermore, the problems caused by faculty shortages at Fort Leonard Wood had instructors traveling back and forth between Fort Leonard Wood and Fort Belvoir to teach courses at both posts.[7]

The most significant event occurred on 31 May and 1 June 1988. On 31 May, the command of the Engineer School at Fort Belvoir passed from the sitting commandant, Maj. Gen. William Reno, to the newly appointed commandant, Maj. Gen. Daniel R. Schroeder. The Engineer School's colors were cased and sent to Fort Leonard Wood, where the TRADOC commanding general, General Maxwell Thurman, uncased and passed those colors to Major General Schroeder on 1 June 1988. This symbolically and substantively made Fort Leonard Wood the new home of the Engineer School and the Engineer Regiment. On 1 October 1988, the post name officially changed to the US Army Engineer Center and Fort Leonard Wood. Just as at Fort Belvoir, the Engineer School was subordinate to the Engineer Center, and the Engineer School's commandant exercised an additional high-headquarters role as the commanding general of the center and the post.[8]

The Engineer School completed its relocation to Fort Leonard Wood by the end of 1989, except for a few straggling elements still at Fort Belvoir. The commandant, Maj. Gen. Daniel R. Schroeder noted in the Foreword to the "Annual Historical Review" for the calendar year of 1989:

> We now train all Engineer soldiers from Private to Colonel here at Fort Leonard Wood, the Army's Engineer Center. The consolidation of the Engineers at Leonard Wood was a monumental effort which required countless hours of effort by soldiers and civilians, both at Fort Belvoir and here at the Engineer Center. This was done in an environment of change . . . and declining resources in manpower and money.[9]

With the move of the Engineer School, eighteen training courses for officers, warrant officers, and noncommissioned officers were brought to Fort Leonard Wood. These amounted to an additional 700–800 students during an average daily training day on Fort Leonard Wood. In 1989, about 31,000 trainees attended Basic Combat Training and Advanced Individual Training in addition to the new courses transferred from Fort Belvoir.[10]

Training, Combat Developments, and Doctrine at the Engineer Center in 1988–90

The Officers Basic Course (OBC) and the Officers Advanced Course (OAC) underwent thorough reviews in 1988 to determine their relevance to current engineering needs. The commandant, assistant commandant, division chiefs, branch chiefs, instructors, and graduates contributed to updating the programs of instruction (POIs). They looked for ways to improve efficiency and address new and continuing trends in the Army.

By the close of 1988, the OAC consisted of ten modules within its new POI:

• Professionalism, which included the common core Army writing program, team building, leadership, and the Army Total Wellness Program.

• Tactics-Doctrinal Foundations, which included tactics and an additional five-hour block on mine/countermine warfare.

• Defensive Tactics, which added instruction on obstacle employment, a six-hour field exercise at Manassas, and an overview of Soviet engineer obstacle breaching capabilities.

• Offensive Tactics, which increased coverage of counter-obstacle operations and added new material on tactical logistics and a five-hour after-action review of the Shenandoah campaign in the Civil War.

• Engineer Doctrinal Foundations, which included quality control, drainage structure inspection, and culvert installation classes; it also replaced quarry operations with construction application of geology.

• Lines of Communication, which added new components on airfield damage repair, asphalt production, and a capstone exercise.

• Basecamps and Contingencies, which included a new scenario based on Southern Command, additional material on electrical utilities, and more on engineer support for contingency operations; the module concluded with a capstone exercise and review on basecamps and on the other two engineering-specific instructions of Engineer Doctrinal Foundation module and the Lines of Communications module.

• Command and Staff, which counted as two modules, devoted time to supply, personnel, maintenance, intelligence, and professional skills and also included two days of mine/demolition training, and a twelve-hour battlefield staff ride.

• The final module was tailored to student follow-on assignments after graduation, such as Combat Heavy, Advanced Terrain Analysis, Advance Light Forces, Advanced Obstacle Tactics, Low Intensity Conflict, and Soviet Military Studies. Allied students also participated and presented their own organizations in this module. The module concluded with various threat briefings.[11]

In addition to restructuring the advanced course, the Department of Military Engineering—the training captain or manager for the advanced course—evaluated the instructional methods. The departmental study revealed that small-group instruction was better than large-group instruction and, therefore, small-group instruction increased during the follow-on advanced courses.[12]

After the successful relocation to Fort Leonard Wood, the OAC prepared to start its first twenty-week residential POIs in January 1990. In all, 342 officers completed the course that year. Closer examination of the backgrounds of those students revealed that only ninety-six officers came from the Army's active component, while 182 were National Guard and Reserve officers. The remaining students included ten Marine Corps officers and fifty-four international students. Some of the Reserve officers could not attend the full twenty weeks of the residential course; therefore, an additional ninety-three officers enrolled in the shorter fourteen-week program or the two-week modular program.[13]

The OAC concentrated on training first lieutenants and captains to be company-level officers. Ideally, they completed this course and moved into command thereafter. To achieve this, several changes were made to the advanced course. The POI shifted away from classroom Department of Combined Arms instruction to more practical exercises or battle-focused training, which was based on the new Field Manuals 25-100 and 25-101. Parallel to these changes and internal to the advanced course, the students also joined their counterparts in the Advanced Noncommissioned Officers Course (ANCOC) for practical problem-solving activities common to company-level units. Another component in the advanced course's POI expanded when military history training added a battle analysis paper requirement and instructors began to use historical examples in their course content.[14]

In 1988, the Department of Combined Arms (DCA), in its role as training captain for the OBC, revised the POI into fifteen weeks of general instruction, plus two weeks covering individual officer future assignments in one of three assignments or tracks: Close Combat Heavy, Close Combat Light, and Combat Heavy (Construction). This became known as the 15+2 POI. Even though the department conducted an internal review of the POI to identify its strengths and weaknesses, no modifications to the POI were made until the course transferred and the first few cycles were completed at Fort Leonard Wood.[15] The 1990 changes made to the Officers Basic Course POI were similar to those changes in the advanced course. The Department of Combined Arms implemented battle-focused training similar to the OAC by the fall of 1990. Blocks of effective writing instruction were revised, and a block of instruction in military history was added, while the use of historical vignettes in other coursework was encouraged. Students enrolling in 1990 also received an eight-hour block of training in operation and maintenance of engineer equipment. This block helped familiarize students with both combat and construction equipment through classroom instruction and hands-on operation.[16]

In 1988, the Department of Combined Arms also conducted a staff ride to the Wilson's Creek Battlefield, some 100 miles southwest of Fort Leonard Wood. This proved to be a professional development opportunity for the seventy civilian and military personnel involved, as well as a fruitful reconnaissance to determine the feasibility and potential of making the staff ride to Wilson's Creek a permanent fixture in POIs. The staff ride achieved both goals due to invaluable support provided by the National

Park Service.[17] By 1990, the department conducted staff rides to Wilson's Creek for the combined OAC and ANCOC. This represented yet another example of shared training and activities within the Engineer School. Another such example was the shared training exercise for OBC, OAC, and ANCOC students which used the vehicle of a tactical exercise without troops. OBC students received operations orders and were required to develop plans to support the order while ANCOC students acted as platoon sergeants and OAC students assumed roles as company commanders. In 1990, about 200 students participated in such shared training exercises.[18]

On 8 August 1988, the first Warrant Officer Advanced Course began at Fort Leonard Wood. The 1st Engineer Brigade assumed overall course administration and support responsibilities and following the first course, parts of the POI had to be rewritten. Subsequent classes were re-designated as the Warrant Officer Senior Course–Common Core and had to be rescheduled or cancelled.[19]

While the officer courses were still at Fort Belvoir during the transition to Fort Leonard Wood, the Noncommissioned Officers Academy/Drill Sergeants School relocated to Fort Leonard Wood on 1 April 1988 and launched its first Basic Noncommissioned Officers Course the following month. The academy became responsible for a variety of noncommissioned officer (NCO) courses to include the Platoon Leadership Development Course, which trained newly promoted or prospective sergeants; almost all of the Basic Noncommissioned Officer Course; the Advanced Noncommissioned Officer Course training in the engineer occupational specialties; and some technical training portions of some specialties that were provided by the 1st Engineer Brigade. The Drill Sergeants School provided needed instruction for select individuals to be drill sergeants. The Initial Entry Training (IET) course instructed cadre in IET units in the training process. The NCO Academy/Drill Sergeants School enrolled more than 2,000 students in 1988; 1,790 NCOs, or 88 percent, graduated from their enrolled courses.[20] During 1989, more courses transferred from the 1st Engineer Brigade into the NCO Academy; in June 1990, a Training and Doctrine Command (TRADOC) accreditation team gave the NCO Academy and the Drill Sergeants School high marks for facilities and POIs.[21] Nevertheless, some problems existed, such as a high failure rate in the Land Navigation Course and sub-standard leadership development counseling that did not address student strengths or weaknesses or make recommendations for improvement. This constituted a serious shortcoming that would require mitigation in the future.[22]

Among the training for other ranks in 1988 and 1989, the 1st Engineer Brigade was responsible for advanced individual training instruction for thirteen engineer skills and two combat service support skills, while the 132nd Engineer Brigade continued to provide both basic and advanced individual training to new engineers.[23] As 1989 came to an end, budget shortfalls forced many courses across TRADOC to reduce hours or be eliminated altogether. The Engineer Center and the Engineer School, however, did not feel the full effect of course cancellations. Instead, the Engineer School reduced the length of advanced individual training for courses such as 12F Tracked Engineer Vehicle Crewman, 62B Engineer Equipment Repairman, 51G Soil Analyst, 81B Draftsman, and 82B Surveyor. None of these courses dropped below the minimum length of four weeks. Despite budgetary challenges, some 6,200 engineer soldiers completed advanced individual training and one station unit training under the 1st and 132nd Engineer Brigades in 1989.[24]

During 1988, the Engineer Center's work in combat developments concentrated on securing new engineer combat vehicles, mine equipment, and topographic devices and production services. The first focus was on the M9 Armored Combat Earthmover or ACE. The engineer in the field needed a reliable armored combat earthmover that could operate on the modern battlefield and keep pace with modern mechanized armored forces. The product of more than thirty years of design and production refinements passed its last necessary tests in 1988, and the Army subsequently released funds to produce the ACE in 1989. What began as an armored dozer became an incredibly versatile workhorse capable of dozing, rough grading, excavating, swimming, and winching in tactical situations. It could be airlifted by any of the Air Force transport aircraft and it kept up with fast-moving armored forces. Not only could it breach obstacles to provide mobility to combat units, but it also could construct defensive positions for countermobility and survivability.[25] The thirty-year-long research, development, and procurement process finally bore fruit when the first nineteen M9 ACEs arrived at Fort Leonard Wood in late 1989. New lesson plans were written for operation and maintenance of the vehicle. These were added into the POIs in the NCO Academy and the basic and advanced officer courses.[26] During the 1980s and following the introduction of AirLand Battle, a number of other engineer vehicles were designed and tested for efficacy in allowing engineers to complete their battlefield missions. Among these were the Counter Obstacle Vehicle (COV), the Combat Mobility Vehicle (CMV), the Combat Gap Crosser (CGC), the Combat Excavator (CEX), the Mine Dispensing Vehicle (MDV), and the Combat Earthmover (CEM).

By the fall of 1988 it became clear to the Engineer School's Directorate of Combat Developments that TRADOC wanted to reduce the overall number of engineer vehicles by combining requirements into as few vehicles as possible. Further testing was cancelled for several of the above-named vehicles. Besides the ACE, the engineers started to field one more piece of new equipment in the late 1980s, the Small Emplacement Excavator (SEE). The SEE was a lightweight, all-wheel drive, diesel engine vehicle which featured a backhoe, bucket loader or utility blade, and other attachments such as a hydraulic rock drill, chain saw, and pavement breaker. The SEE allowed the combat engineer to provide survivability support to the combined arms on the modern battlefield.[27]

The DCD at the Engineer Center also struggled to replace outdated and ineffective mine warfare equipment. A system capable of mobility and countermobility functions at longer distances was needed. The DCD believed the solution could be found in the wide area mine (WAM) effort. Unlike conventional mines that detonate by triggering pressure plates, wide area mines could be detonated at a distance from enemy vehicles and personnel yet still cause lethal damage. It accomplished this by launching an explosive device into the air hitting the enemy vehicle on its likely less-armored roof. The proof of principle was established in 1987 and the proof of principle testing phase continued for several years. Other mine programs such as the Volcano mine dispenser and the Vehicular Magnetic Signature Duplicator (VEMASID) program continued to be tested during the late 1980s. The department added other mine systems, such as the Mine Clearing Line Charge (MICLIC), which could clear an 8-meter-wide by 100-meter-long path through an enemy minefield. US Army Forces Command units received their first MICLICs in 1989, even as testing and improvements continued at Fort Leonard Wood for several years.[28]

In 1989, Combat Developments also worked on modifying the current tank-operated mobile assault bridge, the Armored Vehicle-Launched Bridge or AVLB. The AVLB platform— the M60 main battle tank chassis with an expanded scissor bridge replacing the turret—suffered from several weaknesses. It moved too slowly to keep up with M1 Abrams tanks; lacked survivability of damage from enemy fire; spanned gaps of only eighteen meters; and, most critically, could not bear the weight of seventy-ton M1 tanks. Thus, the AVLB needed to be replaced altogether, and the DCD worked with the Corps of Engineers' Belvoir Research, Development, and

Engineering Center (BRDEC) to find a replacement that mitigated the risks inherent to the AVLB. Possible solutions lay in researching and producing the Heavy Assault Bridge (HAB) or in adopting the German-built Leguan bridge layer. Ultimately in the spring of 1989, the Army chose to adopt the Heavy Assault Bridge design and marry it to the M1 Abrams tank chassis.[29]

Although it was a long-term project, the Engineer Center's combat developers also continued to test and provide input on engineering unit force structures. Over a period of years, the engineers tried to leverage lessons learned during the previous three wars in which Army divisions possessed only a single engineer battalion. In most cases, the single organic engineer battalion was not able to support the division; additional engineering assets had to be acquired. A post-World War II study group and a number of individuals recommended a two-battalion Engineer Divisional Regiment in 1945. The Infantry Division General Board also called for an organic regiment with two battalions, yet the basic system of the single battalion remained consistent for more than two decades and only the size of the divisional battalion fluctuated over the years—ranging from a low of 700 men to a high of almost 1,000 men. The same situation existed on a smaller scale within an Infantry battalion which was supported only by an Engineer platoon. Apart from the limited manpower and equipment, the engineer platoon leader—many times a recent graduate of the Engineer Officer Basic Course—did not have the needed experience or understanding of engineer operations and, therefore, could not competently advise the battalion commander. Under the E-Force concept—later known as the Engineer Restructure Initiative (ERI)—an engineer company would support an infantry battalion; an engineer battalion would support an infantry brigade or regiment; and, finally, an engineer brigade would support a full division.[30] As Schroeder explained in 1989, "Our organizational solution, E-Force, is imperative for the successful execution of [AirLand Battle - Future]. E-Force fixes the present force structure problems."[31] Following several modeling efforts and assessments in 1989, the E-Force concept was completed and approved in June 1990 by the TRADOC commander, General John Foss. The table of organization and equipment was approved by TRADOC in September 1990 and significantly increased the engineer force structure in the mechanized and armored divisions.[32]

The formulation of engineer doctrine in 1988 moved along despite shortages in personnel. Under the auspices of a TRADOC initiative, doctrine was written by instructors who possessed subject-matter expertise and teaching experience in the relevant areas. More importantly, the nuances of doctrine were less likely to be lost in translation between instructors and dedicated doctrine writers. Consequently, the Engineer Center's faculty from the Departments of Combined Arms and Military Engineering bore responsibility for research and writing on tactics, techniques, procedures, and methods into technical, field, and other manuals. Most publications were oriented toward conventional warfare or construction work. Of all the doctrine written, the most effort went into revising Field Manual (FM) 5-100, *Engineer Operations*, which was needed to complete the US Army's seminal Field Manual (FM) 100-5, *Operations.* The engineer concepts were keyed to the AirLand Battle concepts in FM 100-5. TRADOC guidance on doctrinal literature in 1988 called for a reduction of how-to information and a concentration on broad principles, thereby focusing the publication on what engineers must do on the future battlefield with more forceful language compared to previous publications.[33]

The End of the Cold War and Lessons Learned in the Persian Gulf War, 1989–91

With the fall of the Berlin Wall in late 1989 and the eventual dissolution of the Soviet Union on 26 December 1991, the Cold War came to an end. This, of course, didn't mean that US military power would not be challenged by other regional powers competing for local supremacy. In the early morning hours of 2 August 1990, Iraqi troops under the dictatorship of Saddam Hussein launched an overwhelming attack across the border of Kuwait in an unprovoked act of aggression to annex and proclaim tiny but oil-rich Kuwait as Iraq's nineteenth province.[34] On 7 August 1990, President George H. W. Bush approved the deployment of combat forces to defend the Kingdom of Saudi Arabia; the first units of the XVIII Airborne Corps began deploying to Saudi Arabia the very next day.[35] This marked the start of Operation Desert Shield and over the next few months, American troops arrived in the region to support Operation Desert Shield. Some of these units came from Fort Leonard Wood, such as the 515th Engineer Company (Pipeline) and the 5th Engineer Battalion. This latter unit was augmented by additional personnel drawn from the Engineer Center's training units, including the 87th, 577th, and 589th Engineer Battalions. Dozens of other units came to Fort Leonard Wood for specialized engineering training and then deployed to the Middle East.[36]

Apart from personnel, the Engineer Center and the 1st Engineer Brigade sent out mobile training teams (MTTs) to active and reserve component units readying to deploy. These teams provided clarification on doctrine and equipment. They also trained engineers in small units or even individuals as needed. One of the first MTTs assisted the 20th Engineer

Brigade, 18th Airborne Corps at Fort Bragg, North Carolina. The MTT trained the Airborne Engineers in topographic support, obstacle control, logistical support structures, and lessons learned from Combined Training Center rotations of heavy/light engineer forces. From mid-August to the end of September, the Engineer School worked on a formal POI for these MTTs in order to offer deploying and already deployed engineers some common training in support of the upcoming defensive and offensive operations. The final product covered four major areas. The first area dealt with tactical training in threat analysis; engineer estimates and battlefield assessment; offensive and defensive operations; desert reconnaissance; nuclear, biological, chemical (NBC); and Combined Training Center lessons learned. The next area looked at security engineering/force protection; the third area consisted of topics in the combat engineering field, primarily demolitions and mine warfare. The fourth and final area was based on construction engineering to include desert construction, airbase and main supply route maintenance. The new POI ran between thirty-four to forty-six hours and was easily modified by the receiving unit commander depending on the unit's mission. By December, other MTTs deployed to Europe to work with the 18th Engineer Brigade and eight engineer battalions preparing to move into Saudi Arabia. Still more teams supported National Guard and Reserve units being called up for the potential conflict. In addition, the 1st Engineer Brigade sent out new equipment training teams (NETTs) to help familiarize soldiers with new vehicles like the M9 Armored Combat Earthmover (ACE) and new weapons systems like the MICLIC. This instruction anticipated the need to breach Iraqi field fortifications and clear mine fields in support of the US Army's fast-moving armor forces.[37]

Other efforts included the Department of Topographic Engineering's preparation of a terrain overview of the area of operation, and work by other directorates and departments in compiling a *Desert Shield Engineer Handbook.* The Engineer Center also worked with the Belvoir Research, Development, and Engineering Center (BRDEC) to design, test, and install mine rakes large enough to clear a tracked vehicle's entire width.[38]

Meanwhile, Operation Desert Shield was composed of soldiers from an international coalition of thirty-two countries. The combined force not only halted any attempts of an Iraqi advance into Saudi Arabia but also forced Iraq into a static defensive posture along their "new" border with Saudi Arabia. By 16 January 1991, US and coalition military buildup in support of Operation Desert Shield was of historic proportions. With the passing of the midnight 16 January 1991 deadline, the defensive Operation Desert Shield transitioned to the offensive operation known as Operation Desert Storm.[39]

The air phase of Desert Storm began on 17 January 1990; coalition air forces flew thousands of air sorties in the next thirty-eight days before the start of the ground campaign. Finally, on 24 February, American and coalition forces launched their ground campaign with the goal of liberating Kuwait and reducing Iraqi military capabilities. The massive American force included nine Army divisions, two Marine divisions, and two Army armored cavalry regiments. The coalition nations contributed several more divisions. This powerful force defeated the Iraqi Army and pushed its remnants out of Kuwait by 28 February 1991 when a cease-fire was called. Only five to seven of their once forty-three Iraqi combat divisions remained capable of offensive operations. The Iraqi Army lost 3,847 of its 4,280 tanks; over half of its 2,880 armored personnel carriers; and nearly all of its 3,100 artillery pieces.[40]

Engineers played a significant role during Desert Shield and Desert Storm. During Desert Shield, engineers set up defenses along the border as part of countermobility and survivability. Construction units helped build the lines of communication and supply in the unforgiving environment. Topographical units used the latest technology to help create accurate maps of the area of operations for combat commanders. Still other units helped build bases for the coalition in Saudi Arabia and later reconstructed the infrastructure in Kuwait. When the ground campaign began, engineer units were responsible for locating and breaching enemy obstacles, to include berms and minefields. Among these was Fort Leonard Wood's own 5th Engineer Battalion, organized as Task Force 5th Engineer. The unit crossed the berm with the 24th Infantry Division and helped spearhead their advance.[41] Ultimately, 141 Army engineer units deployed to the Persian Gulf, including an engineer command, three engineer brigades, six engineer groups, thirty-two engineer battalions, and ninety-nine separate companies and teams. There were 19,453 engineers from the active component, 2,275 from the Army National Guard, and 1,953 from the Army Reserve, for a total of 23,681 engineers.[42]

Although successful overall, Operations Desert Shield and Desert Storm offered many insights and lessons. The Engineer Center's Directorate of Evaluation and Standardization (DOES) was the central agency for deriving lessons learned from combat engineer operations in Southwest Asia. Even before the initiation of the offensive ground campaign, the directorate coordinated engineer representation on two wartime les-

Figure 10.1. Members of the 72nd Engineer Company, 24th Infantry Division, test a mine-clearing rake attached to an M-728 Combat Engineer Vehicle (CEV) during Operation Desert Storm. Source: US Army Engineer School History Office Archives.

sons learned program (WALLP) teams. The two engineer representatives provided valuable observations of combat engineer activities to engineer units in the field, and these representatives participated in the writing of the Army Desert Storm After Action Report. Following the war, Directorate of Evaluation and Standardization (DOES) analysts developed an extensive Engineer Lessons Learned Collection Plan and conducted oral interviews with engineers regarding vehicles, equipment, training, and leadership. The directorate also collected some 600 documents relating to engineer operations in Desert Shield and Desert Storm.[43] Analysis of engineer operations during the previous seven months revealed a few surprises to the Engineer Center and some of the major insights and lessons, including:

• Verified the fact that the AVLB and the CEV were not able to keep pace with M-1 Abrams tanks and Bradley Fighting Vehicles. This reinforced the belief among engineers that they needed mobile bridging and breaching vehicles.

• Demonstrated the effectiveness of mine rakes and mine plows when mounted on M-1 Abrams tanks, rather than on CEVs.

• Exposed the 50 percent failure rate of MICLICs prior to combat operations. These failures occurred for several reasons such as the lack of familiarity among engineers using the breaching device, quality control problems in production, lack of mobility in the desert environment due to being fired from an attached wheeled trailer, and ineffectiveness against some mines emplaced by the Iraqis. Most of the problems were solvable via more careful training of units and better monitoring of the production process.

• Exposed the relative weakness of US Army hand-held detection devices when the enemy used mines with little metal content. Improving the detection success required engineers to develop better hand-held devices.

• Revealed that the engineers' topographical support in the field could not produce accurate maps quickly enough for maneuver unit commanders. Increasing the speed and accuracy of terrain analysis, map-making, and map distribution was achieved by mounting color printers on vehicles able to drive to the right place at the right time.

• Pointed to the need for better guidance coming down from corps to division or brigade, then to battalion, and on to company.

• Identified the plans as too rigid and conventional. The planning process needed to consider contingencies, including operations "short of war."[44]

Despite some of these critical observations, Major General Schroeder praised the Engineer Center and Engineer School in his end-of-tour exit interview in June 1991. He believed that engineers showed agility in training and operations during Desert Shield and Desert Storm. Schroeder stated:

> Fort Leonard Wood is now the Engineer Center. Everybody recognizes that. We are indeed legitimate, credible players at any discussion having to do with combined arms operations. [During] the pre-deployment training and preparation of the force for Desert Shield/Desert Storm, the [Engineer] School made true contributions to that. Our responsiveness to the field is not matched anywhere else.[45]

The ground phase of Desert Storm might have only lasted 100 hours but the success was in the making since 1982 with the introduction of AirLand Battle doctrine. Even though it was designed to tackle the problem of defending Europe against the Soviet Union and said war against the Soviet Union and the Warsaw Pact never materialized, it did prepare the US military for the fight against Saddam Hussein's forces in the desert of Iraq.

Evolution of Curricula, Doctrine, and Equipment at the Engineer Center, 1991–95

Following the return of American forces from their Persian Gulf War deployments in 1991, the Army and the Engineer Center attempted to return to normalcy. Morale was much higher than at the end of the Vietnam War. Public support also soared high above the sentiments toward that past conflict. Yet the US military suffered from budget and manpower cuts.[46] The active duty Army's 1991 figure of just over 710,000 soldiers steadily slipped to just under 510,000 in 1995 and settled at a little over 480,000 by early 2001.[47]

Like the rest of the US Army, fiscal austerity impeded the Engineer Center's efforts to prepare the next generation of engineers. Nevertheless, even within these limitations, the Engineer Center tried to apply lessons from Desert Shield and Desert Storm in training, professional development, doctrine, combat developments, equipment, and engineering systems. Of these, then-Army Chief of Staff General Gordon Sullivan prioritized the first two—training and professional development—as essential "to maintaining the edge" of well-prepared soldiers.[48] The challenge came in synchronizing those two areas with doctrine. After that, combat developments, equipment, and engineering systems could be aligned accordingly. To put it another way, the Engineer Center needed to match the right balance of courses to the needs of the field.[49]

To help streamline training after the end of the Persian Gulf War, several organizational changes occurred at the Engineer Center. The Departments of Military Engineering and Combined Arms merged to form the Department of Instruction. The director of the resulting department became the overall director for all officer training at the Engineer School. The Department of Instruction's course managers, in turn, assumed responsibility for executing specific courses. For example, the Engineer Officer Advance Course Division served as the course manager for the course named in its title, while the 554th Engineer Battalion served as the course manager for the Engineer Officers Basic Course. Both entities managed their respective courses for the reserve components. The Department of Instruction also took over management of the specialized Pre-Command Course and the Reserve Component Staff Refresher Course.[50]

The Engineer School's reorganization created three new departments, the Departments of Military Engineering, Sustainment, and Motor Maintenance. They fell under the control of the 87th Engineer Battalion and the 58th Transportation Battalion. These departments and units concentrated

on enlisted training. The 87th Engineer Battalion also managed warrant officer training which, for example, graduated thirty-five students in 1991.[51]

In its restructuring, the Engineer School's Department of Topographic Engineering shifted to the Department of Instruction (DOI) and became the Office of Topographic Engineering. The general responsibilities of the office remained the same, but they were able to reduce the personnel by more than 50 percent with the restructure.[52]

With these organizational changes and a few other ones in place, the Engineer Center could turn to the practical aspects of training in 1991. In all, the Department of Instruction and the 554th Engineer Battalion trained 900 students in the Engineer Officer Basic Course, 449 in the Engineer Officer Advance Course, 90 in the Engineer Officer Basic Course – Reserve Component, 70 in the Reserve Component Company Commander's Course, and 40 in the Pre-Command Course. The NCO Academy graduated more than 1,300 students, of which more than 200 were connected to the mobilization efforts of Reserve components in support of Desert Shield and Desert Storm. Lastly, some 20,000 new enlistees passed through the initial entry training, and another 4,000 soldiers received advanced individual training as engineers.[53]

Figure 10.2. Mine detection training at Fort Leonard Wood in the 1990s. Source: US Army Engineer School History Office Archives.

The Engineer School began to change the Engineer Officer Basic Course's POI beginning in February 1991 even as the Persian Gulf War started. The 554th Engineer Battalion initiated a "soldierization" phase in the Engineer Officer Basic Course. During their first three weeks at the Engineer School, students went through a civilian-to-military transition that included training and evaluation of common military skills, such as land navigation, rifle marksmanship, and weapons familiarization. This occurred in part because the Reserve Officer Training Corps, Officer Candidate School, and US Military Academy did not provide consistent levels of exposure to future second lieutenants in their respective training regimens. These deficiencies became obvious in the rapid mobilization of US forces sent to the Persian Gulf in 1990 and 1991. This three-week-long phase also entailed physical fitness, mathematics, and English testing. In sum, the Engineer School tried to provide a baseline of skills and knowledge to build on during the rest of the Engineer Officer Basic Course.[54]

Late in 1991, the 554th Engineer Battalion added some more components to the Engineer Officer Basic Course's POI, such as a new course to prepare lieutenants who planned to take the Ranger Program. In response to feedback from former students as well as the Ranger School, the battalion's Company D developed a Ranger preparation course. The 554th also consolidated two field training exercises into a single sixteen-day exercise which combined warrior training with sapper training and a tactical leadership course. This decision made the flow of classroom work and use of the training areas more efficient.[55]

The POIs of other engineer courses also evolved during the decade. For example, in 1993, new classes were devoted to operations other than war, including countermine operations, combatting terrorism, and noncombatant evacuations. POI changes were consistently examined and many recommendations were made by instructors as well as students. One major recommendation was increasing shared training opportunities between the officers and their NCO counterparts. Eventually, both officer courses participated in shared training with NCO Academy students, with the goal of increasing effective command and control in small units. The changes were, however, relatively minor in total time commitment in the POIs.[56]

During the decade after the Persian Gulf War, ongoing budget cuts hampered many Engineer School activities. Engineer School Commandant Maj. Gen. Daniel W. Christman recalled in his 1993 end-of-tour exit interview how "very, very tough" it was for him to continue to maintain quality training "while spending fewer dollars against those training re-

Figure 10.3 Soldiers from 554th Engineer Battalion learning to build a medium girder bridge at Fort Leonard Wood in the 1990s. Source: US Army Engineer School History Office Archives.

quirements."[57] His entire budget at Fort Leonard Wood and the Engineer Center dropped from $110 million in 1991 when he arrived, to $75 million when he transferred to his next post in 1993, yet there was only a slight reduction in the training load associated with both budgets. In fact, during Chrisman's interview, he assessed his efforts in an environment with such limited resources and funding as being successful:

> We have cut by almost a third the resources devoted to a fixed training product and still, I think, are doing darn well in producing soldiers for our war-fighter commanders and chiefs. . . . We've done that by flattening and organization across to the board making [the post and Engineer Center] much, much leaner. We've done it by dusting ourselves in many instances of activities not central to our training mission.[58]

Some "flattening" and "dusting" came from increasing coordination among the various departments and training units that sometimes suffered from overlapping or duplicated efforts.[59]

The deepening budgetary constraints in the 1990s forced the Defense Department in general and the Engineer Center in particular to reduce expenses. One of the main cost-saving programs, known as Interservice Training Requirements Organization (ITRO), consolidated and combined training across several branches of the armed services to save some resources.[60]

In 1994, a decision was made that the cost savings by combining motor transport operator training at Fort Leonard Wood had budgetary benefits and, therefore, the course was consolidated by 1995. Projections set the training load at 8,000 Army and Air Force students per year by 1996. In addition to the resources already at Fort Leonard Wood, instructors and personnel moved from Fort Eustis and elsewhere to Fort Leonard Wood.[61]

In late 1993 and early 1994, the ITRO process was also applied to civil and construction engineering training. This led to relocating the US Navy's Engineering Aide training from Gulfport, Mississippi, to the Engineer Center. Later, all engineer equipment operator training for all services merged at the Engineer Center while other courses moved to other bases, such as the training for the Army plumbers relocating to Sheppard Air Force Base, Texas. This drew instructors and materiel from several other posts and bases to Fort Leonard Wood. Changes in training occurred as soldiers, sailors, marines, and airmen brought their own institution field manuals with them. These needed to be integrated into coherent POIs. It is also worth noting that some engineer military occupational specialties relocated elsewhere (e.g., carpenter training relocated to the Naval Construction Training Center in Gulfport).[62]

Most of the planning and some of the execution of the ITRO relocations and consolidations occurred during Maj. Gen. Joe N. Ballard's commandancy from 1993 to 1995. In his end-of-tour exit interview, he shared a great sense of pride because he worked hard to bring ITRO to Fort Leonard Wood. This Army post, according to Ballard, had ceased to be an Army green installation but a "purple suit installation . . . we drove it home during my watch and it was a deliberate process on my part to really protect this installation from any future [base closure] or downsizing initiative by making it a DOD installation."[63] By the time Ballard departed from Fort Leonard Wood and the Engineer Center in 1995, the ITRO programs had expanded to nearly 400 joint courses. Among these were the Army-run foreign languages training at the Presidio in Monterrey, California; the Air Force-run dog handler training at Lackland Air Force Base in San Antonio, Texas; and the Navy's metal-working training in Memphis, Tennessee. In addition to cutting costs, joint courses offered the benefits of cross-fertilization among the different services.[64]

Despite the budgetary constraints facing the Engineer Center, engineers continued to revise outdated doctrines, codify current ones, and

formulate new doctrine. The Engineer Center's 1992 "Annual Command History" stated that the Engineer Center's doctrinal priority "continued to be preparedness to conduct combat operations at all levels of the operational continuum worldwide."[65] This work required aligning engineering doctrine with the Army's later iteration of FM 100-5. Major General Christman and other key officers assembled a steering committee to ensure emphasis and continuity. With this initiative, TRADOC also coupled the rapid development of joint manuals such as *Operations Other Than War* and *Echelons Above Corps*, which received the most attention from the committee. The committee also directed the Engineer Center's doctrine to add material to the engineer capstone FM 5-100. The subsequent revisions to FM 5-100 and other engineering publications served as guides on "how to fight" and "what to do." The following manuals addressing operations other than war appeared in 1992 and shortly thereafter:

- Field Manual (FM) 5-114, *Engineer Operations Short of War*
- Field Manual (FM) 100-19, *Domestic Support Operations*
- Field Manual (FM) 100-23, *Peace Support Operations*

Other manuals covered roles and expectations for combat engineering units:

- Field Manual (FM) 5-10, *Engineer Platoon*
- Field Manual (FM) 5-71-3, *Brigade Engineer Combat Operations (Armored)*
- Field Manual (FM) 5-71-2, *Task Force Engineer and Engineer Company Combat Operations*
- Field Manual (FM) 5-7-30, *Brigade Engineer and Engineer Company Combat Operations*
- Field Manual (FM) 5-71-100, *Division Engineer Combat Operations*
- Field Manual (FM) 5-100-15, *Corps Engineer Combat Operations*

In addition to these two areas, the Engineer Center compiled field manuals applying doctrine and tactics, techniques, and procedures to the five engineering functions of mobility, countermobility, survivability, sustainment engineering, and topographical engineering. In all, more than thirty-five manuals were started, continued, or completed in the years following the Persian Gulf War.[66] These manuals aligned engineer units of all sizes with the doctrine supporting maneuver units in the combined arms. Such field manuals maintained the branch's relevance on the post-Cold War battlefield. This work tended to focus on conventional operations, not much different than those planned during the Cold War. Slowly, however, other contingencies like operations other than war began to appear in the doctrinal publications. They incorporated engineering missions into joint operations, such as in Joint Chiefs of Staff Publication 3-15, *Joint Doctrine Barriers, Obstacles, and Mine Warfare.* The publications also affected and were affected by evolving training POIs and engineering systems.[67]

Meanwhile, in the early 1990s, the Engineer Center's combat developers worked to identify critical shortcomings from the Persian Gulf War, forecast what systems might be required in future operations, and then match new engineering systems to those needs. The new doctrine and training courses likewise demanded equipment and vehicles capable of meeting the branch's operational responsibilities. In his 1993 end-of-tour exit interview, Major General Christman emphasized the need for newer, better systems:

> There's nobody that's questioning, it seems to me, the engineer role for disaster relief. . . . But there's always folks out there that would argue that the role of the battlefield, narrowly defined the shooting battlefield, is something that might be picked up by others. History has shown the unique contributions we [engineers] make on the battlefield. We have got to be able as a branch to sell that uniqueness and that's why the equipment piece, to come full circle on this, is so vital to the future of the base. If we go out there in the year 2000 with dump trucks when we're supporting a combined arms teams equipped with Bradleys and M1s, our relevance will justifiably be questioned and we can't let that happen.[68]

Christman's quote is as valid today, which makes his statement a timeless argument in the fight to maintain engineer relevance in combat operations.

Despite the clear need for innovation, the budgetary constraints made research, development, and procurement of new systems difficult at best. The process of nurturing equipment from concept design into operational reality could take years and even decades in the best circumstances. Among the most conspicuous areas needing innovation were specialized engineer vehicles that could breach obstacles and bridge gaps. The existing platforms—the CEV and AVLB—proved incapable of keeping pace with the fast-moving armor campaign of Desert Storm. Other problems became apparent as well and ranged from the CEV's lack of horsepower to push a mine-clearing rake to the maximum weight the AVLB could support. The subsequent losses of mobility would prove to be hazardous in future operations where maneuver commanders needed these mobility and sustainment capabilities.[69]

The solution to the Engineer Branch's deficiencies in breaching and bridging vehicles lay in leveraging the M1's chassis and engine. In 1991, the Engineer Center's combat developers received seed funding and began working to modify the M1 chassis to serve as bridging and breaching vehicles. Thus, the Combat Mobility Vehicle (CMV) "Grizzly" and the Heavy Assault Bridge (HAB) "Wolverine" were designated as superior replacements for the obsolete CEV and AVLB, respectively.[70] The Engineer Center ranked these two engineering vehicles as top priorities in 1994.[71]

As commandants from 1989–95, Major Generals Schroeder, Christman, and Ballard shepherded the Wolverine and the Grizzly in their early stages of funding and testing. During Ballard's 1995 end-of-tour exit interview, he recalled:

> Obtaining a robust force development, materiel development budget line[s], and getting the thing[s] designed which will protect us for the next five years fiscally and convincing the Department of the Army that they needed to make the capital investment in engineers was a tremendous accomplishment because for the first time we now had a truly robust modernization program . . . we have never had that. [72]

The Grizzly and the Wolverine represented not only specific improvements in breaching and bridging, but also a means to maintain the Engineer Branch's relevance in the Army.

The Engineer Center's combat developers did not limit their efforts to these two vehicles. They also devoted years to testing and fixing problems on the ACE and the Improved Ribbon Bridge. In topographical engineering, a new Digital Topographical Support System was nearing completion in 1993. In mine warfare, new technologies allowed development and field testing of more effective mine warfare systems. Among these were the Standoff Minefield Detection System, Multiple Delivery Mine System "Volcano," and the WAM program. Finally, ongoing improvements were made in the reliability and mobility of the MICLIC. The ongoing progress in these projects was a major accomplishment for the Engineer Center's combat developers, who continually struggled with personnel and resource shortages.[73]

Despite great strides in updating engineering doctrine, training, and equipment under severe fiscal constraints in the early 1990s, the Engineer School was not able to improve every critical capability equally well. Mine warfare, for instance, lagged behind the advances made in mobile bridging and breaching vehicles. Ballard lamented in his 1995 end-of-tour exit interview:

> The Engineer School used to be the world leader in [mine warfare]. We no longer even teach as a primary course booby-trapping and force protection. As a force protection of the Army, and that's the engineer responsibility, we need to reinvent that.[74]

His words proved to be a forewarning regarding the challenges that engineers were about to face in upcoming military operations in former Yugoslavia and the Middle East.

Force XXI and its Effects on the Engineer School, 1994–2000

In March 1994, Army Chief of Staff General Gordon R. Sullivan ordered the start of a major campaign effort to prepare the Army for the early years of the twenty-first century. The Force XXI redesign was a significant change from previous efforts, with the goal to include some major operational reorganizations and technological advances which would secure victory in the twenty-first century. Force XXI became the first force redesign that used emergent, computer-driven virtual simulation methods combined with live field simulations to test and analyze military unit designs. Because Force XXI required new training and doctrine to support soldiers and units, TRADOC took on major roles in both these functions. The Engineer Center and other branch schools used their lessons learned offices and battle laboratories to create simulations and wargames capabilities exploring their respective branch's units, weapons systems, and vehicles. For example, the first so-called Advanced Warfighting Experiment occurred in 1994 at the National Training Center (NTC) at Fort Irwin, California. The NTC's own specially trained opposing force fought a simulated battle against a brigade-level contingent from the 4th Infantry Division (Mechanized). This division's soldiers tested the digital communications and displays that gave them nearly real-time information. The experiment at the NTC failed insofar as the 4th Infantry Division's soldiers were not sufficiently familiar with the new technologies, but data from the simulated battles offered many areas for future training, doctrine, and research and development. Over time, other Advanced Warfighting Experiments followed and tested those refinements of digital resources, force structure, weapons systems, and other elements.[75] The changes coming out of Force XXI played significant roles in dictating many lines of effort at the Engineer School for the rest of the decade. This included doctrine, training, combat developments, and force structure ranging from Force XXI to operations other than war.[76]

Two of the most significant lines of effort were the previously discussed research, development, and testing of the M1 Breacher (Grizzly) and the Heavy Assault Bridge (Wolverine). These two vehicles were, for the engineers, the obvious priorities because they upgraded the aging and obsolete CEV and AVLB. The Grizzly and the Wolverine more closely matched the needs of the modern, mobile armored units within the new maneuver-oriented battlespace. Throughout the late 1990s, the School's Engineer Force Simulations Centers worked to create the proper number of lanes and right equipment to test the Grizzly in deliberate breaching operations.[77] Relevant testing, as well as accurate modeling and critical analysis, would only occur if the two commandants—Maj. Gens. Clair F. Gill (1995–97) and Robert B. Flowers (1997–2000)—could procure sufficient funding. This proved no easy task because they needed to convince TRADOC senior leaders of the value and viability of the Grizzly and Wolverine; then the school commandants and TRADOC leaders needed to secure funds in the Department of the Army's resource-poor environment.[78] The engineers did find some cost-saving workarounds within their limited budgets thanks to increased use of simulators and simulations in newly established Engineer School classrooms geared toward computer-based instruction.[79] Flowers stated that during his commandancy, "We justified the Grizzly and Wolverine systems and we now have the Wolverine in production . . . we're still fighting hard with Grizzly."[80]

Although among the most expensive and conspicuous, the Grizzly and the Wolverine were hardly the only pieces of equipment the Engineer School tried to innovate or upgrade. Among others were the Digital Topographic Support System, modern mine systems, and an engineer-specific version of the Bradly Fighting Vehicle. These priorities were outlined in documents like the *Prioritization Paper for the Engineer Future Capabilities* and the *Engineer 1999 Future Operational Capabilities*. These documents and coinciding discussions identified engineer branch future needs: overcome barriers, obstacles, and mines; conduct river crossing operations; conduct countermobility operations to disrupt, fix, turn, and block enemy movements; provide general engineer support; and protect individuals and systems from enemy attack. Although looking to the future and using slightly different terminology, these needs equated to timeless combat functions of mobility, countermobility, survivability, and sustainment engineering.[81]

The Wolverine and the Grizzly, for example, provided necessary capabilities for engineers to perform several future needs. Meanwhile, most factors played into the ongoing development of the Wolverine and Grizzly.

In terms of training, additional skill identifiers needed to be created and approved so that engineers could receive the proper instruction and certifications to operate the Grizzly and Wolverine. These needed to be added into the POI for the 12B (Combat Engineer) military occupational specialties. But, again, low budgets constantly handicapped the school's work to acquire working prototypes to train soldiers on the new equipment.[82]

Just as the first Grizzly rolled off the assembly line and as the efforts to correct glitches began, the new Army Chief of Staff General Eric K. Shinseki cancelled the Grizzly program at the end of the decade. Instead, he redirected the resources toward the new concept of Army Transformation. The Wolverine fell victim to similar logic when it was cancelled shortly thereafter.[83] As commandant from 1997 to 2000, Maj. Gen. Robert B. Flowers spent much of his time managing the expansion of Fort Leonard Wood and the integration of the Military Police and Chemical Schools. He tried to set up the structure and establish relationships among the three schools in the new Maneuver Support Center at Fort Leonard Wood.[84]

Reorganization under the Maneuver Support Center, 1995–99

Under the 1995 provisions of the Base Realignment and Closure Act, the secretary of the Army announced the closure of Fort McClellan, Alabama, and the relocation of the Chemical and Military Police Schools to Fort Leonard Wood. Over the next four years, the staff of the two installations and the three schools worked together to develop a structure for the Maneuver Support Center (MANSCEN). TRADOC Commander General William Hartzog rejected the idea of simply relocating the two schools and, therefore, having three independent branch schools at Fort Leonard Wood. Integration of functions and economy was the goal. Finally, on 1 October 1999, MANSCEN was formally activated at Fort Leonard Wood. With the activation of MANSCEN, the installation ceased to be the Engineer Center but became an integrating center with all three schools.[85]

MANSCEN combined some functions, primarily training development and combat development efforts. The Directorate of Combat Development (DCD) and Directorate of Training Developments (DOTD) became separate MANSCEN organizations reporting to the MANSCEN commander. Each directorate was divided into subgroups. The DOTD had Warrior, Warfighter, WARMOD (modernization training), and Development Support departments. The personnel responsible for engineer training developments were in the first three departments and essentially performed as they had before. The same was true of the combat development effort. The DCD had divisions for each of the branches, and the DCD also had Analysis and Simulation and Robotics Technology divisions as well as a program management office. To ensure that branch personnel remained responsive to the needs of each school, the senior branch officer in each directorate was rated by the director and senior-rated by the respective school commandant. Like the DOTD, the Maneuver Support Battle Lab did not have specific branch cells in its organizational structure; it reflected the three major efforts of the lab, which were the mechanized force/Division Capstone Exercise, the light force/Joint Contingency Force, and the brigade combat team.[86]

Due to the creation of MANSCEN, the professional development of officers, warrant officers, and NCOs was consolidated. The Directorate of Common Leader Training was created to manage and conduct instruction common to all three branches present at MANSCEN. Branch-specific instruction remained the responsibility of the schools. The old Engineer School leadership reorganized the school proper with the remaining resources—establishing two main organizations that fell under the Engineer School, the Directorate of Training (DOT), and the 1st Engineer Brigade. In addition to the two main organizations, the Engineer School had a small integration cell for doctrine, training, leader development, organization, material, soldier's issues, and some National Guard and Army Reserve advisors.[87]

The Directorate of Training (DOT) formed the Department of Instruction, which carried out most of the instruction for the officer and warrant officer professional development programs. Most of the personnel for the Directorate of Training came from the Department of Tactics, Leadership, and Engineering (DTLE) in the recently terminated old structure. The rest of the Department of Tactics, Leadership, and Engineering manpower was transferred to the MANSCEN Directorate of Common Leader Training. The Directorate of Training gained the Engineer Personnel Proponency Office (EPPO), which previously was a separate directorate-level organization. The Directorate of Training also gained the Total Army School System (TASS) division and the Doctrine Development Division from the old DOTD. The Engineer Personnel Proponency Office, the Total Army School System, and the Doctrine Development division performed the same functions as before.[88]

The second main organization under the newly reorganized Engineer School was the 1st Engineer Brigade. The brigade, previously under the administrative control of the garrison commander, was aligned under the Engineer School. But with the establishment of MANSCEN, the 1st Engineer Brigade lost the 58th Transportation Battalion to the 3rd Chemical Brigade. The move was needed to create a chemical brigade of sufficient size to justify a full colonel as the brigade commander. The brigade's headquarter detachment was expanded to a headquarters and headquarters company. The primary functions and tasks performed by the brigade changed little with the alignment.[89]

The creation of MANSCEN had several substantive impacts on the Engineer School proper, including losing personnel to organizations directly aligned under MANSCEN such as DOTD, DCD, and the Directorate of Common Leader Training. In other instances, the reorganization shifted manpower to include administrative staff, which left fewer personnel to perform administrative and mission support functions needed at the Engineer School proper. An even bigger and more important impact was on the functions of the Engineer School itself. The school had the responsibility for training engineer officers and NCOs and the development of training products and literature needed to perform this task in-house and non-resident for the last fifty years prior to the establishment of the MANSCEN. The school also was responsible for combat, concept, and force structure development following the 1972 Operation Steadfast reorganization. The school's leadership reorganized the institution to achieve greater efficiency, coordination, cooperation, and integration of the school's staff throughout the years. The Engineer School commandant, as proponent for the engineer branch, had been responsible for these functions for the previous twenty-eight years. Under the new MANSCEN structure, the Engineer School commandant no longer had direct control and supervision over some of the school's traditional functions. The added problems of inter-departmental coordination and cooperation, which commandants tried to resolve through various reorganizations in prior years, were further complicated because some of these functions now were outside of the Engineer School structure. By the end of 1999, the Engineer School's "Annual Command History" concluded that even though the Engineer School and the 1st Engineer Brigade were firmly established in their reorganized structure, "it was not possible to determine if the synergy and resource savings generated by the consolidation of some functions under MANSCEN control was greater than the difficulties encountered in accomplishing proponents tasks for the branch and the Army."[90] The following years would show that more reorganizations were necessary to improve operations at all three of the schools under MANSCEN control.

Conclusion

The Engineer School's late 1980s move from Fort Belvoir to Fort Leonard Wood—combined with the many challenges of the 1990s that the United States military and the Engineer School experienced—was significant in many arenas. Tremendous budget cuts, the move to digitization in training and combat development, and a major reorganization which meant the loss of even more resources were all tests the Engineer School had to overcome in order to survive and launch itself into the twenty-first century under the new MANSCEN structure.

Notes

1. US Army Engineer School, "Annual Historical Review, 1 January 1988–31 December 1988," June 1989, Foreword, US Army Engineer School History Office Archives.

2. US Army Engineer School, I, 1.

3. US Army Engineer School, 3–4; US Army Engineer School, "Annual Historical Review, 1 January 1989–31 December 1989," July 1990, 17, US Army Engineer School History Office Archives.

4. Command Sergeant Major Acie R. Gardner, "Bridge the Gap," *Engineer–The Professional Bulletin for Army Engineers* (March 1989): 3.

5. US Army Engineer School, "Annual Historical Review, 1 January 1988–31 December 1988," 1–3, 7; and US Army Engineer School, "Annual Historical Review, 1 January 1989–31 December 1989," 3.

6. US Army Engineer School, "Annual Historical Review, 1 January 1989–31 December 1989,“ 1–2.

7. US Army Engineer School, "Annual Historical Review, 1 January 1988–31 December 1988," 5–6.

8. Maj. Gen. Daniel R. Schroeder, "Exit Interview," 11 June 1991, 6–7, US Army Engineer School History Office Archives; and US Army Engineer School, "Annual Historical Review, 1 January 1988–31 December 1988," 5.

9. US Army Engineer School,"Annual Historical Review, 1 January 1989–31 December 1989."

10. US Army Engineer School, "Annual Historical Review, 1 January 1988–31 December 1988," 7; and Paul W. Bass, *The History of Fort Leonard Wood, Missouri* (Morley, MO: Acclaim Press, 2016), 161.

11. US Army Engineer School, 17–18.

12. US Army Engineer School, 18.

13. US Army Engineer School, "Annual Historical Review, 1 January 1990–31 December 1990," July 1991, 18, US Army Engineer School History Office Archives.

14. US Army Engineer School, 19–20.

15. US Army Engineer School, "Annual Historical Review, 1 January 1988–31 December 1988," 19.

16. US Army Engineer School, "Annual Historical Review, 1 January 1990–31 December 1990," 21.

17. US Army Engineer School, "Annual Historical Review, 1 January 1989–31 December 1989," 18.

18. US Army Engineer School, "Annual Historical Review, 1 January 1990–31 December 1990," 21–22.

19. US Army Engineer School, "Annual Historical Review, 1 January 1988–31 December 1988," 22.

20. US Army Engineer School, 22–23.

21. US Army Engineer School, "Annual Historical Review, 1 January 1989–31 December 1989," 21–22.

22. US Army Engineer School, "Annual Historical Review, 1 January 1990–31 December 1990," 23.

23. US Army Engineer School, "Annual Historical Review, 1 January 1988–31 December 1988," 23.

24. US Army Engineer School, "Annual Historical Review, 1 January 1989–31 December 1989," 22–24.

25. Lt. Col. Robert J. Sperberg and Capt. Craig S. Pickett, "ACE—The Armored Combat Earthmover," *Engineer–The Professional Bulletin of Army Engineers* (March 1990): 20–23; and US Army Engineer School, "Annual Historical Review, 1 January 1988–31 December 1988," 42–44.

26. US Army Engineer School, "Annual Historical Review, 1 January 1989–31 December 1989," 25.

27. US Army Engineer School, "Annual Historical Review, 1 January 1988–31 December 1988," 44–47.

28. US Army Engineer School, 47–50; and US Army Engineer School, "Annual Historical Review, 1 January 1989–31 December 1989," 65.

29. US Army Engineer School, "Annual Historical Review, 1 January 1989–31 December 1989," 69–71.

30. US Army Engineer School, "Annual Historical Review, 1 January 1988–31 December 1988," 64–66.

31. Maj. Gen. Daniel R. Schroeder, "Clear the Way," *Engineer–The Professional Bulletin of Army Engineers* (March 1989): 2.

32. US Army Engineer School, "Annual Historical Review, 1 January 1989–31 December 1989," 56–59; and US Army Engineer School, "Annual Historical Review, 1 January 1990–31 December 1990," 43–44.

33. US Army Engineer School, "Annual Historical Review, 1 January 1988–31 December 1988," 59–60.

34. James Blackwell, *Thunder in the Desert: The Strategy and Tactics of the Persian Gulf War* (New York: Bantam Books, 1991), 69–73.

35. Frank N. Schubert and Theresa L. Kraus, *The Whirlwind War: The United States Army in Operations Desert Shield and Desert Storm* (Washington, DC: US Army Center of Military History, 1995), 49–52.

36. US Army Engineer School, "Annual Historical Review, 1 January 1990–31 December 1990," 76–77; and US Army Engineer School, "Annual Command History, 1 January 1991–31 December 1991," July 1992, 81–82, US Army Engineer School History Office Archives.

37. US Army Engineer School, "Annual Historical Review, 1 January 1990–31 December 1990," 73–76.

38. US Army Engineer School, 73–74, 76–77.

39. Field Manual (FM) 3-0, *Operations* (Washington, DC: 6 October 2017), 4-2.

40. Center of Military History (CMH) Publication 70–117–1, *War in the Persian Gulf: Operations Desert Shield and Desert Storm August 1990–March 1991* (Washington, DC: US Army Center of Military History, 2010), 29–35, 63.

41. US Army Engineer School, "Annual Command History, 1 January 1991–31 December 1991," 84, 87–88; and US Army Corps of Engineers History Office, "Historical Vignette 041 – Operations Desert Shield and Desert Storm," January 2002, http://www.usace.army.mil/About/History/Historical-Vignettes/Military-Construction-Combat/041-Desert-Storm/.

42. Janet A. McDonnell, *After Desert Storm: The U.S. Army and The Reconstruction of Kuwait* (Washington, DC: 1999), 30.

43. US Army Engineer School, "Annual Command History, 1 January 1991–31 December 1991," 91.

44. US Army Engineer School, 91–94; and Vernon Lowrey, "Initial Observations by Engineers in the Gulf War," *Engineer–The Professional Bulletin of Army Engineers* (October 1991): 42–48.

45. Schroeder, "Exit Interview," 21.

46. Schroeder, 32–33; and Maj. Gen. Daniel W. Christman, "Exit Interview," 21 July 1993, 2–3, US Army Engineer School History Office Archives.

47. Garry L. Thompson, "Army Downsizing following World War I, World War II, Vietnam, and a Comparison to Recent Army Downsizing" (MMAS thesis, US Army Command and General Staff College, Fort Leavenworth, KS, 2002), referenced in Russell F. Weigley, *History of the United States Army*, enlarged ed. (Bloomington, IN: Indiana University Press, 1984), 596–97.

48. Maj. Gen. Daniel W. Christman, "Clear the Way," *Engineer–The Professional Bulletin of Army Engineers* (February 1992).

49. Christman.

50. US Army Engineer School, "Annual Command History, 1 January 1991–31 December 1991," 1–2.

51. US Army Engineer School, 3, 26.

52. US Army Engineer School, 3.

53. US Army Engineer School, 26–29.

54. US Army Engineer School, 26.

55. US Army Engineer School, 26–27.

56. US Army Engineer School, "Annual Command History, 1 January 1994–31 December 1994," July 1995, 30–31, US Army Engineer School History Office Archives.

57. Christman, "Exit Interview," 9.

58. Christman, 9.

59. US Army Engineer School, "Annual Command History, 1 January 1993–31 December 1993," August 1994, 23, US Army Engineer School History Office Archives.

60. US Army Engineer School, 23.

61. US Army Engineer School, "Annual Command History, 1 January 1994–31 December 1994," 29.

62. U.S. Army Engineer School, 29–30.

63. Maj. Gen. Joe N. Ballard, "Exit Interview," 6 June 1995, 8, US Army Engineer School History Office Archives.

64. Henry Viccellio Jr., "The Joint Challenge of Interservice Training," *Joint Force Quarterly* (Spring 1995): 44–45.

65. US Army Engineer School, "Annual Command History, 1 January 1992–31 December 1992," June 1993, 40, US Army Engineer School History Office Archives.

66. US Army Engineer School, 40–50.

67. US Army Engineer School, 40.

68. Christman, "Exit Interview," 11.

69. US Army Engineer School, "Annual Command History, 1 January 1991–31 December 1991," 52–55; US Army Engineer School, "Annual Command History, 1 January 1992–31 December 1992," 52–53; and Maj. Gen. Joe N. Ballard, "Exit Interview," 6 June 1995, 3, US Army Engineer School History Office Archives.

70. US Army Engineer School, "Annual Command History, 1 January 1991–31 December 1991," 52–55.

71. US Army Engineer School, "Annual Command History, 1 January 1994–31 December 1994," 55.

72. Ballard, "Exit Interview," 8.

73. US Army Engineer School, "Annual Command History, 1 January 1991–31 December 1991," 57–60; US Army Engineer School, "Annual Command History, 1 January 1992–31 December 1992," 53–55; and US Army Engineer School, "Annual Command History, 1 January 1993–31 December 1993," 44–48.

74. Ballard, "Exit Interview," 9.

75. Benjamin King, *Victory Starts Here: A 40-Year History of the US Army Training and Doctrine Command* (Fort Leavenworth, KS: Combat Studies Institute Press, 2013), 20-21; and TRADOC Pamphlet 525-5, *Force XXI Operations* (Washington, DC: US Government Printing Office, August 1994).

76. Ballard, "Exit Interview," 1–2.

77. US Army Engineer School, "Annual Command History, 1 January 1996–31 December 1996," August 1997, 53, US Army Engineer School History Office Archives.

78. US Army Engineer School, "Annual Command History, 1 January 1997–31 December 1997," March 1999, 58–59, US Army Engineer School History Office Archives; and US Army Engineer School, "Annual Command History, 1 January 1998–31 December 1998," September 1999, 46, US Army Engineer School History Office Archives.

79. US Army Engineer School, "Annual Command History, 1 January 1999–31 December 1999," June 2000, 12, US Army Engineer School History Office Archives.

80. Maj. Gen. Robert B. Flowers, "Exit Interview," 24 August 2000, 40, US Army Engineer School History Office Archives.

81. US Army Engineer School, "Annual Command History, 1 January 1999–31 December 1999," June 2000, 12–14, US Army Engineer School History Office Archives.

82. US Army Engineer School, 19.

83. US Army Engineer School, 31–32.

84. Flowers, "Exit Interview," 24 August 2000, 1–23, US Army Engineer School History Office Archives.

85. US Army Engineer School, "Annual Command History, 1 January 1999–31 December 1999," Foreword, 1.

86. US Army Engineer School, 1–2.

87. US Army Engineer School, 2.

88. US Army Engineer School, 2.

89. US Army Engineer School, 3.

90. US Army Engineer School, 3–4.

Chapter 11
The Engineer School at Fort Leonard Wood: The Transition to Counterinsurgency Operations and Back to Large-Scale Combat Operations, 2000–20

The first two decades of the twenty-first century were defined by the fast-changing US geopolitical landscape. To keep pace with contemporary and potential future military operations, the Engineer School needed an extensive transformation in technology, force structure, doctrine, leader development, and training. This transformation was not just in response to the many years of counterinsurgency and stability operations in the Middle East, but also due to the emerging threats of peer and near-peer adversaries. The possibility of large-scale ground combat operations in a multi-domain battlefield increased exponentially and resulted in a changed focus in training and preparedness for the Army, the Engineer Regiment, and the Engineer School.

The Calm before the Storm

Needed improvements began in the Maneuver Support Center (MANSCEN) upon its activation on 1 October 1999 under Maj. Gen. Robert B. Flowers and continued with the arrival of Maj. Gen. Anders B. Aadland in the summer of 2000. Both leaders faced the same challenges on how to ensure the vitality of each branch during integration of the engineer, military police, and chemical schools under the new MANSCEN organization, while still fostering branch autonomy to train soldiers and develop doctrine, concepts, force structure, materiel requirements, and experiments. To complicate things even more, the MANSCEN commander, a major general billet, was also installation commander and dual-hatted as the Engineer School commandant. Each of the school's commandants had direct responsibility over their branch-specific functions while many other shared functions were consolidated under the MANSCEN construct. The shared MANSCEN staff organizations included the Directorate of Common Leader Training (DCLT), Directorate of Training Development (DOTD), Directorate of Combat Developments (DCD), Maneuver Support Battle Lab, and Noncommissioned Officers Academy. These staff organizations shared equal responsibility with each school and, therefore, reported not only to the MANSCEN commander but also to each proponent school commandant for mission execution.[1]

Other Army-wide reorganizations greatly impacted the Engineer Regiment and the Engineer School for the first two decades of the twenty-first century. On 12 October 1999, Chief of Staff General Eric K. Shinseki announced plans to transform the Army to a more "responsive, deployable, agile, versatile, lethal, survivable, and sustainable" organization in the coming years, which included changes in doctrine and materiel. The idea was to move away from the Cold War divisional fight and toward combat-ready brigades able to deploy anywhere in the world within ninety-six hours. This thinking can be attributed to the lessons of Desert Shield, during which a brigade of light infantry of the 82nd Airborne Division was quickly airlifted to Saudi Arabia to block Saddam Hussein's forces on the border with Kuwait. This was a gamble since in all actuality, it took weeks to build up the required manpower and lethality found in the heavy divisions of the 1980s to seriously match Iraq's heavy mechanized forces if they would have continued their move south toward the strategic airfields and ports of Saudi Arabia.[2] Shinseki's transformation—establishment of brigade combat teams (BCTs) and the updated Field Manual (FM) 3-0, *Operations*—translated into a renewed fight to keep sufficient engineer forces in these newly created modular organizations. This fight fell in the lap of the Engineer School commandant and his team, who were responsible for the development and design of engineer organizations consistent with the Army's needs.[3]

First Impacts of the Global War on Terrorism on the US Army Engineer School

Following the devastating al-Qaeda terrorist attacks on the United States of America on 11 September 2001, and following the Taliban regime's refusal to expel the al-Qaeda terrorists responsible for the attacks from Afghanistan, the United States took military action. It took less than two months, from October until early December of 2001, to oust the established Taliban regime out of major cities and into the rugged mountains of Afghanistan.[4] A new Afghan government and Afghan National Army was established with the help of the United States and other Coalition partners. The North Atlantic Treaty Organization (NATO)-led International Security Assistance Force (ISAF) assisted in training the new Afghan National Security Forces (ANSF) and supported rebuilding Afghanistan's key infrastructure and government. But the war in Afghanistan was long from over, and continued attacks by Taliban and other terrorist and insurgent forces against American and ISAF forces wouldn't peak until 2010. The conventional Phase III portion of the 2003 US invasion of Iraq to evict Saddam's regime was accomplished rather rapidly. The follow-on stability operations created several similar challenges to what US and Coalition forces experienced and were still experiencing in Afghanistan at that time. The result was a prolonged unconventional war in which the enemy avoided direct combat actions to offset the advantages of US and Coalition forces.[5]

The major threat in both theaters of operations came in the form of the improvised explosive device or IED. These cheap and simple homemade devices became a costly feature for American troops in Afghanistan and Iraq.[6] Thankfully, the Engineer School had some recent experience in establishing training and information centers concerning countermine, mine awareness, and booby trap operations. In May 1996, the Countermine Training Support Center (CTSC) was formed; this was followed by the September 1996 establishment of the Humanitarian Demining Training Center (HDTC). Both organizations were established at the Engineer School at Fort Leonard Wood in direct response to President Clinton's 1996 landmine policy directives.[7] Following the 2001 start of military operations in Afghanistan, the Army formed the Countermine Task Force to address the reality that continued operations with conventional troops in Afghanistan would be conducted in an environment heavily laced with mines and unexploded ordnance from previous conflicts. At the direction of the US Army Training and Doctrine Command (TRADOC) commander, the task force evaluated the Army's capabilities against mines. The Global War on Terrorism's first impact on the Engineer School was the establishment of the Countermine/Counter Booby-Trap Cell (CMBTC) at Fort Leonard Wood, Missouri, on 25 January 2002. Personnel drawn from various school organizations and the post formed the initial cell; its members examined how mines and explosive devices affected mobility and force protection within the context of the contemporary operational environment (COE).[8] Over the next two years, the cell grew in personnel supporting these efforts and changed its name several times before the Army assistant chief of staff and Plans Operations (G-3) approved the Counter Explosive Hazards Center (CEHC) in November 2004. Its official mission was to "synchronize and integrate explosive hazards countermeasure concepts, technology, and materiel across the DOTMLPF [doctrine, organization, training, materiel, leadership and education, personnel, and facilities] spectrum to support assured mobility, protect the force, and counter explosive hazards in the contemporary environment."[9] By 2005, CEHC offered eleven courses to approximately 4,000 students annually.[10] The CEHC staff also provided significant training support both to engineer elements and entities external to the Engineer School in subsequent years. Some was mission-specific individual and unit contingency training for route clearance and other operations while other courses ranged from Counterinsurgency (COIN) Fundamentals to IED Defeat Train the Trainer (IEDD-T3). Other CEHC-led initiatives developed solutions put in place at the Army and Department of Defense level, including blast-resistant route clearance equipment (RCE) such as the Buffalo, Husky, and RG-31; development of an explosive hazards tracking system to provide analysis and a common operational picture; early fielding of the AN-PSS/14 Mine Detector; prediction of the timing, use, technology, migration, and evolution of enemy IEDs; counter-explosive awareness training packages; and integration of the combat training centers in counter-explosive collective training.[11]

The Engineer School and CEHC also developed a mine detection dog program and a specialized search dog program which led to the establishment of the 67th Engineer Detachment (Mine Dog), part of the 577th Engineer Battalion, 1st Engineer Brigade, at Fort Leonard Wood. The additional skill identifier K9 was created for engineer soldiers trained as mine detection dog handlers. Both types of dog teams were successful in Iraq and Afghanistan as well as other mined areas of the world.[12]

A Lessons Learned Example from Operation Iraqi Freedom and its Effect on the Engineer School Curriculum

After Operation Iraqi Freedom (OIF) Phase III operations ended in 2003, the US Army Engineer School identified the need for a comprehensive review of the tactical employment of engineers and issues they experienced in Iraq. Senior Engineer Regiment leaders met in Savannah, Georgia, while attending the Society of American Military Engineers and the Army Engineer Association Regional Conference at the beginning of November 2003. The school captured roughly sixty engineer-specific lessons learned from OIF Phases I to III. The school assembled an Operation Iraqi Freedom DOTMLPF action officer board which analyzed the findings in detail and documented DOTMLPF framework recommendations to improve the Engineer Regiment.[13] Other organizations and units also used the DOTMLPF framework to collect their own unit lessons learned, which were then either sent to the Engineer School's Center for Engineer Lessons Learned (CELL), or published in *Engineer–The Professional Bulletin of Army Engineers* to start the conversation and improvement process. One such example was submitted in 2003 by the 130th Engineer brigade commander, Col. Greg F. Martin, who would eventually become the commandant of the Engineer School in 2007. His "130th Engineer Brigade Lessons Learned and Recommendations from Operation Iraqi

Freedom" article introduced a long list of items to sustain and improve under each DOTMLPF category. The article sections on training and leader development contained several interesting points worth mentioning related to how the Engineer School could implement lessons learned in the field. While Martin acknowledged the Engineer School's mobile training teams were highly beneficial to his unit, he suggested improvements to address basic and career course curriculum shortfalls. He believed that "all engineers must be builders" and, therefore, the basic and advanced officer courses taught at the Engineer School had "to ensure that engineer leaders are prepared to build."[14] Martin also advocated for engineer officers to have a better understanding of and knowledge about contracting, especially as it pertained to Phase IV Stability Operations. By 2008, the twenty-hour contracting officer's representative (COR) web-based distributed learning course offered through the Defense Acquisition University was mandatory prior to starting the Engineer Captain's Career Course. In 2009, the course also became mandatory for students in the Basic Officer Leader Course and several noncommissioned officer (NCO) courses taught at the Engineer School.[15] Other changes due to lessons learned from the field and thanks to the new FM 3-0 resulted in the Building Great Engineers (BGE) initiative, spearheaded by the Engineer School's DOTLD and its Department of Instruction (DOI). The engineering body of knowledge expanded during this time via joint, interagency, intergovernmental, and multinational (JIIM) training events such as the Joint Engineer Operations Course; integration of gaming and technology in the classroom; and expansion of leader development and education initiatives to include degree program opportunities with several local universities as well as joint engineer training partnerships with other services. All were part of the drive to improve general engineering technical skills to better support full spectrum operations.[16]

MANSCEN Reorganization to a Center of Excellence

On 1 October 2009, the Maneuver Support Center (MANSCEN) was re-designated the Maneuver Support Center of Excellence (MSCoE) to posture TRADOC to be more effective and support the Army in transition as well as execute DOTMLPF integration of the future force. MSCoE also executes force modernization and capabilities development responsibilities in support of the protection warfighting function (WfF). Each center of excellence under the TRADOC umbrella was to have a capabilities development and integration directorate (CDID). This directorate would develop maneuver support-related concepts and determined maneuver support, chemical, engineer, and military police organization and materiel requirements through capabilities-based assessments and experiments to define DOTMLPF-integrated combined arms capabilities and assure the mobility, freedom of action, and protection of Army forces. Due to this restructure, the US Army Engineer School created the civilian position of deputy commandant (DC) in 2009 and hired James Rowan. As the continuity and strategic planner for the Engineer School, the DC makes recommendations to the commandant and works collaboratively with subordinate commanders and directors. The DC also serves as the commandant's lead for future and current force capabilities and, therefore, works directly with Engineer School units and directorates as they oversee and integrate capability areas assigned to them based on their professional and military expertise. The DC provides engineer guidance to MSCoE directorates and is the primary contact to CDID.[17]

Army and Engineer Doctrine Impacts on the Engineer School and the Engineer Structure

Part of General Shinseki's transformation discussed earlier in this chapter included the need for doctrinal change. With the increase of new threats to the nation, new technologies, and a new *National Security Strategy*, the US Army published its new doctrine in June 2001. With FM 3-0, for the first time the Army's iteration of doctrine was developed in a more systematic manner and written at the operational level of war that linked Army doctrine to joint doctrine The new doctrine addressed participation in the full spectrum of operations (offense, defense, stability, and support) in noncontiguous areas of operations. By January 2004, the Engineer School Doctrine Development Division (DDD) followed this lead and published its first Field Manual (FM) 3-34, *Engineer Operations*, which provided the foundational principles for subsequent Engineer Regiment manuals. FM 3-34 merged the engineer functions, responsibilities, and principles addressed in joint publications. Lt. Col. Anthony Funkhouser, who supervised the compiling of FM 3-34 and later became the Engineer School commandant in 2013, wrote:

> First, the manual weaves a theme of engineer operations at the operational level of war throughout the entire manual. Second, it describes new threats in the operational environment and the implications to engineers around the Regiment. Third, it expands upon the role of the Regiment. It specifically discusses how the entire Regiment contributes to the operational-level commanders and how the Regiment interacts with all of its various engineer organizations to support the Army's senior level commanders.[18]

FM 3-34 helped guarantee the Engineer Regiment's relevance because it was "tightly linked" to Army doctrine and incorporated new concepts such as assured mobility, geospatial engineering, and field force engineering.[19]

By 2008, the world and the Army were different from when FM 3-0 was published in June 2001. The US Army had been fighting COIN operations in Afghanistan and Iraq for years. Under General William S. Wallace, TRADOC commander since October 2005, TRADOC directed input into all COE activities and help prepare soldiers and leaders for wartime challenges they would face in the field. All basic and advanced training was tailored to the ongoing conflicts in Afghanistan and Iraq, and TRADOC schools throughout the country expanded their curriculum, adding training such as military operations in urban terrain (MOUT) and basic understanding of and dealing with different cultures. Next, the 2008 version of FM 3-0 was published, stressing the importance of stability operations with a *whole government approach*.[20]

The idea of providing essential services, security, economic recovery, capacity building, or a combination thereof, following a force-on-force fight or during counterinsurgency operations had been the reality for many engineers in Afghanistan and Iraq, long before the 2008 version of FM 3-0 was published. The problem the Engineer Regiment faced was how to stay relevant. A BCT-centric, combined arms environment—in which force-on-force operations during US Army combat training center rotations were the culminating point of combined arms training for BCTs—left little need for active-duty construction units; they were, therefore, reduced in number and size. To stay relevant in the BCT-centric Army, engineer education focused on combat capabilities rather than technical engineering skills and abilities. The 2008 revision along with actual engineer experience in Afghanistan and Iraq validated the dire need to improve the Engineer Regiment's stance in the BCT.[21]

In a post-deployment interview about his experiences commanding the 555th Engineer Brigade in Operation Iraqi Freedom in 2005–6, Col. Bill Rapp discussed some of the BCT force structure problems:

> When you start looking at all the things that are being required of that BCT commander and his battlespace, it overwhelms portions of his staff. That young engineer, the brigade engineer if he's not out on a MITT team [military transition team], is worried about reconstruction. He's worried about coordinating the combat engineering, the route clearance, the counter-IED portion of the fight

in that brigade battlespace and he's not really resourced or even staffed and do all of the things that he's being asked.[22]

Figure 11.1. A 510th Clearance Company, 20th Engineer Battalion route clearance patrol vehicle pushes through a tight section of road next to a qalat wall near Kandahar City, Afghanistan. Source: Mass Communication Specialist 2nd Class Ernesto Hernandez Fonte, US Navy.

In March 2009, Brig. Gen. Bryan G. Watson, the new commandant of the Engineer School, made it his top priority to address and fix these deficiencies. Watson, along with newly hired deputy commandant James Rowan, the, and MSCoE CDID's Concepts Development Directorate (CDD) evaluated existing engineering capabilities in the brigade combat team and determined how its engineering needs could be satisfied. The solution was to develop a brigade engineer battalion (BEB) that would reestablish an engineer battalion headquarters in every Army brigade combat team and also increase the engineer capability within the brigade combat team. The long and drawn out evaluation process was supported by brigade combat team commanders; the Maneuver Center of Excellence (MCoE) out of Fort Benning, Georgia; and senior-ranking Army leaders. The BEB was specifically designed to solve problems created by modularity in BCT-centric forces. In the past, engineer functions were performed by a brigade special troops battalion (BSTB) with a single company as its modular engineer force. Gaps in the BSTB's capabilities had to be filled in an ad hoc manner by engineer assets from echelons above brigade (EAB) or echelons above division (EAD). But even these assignments were problematic because the BSTB lacked command and control as well as planning capacities and, finally, because the BCT lacked available experienced engineer staff. The BEB, however, was designed to provide the BCT with a baseline for full-spectrum operations that included sappers, assault bridging, route clearance, and vertical and horizontal construction. The BCT commanders recognized the need for the BEB. Infantry brigade combat team (IBCT) and heavy brigade combat team (HBCT) commanders were willing to trade the existing BSTB for the BEB; while Stryker brigade combat team (SBCT) commanders wanted the BEB to be added to their table of organization and equipment. Some were concerned that loss of the BSTB and associated risks that the BEB could become a force provider for higher echelons; the BEB, nevertheless, represented the means to fulfill these needs. As Brigadier General Funkhouser commented in 2013, "The BEB represents the largest change to the Engineer Regiment in more than a decade."[23] Gaining approval for the BEB took more than four years; BEB implementation was completed in the active-duty Army in 2015, and the Mississippi's National Guard 150th BEB became the last unit to transform in 2018.[24]

New Threats, New Challenges, and Back toward Large-Scale Combat Operations

Following the wars in Afghanistan and Iraq, the United States faced an unpredictable and complex strategic security environment. Emerging regional threats like Russia, China, North Korea, and Iran endangered American and Coalition interests. The US Army needed to shift its doctrine to address future large-scale ground combat operations (LSGCO) against peer or near-peer competitors. In July 2014, TRADOC's Army 2020 efforts were redesignated as Force 2025 and Beyond (F2025B).[25] By 2017, the newly published FM 3-0 provided a new doctrinal approach for US Army theater armies, corps, divisions, and brigades to address the challenges associated with large-scale ground combat and how to fight a peer threat with available forces and current capabilities. Based on the revised doctrine and the conceptual work on multi-domain operations (MDO), the Engineer School changed its professional military education (PME)—changes that were still in place as this book went to print.[26]

The Engineer Captain's Career Course (ECCC) underwent a complete review of the common core as well as the engineer tactical subject area. The school aligned the course with FM 3-0 and LSGCO—replacing previous references and examples of counterinsurgency or stability operations with historical case studies such as the September 1944 wet-gap crossing at Nancy, France, or the virtual staff ride of the February 1951 Battle of Chipyong-ni, Korea. The ECCC aim point was adjusted to a more balanced approach that would prepare its students for command as well as battalion and brigade staff positions.[27]

The Engineer Basic Officer Leader Course (EBOLC) also experienced major changes due to the changing doctrine, as well as feedback from US Army Forces Command units and collective training centers. A critical-task and site selection board (CTSSB) in March 2018 included leaders from all three Army engineer components. The outcome was a comprehensive new military occupational specialty (MOS) 12A, Engineer Officer, critical task list, which the Engineer School commandant approved to implement in associated PME courses taught at the Engineer School. Similar to the Engineer Captain's Career Course, the realignment of the course with the updated FM 3-0, and the redesign and inclusion of topics and subjects related to large-scale combat operations versus the counterinsurgency operations focus, would better prepare the newly minted platoon leader for emerging threats. Changes in content, context, and focus of teaching within the Tactics Division of EBOLC heavily impacted several areas of instruction.[28]

The modernization and update to the EBOLC program of instruction resulted in a 30 percent increase of time spent in the field; junior officers would be afforded more time to develop and practice their small-unit tactical knowledge and understanding. This would build the foundation they needed before undertaking engineer-focused missions in follow-on field training exercises. Other affected areas included the decisive action module, in which the number of forced entry, breaching of enemy obstacles, and gap crossing exercises was increased; the task force engineer module, which exposes the student to staff responsibilities; the general engineering module; the project management module; and the technical leaders' module. Across the course modules, the method of instruction changed. Instead of traditional PowerPoint presentations, the Engineer School adopted interactive "hands-on" learning to deepen student comprehension and understanding by solving practical and realistic problems.[29]

Along the same lines, warrant officer PME at the Engineer School changed to a sequential and progressive series of courses for specific engineer MOSs. For example, the 125D Geospatial Engineering Technician Warrant Officer Basic and Advanced Courses, and the 120A Construction Engineering Technician Warrant Officer Basic and Advanced Courses

were revitalized; the increased academic rigor helped ensure a common core focus on critical warfighting tasks aligned with the FM 3-0 revision, preparing students for service at the tactical levels and enhancing their foundational technical and warfighting skills.[30]

The Noncommissioned Officer (NCO) PME consisted of a series of resident schools prefaced with digital coursework to help students get the most out of residential instruction. The Basic Leader Course (BLC) was the foundation for the sequential and progressive NCO courses; it was not branch-specific, focusing on common leader core competency tasks such as leadership, readiness, communications, program management, operations, and training management. Two follow-on courses, the Advanced Leader Course and Senior Leader Course, were branch-specific. Taught at the Engineer School, they focused on occupation-specific tactical, technical, and leadership skills that NCOs would need to perform their warfighting responsibilities. Unnecessary or low-risk education topics were replaced with technical, tactical, and leadership skills education and training to ensure the modern engineer NCO would be prepared to lead and fight during large-scale ground combat operations on the multi-domain battlefield of the future.[31]

Figure 11.2 During a 2020 Geospatial Warrant Officer Basic Course, four students assess soil composition (screen), comparing it with elevation (3D map), and how the two influence maneuver throughout Afghanistan. Source: US Army photo by 1st Lt. Memory Strickland.

In the spring of 2019, MSCoE CDID re-organized once more, this time to support creation of the Army Futures Command (AFC). The re-organization caused MSCoE CDID to split in three directions: doctrine moved to the MSCoE G-3, the Requirements Determination Division (RDD), concepts, and the Battle Lab shifted to the newly created Army Futures Command (AFC), and organization branch stayed in the TRADOC-owned Future Force Integration Division. Approximately thirty personnel were picked up in the transition and joined the Engineer School's DOTLD under the Systems Training Integration Division (STID). Additionally, in July 2019, the Engineer School assistant commandant assumed responsibility for the engineer multinational engagement coordinator and four engineer foreign liaison officers (FLOs), who were put under the administrative control of the school and would be administratively controlled by the school headquarters.[32]

Today's Engineer School

As this book goes to print, the Engineer School's mission is to "Synchronize and integrate the DOTMLPF-P domains (Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, Facilities, and Policy) to ensure the Engineer Regiment is prepared to provide engineer support now and into the future."[33] US Army Engineer School Commandant Brig. Gen. Mark C. Quander leads the school and the Engineer Regiment with the vision to have "a Regiment of tactically and technically competent engineer warriors and leaders of character serving the commander and committed to overcome any challenge to the success of the team's mission."[34]

The US Army Engineer School organization consists of several directorates, offices, and the 1st Engineer Brigade. The school's command group includes the commandant, assistant commandant (AC), deputy commandant (DC), Regimental/Engineer School command sergeant major (RCSM/ ESCSM), Regimental/Engineer School chief warrant officer (RCWO/ ESCWO), and chief of staff (CoS). Engineer School senior staff members are the deputy assistant commandant for US Army Reserve (DAC-USAR) and deputy assistant commandant for Army National Guard (DAC-ARNG). Engineer School directors and chiefs manage the Directorate of Training and Leader Development (DOTLD), the Counter Explosive Hazards Center (CEHC), the Directorate of Environmental Integration (DEI), and the Engineer Personnel Development Office (EPDO). The Engineer School chain of command runs directly up from the directors through the AC to the commandant. The commander, 1st Engineer Brigade, has a unique chain of command flowing through the

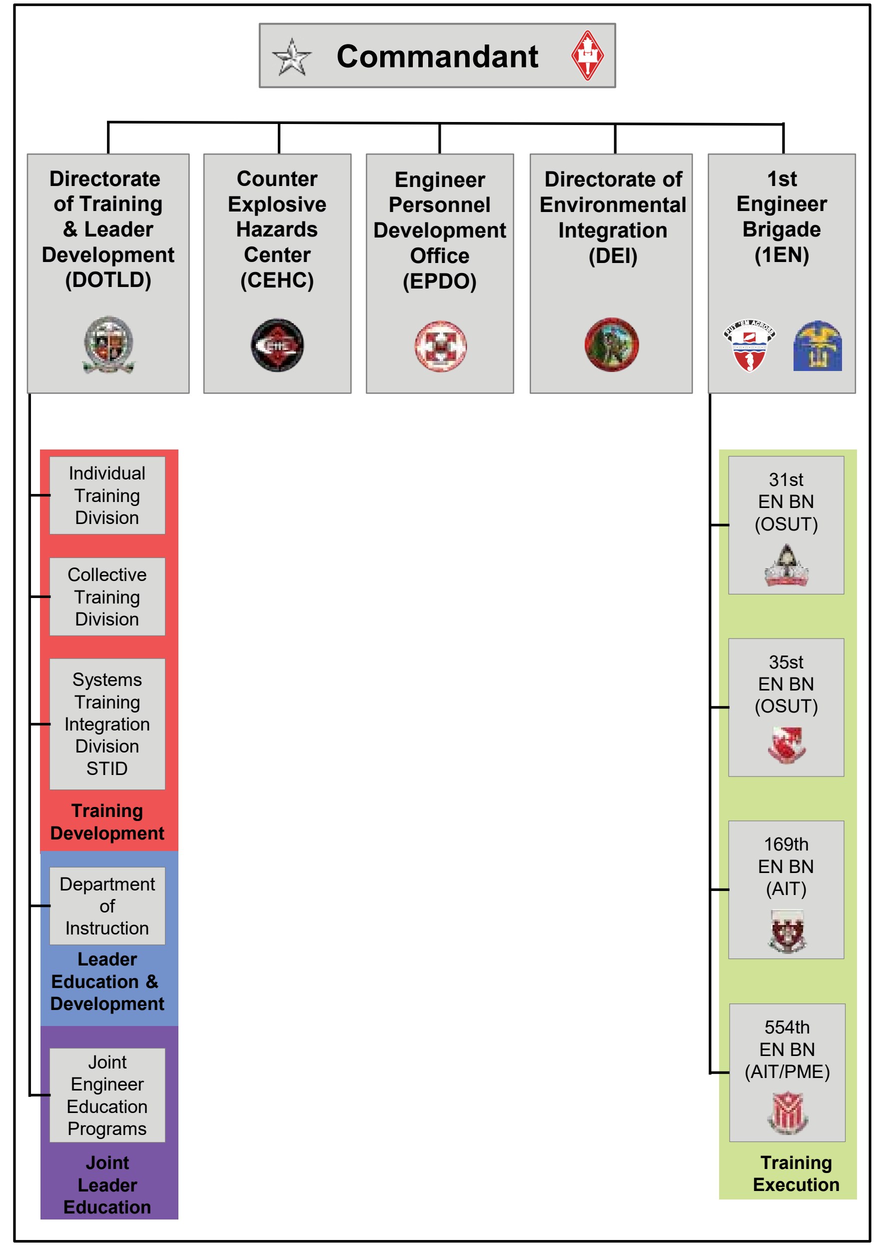


Figure 11.3 Organizational Chart of the US Army Engineer School in 2020. Created by Army University Press.

commandant to the commanding general of the MSCoE. The DC and the CoS are not additional echelons in the chain of command; rather, they assist the commandant with full authority to direct mission activities and implement and enforce decisions, guidance, and policies. The commandant's special staff includes the knowledge management officer, Engineer Museum director, US Army Engineer School command historian, and chaplain. The special staffs maintain distinct organizational relationships and operate among the regular staff as required. They coordinate their activities through the CoS and meetings within the battle rhythm, and provide any special support as required.[35]

The Directorate of Training and Leader Development (DOTLD) develops and integrates engineer and joint engineer training programs, materials, and products across the Engineer Regiment and joint engineer community; develops combined arms training strategies; manages resident and nonresident officer and warrant officer institutional training; and conducts leader training and education. The directorate also coordinates institutional training for deploying active duty, National Guard and Reserve Engineer forces. DOTLD is the primary organization that engages in Memorandums of Agreement and Memorandum of Understanding that impact training and leader development with outside organizations such as the Ordinance School, National Geo-Spatial Intelligence Agency, and colleges and universities. DOTLD also oversees the *Joint Engineer Education Program (JEEP)* and the *Quality Assurance Office (QAO)*.[36]

The Department of Instruction (DOI) under DOTLD conducts training and leader development to produce technically and tactically competent, adaptive, disciplined, and fit engineer officers. DOI provides leadership, combined arms, "common core," combat, general, and geospatial engineering instruction for all officer courses at the Engineer School. It produces engineer officers who are well rounded in leadership principles, combined arms, combat, general, and geospatial engineering doctrine; understand the intricacies of command at the tactical level; and can develop effective solutions to complex problems. DOI provides subject matter expert support to DOTLD in mission writing, reviewing, validating, and critiquing doctrine; lessons learned; tests; and other instruction materials. DOTLD and DOI are course managers and primary trainers for the Pre-Command Course (PCC), ECCC, Construction Engineering Technicians (120A), Geospatial Engineering Technicians (125D), and Engineer Equipment Maintenance Technicians (919A) courses; the 554th Engineer Battalion provides personnel, administrative, and logistical support. For

EBOLC, DOTLD provides support through instructors, while the 554th Engineer Battalion is the course manager and provides platoon trainers.[37]

The Individual Training Division (ITD) under DOTLD provides analysis, design, and development of technically and doctrinally correct institutional training courseware and individual training products for engineer resident, non-resident, and self-development training.[38]

The Collective Training Division (CTD) under DOTLD develops and provides collective training products for engineers to include unit task lists (UTLs), army universal task lists (En AUTLs), combined arms training strategies, Department of the Army standardized mission essential task lists, and engineer qualification tables (EQTs).[39]

The Systems Training Integration Division (STID) is the warfighters training modernization representative, documenting and developing all training requirements during the acquisition process for emerging engineer materiel systems in support of assured mobility, freedom of action, and protection of the supported force. Core functions include documenting training requirements within capability gaps to develop materiel solutions with program managers and MSCoE G-8 for funding; developing training strategies for materiel systems including Training Aids, Devices, Simulators and Simulations (TADSS); and conducting Doctrine & Tactics Training (DTT) in conjunction with New Equipment Training (NET) to help units integrate new equipment into their standard operating procedures (SOPs) and tactics, techniques, and procedures (TTPs).

The Counter Explosive Hazards Center (CEHC) serves as the Army's integrator for all explosive hazards countermeasures. It develops, synchronizes, and integrates those countermeasures across the doctrine, organization, training, materiel, leader development, personnel, and facilities spectrum to enable mobility in urban and complex terrain. This provides new or emerging capabilities, skills, and tools to help soldiers fight terrorism and institutionalize new explosive hazards countermeasures to better prepare the Army for future conflicts. As the primary action agent for Army improvised explosive device defeat proponency, CEHC is the center of excellence in identifying future explosive threats and respective countermeasures. CEHC is a critical "reach back organization" for all Army and joint forces to defeat IEDs by complementing asymmetric warfare initiatives, supporting the operational and forward-deployed forces, and maintaining contact with engineer commanders across the Army as they progress to a modernized and well-integrated maneuver support element.[40]

The Engineer Personnel Development Office (EPDO) advises and assists the Army Engineer School commandant in establishing personnel management policies that produce technically and tactically proficient engineer soldiers for the total force by utilizing the eight life cycle functions of structure, acquisition, training and education, distribution, deployment, sustainment, professional development, and separation. The chief of EPDO manages the interface effort of the proponent with the programs of other directorates and activities of the USAES, MSCoE, TRADOC, and the Department of the Army. The chief of EPDO's activities also include regular communication and coordination with Human Resources Command in order to manage officer and enlisted assignments, requirements, and priorities. The chief of EPDO also manages and maintains liaison between parallel offices in other Army branches and military services.[41]

The Directorate of Environmental Integration (DEI), which resulted from the 1 December 2000 Army Environmental Campaign Plan and Operational Directive signed by the undersecretary of the Army and the Army's vice chief of staff. The directive designated the US Army Engineer School as the Army (and the branch) proponent for the integration of environmental considerations across DOTMLPF and within military operations. DEI represents the Engineer School in the day-to-day execution of this mission by developing, training, integrating, evaluating, standardizing, and synchronizing environmental considerations into and across the domains of DOTMLPF. The outcome is increased soldier and civilian awareness and knowledge so they can positively affect environmental sustainability in the conduct of military training and operations. The directorate also ensures sustainable Army training areas and ranges, leaders and units that are environmentally considerate when operationally deployed, and a program synchronized with the Army's other four areas of environmental concentration: capability development, installation management, operations, and public outreach. Additionally, DEI is charged with collecting and disseminating environmental lessons learned.[42]

The 1st Engineer Brigade trains and develops engineer soldiers, sailors, airmen, and marines for full-spectrum operations to fight and win our nation's wars. The brigade is composed of four TRADOC battalions. The 31st and 35th Engineer battalions transform civilians into soldiers and develop disciplined combat engineers and bridge crewmembers ready to immediately contribute to their operational units for full-spectrum operations. The 169th Engineer Battalion works with Basic Combat Training graduates, prior service, and MOS-T reclassification soldiers at Fort Leonard Wood; Panama City, Florida; Gulfport, Mississippi; Sheppard Air Force Base, Texas; and Goodfellow Air Force Base, Texas. The battalion transforms them into technically and tactically competent, values-based, and Career Management Field 12 (12D, 12K, 12M, 12R, 12T, 12W and 12Y) soldiers. The 169th also conducts the Sapper Leader Course at Fort Leonard Wood. This course is designed to build esprit de corps by training soldiers in troop leading procedures, demolitions (conventional and expedient), and mountaineering operations.

The 554th Engineer Battalion conducts training to produce technically and tactically competent, values-based 12N Horizontal Construction Engineers for the armed services and conducts leader development training to produce engineer leaders (EBOLC, ECCC, 919A, 120A warrant officers, and 91L soldiers).[43]

Conclusion

The US Army Engineer School of the twenty-first century has a long and proud history intertwined with the 245-year history of the US Army Corps of Engineers. The geopolitical environment, technological advancements, changes in Army doctrine, and threats the nation and the US Army have faced—over the last two decades and since its inception—made the Engineer School what it is today. Transformation and forward thinking are keystones to success for leaders and organizations. Throughout its history, Army Engineer School commandants and their engineer teams have leaned forward, adapted rapidly to change, searched for solutions, and solved problems, no matter how big or small. Through the years, commandants have worked tirelessly to direct the Engineer Regiment's ongoing modernization efforts in a fiscally constrained environment. Given the turnaround time with the Army acquisition program, the Army may be required to fight tomorrow's wars with vehicles designed in the 1970s and fielded in the 1980s. The Engineer Regiment is a step behind the rest of the Army, still using the outdated M113 armored personnel carrier in service since the 1960s. Replacing antiquated systems in the Engineer Regiments' force structure continues to be a priority for Engineer School commandants.[44] But at the end of the day, using the latest armored personnel carrier or robotic bridging asset will not ensure a win on the multi-domain battlefield. It will be the highly technical and tactical engineer leader who will clear the way, move into and through the breach, and appear victorious on the other side. For centuries, the Engineer Regiment has invested heavily into its human capital and will continue to do so at the US Army Engineer School of today and the future. Essayons!

Notes

1. Mark T. Premont, "The MANSCEN Construct," *Engineer–The Professional Bulletin of Army Engineers* (August 2001): 10–12; and Jim Evans, "How the Engineer School Runs," *Engineer–The Professional Bulletin of Army Engineers* (August 2001): 13–16.

2. General Eric K. Shinseki, interview by *PBS Frontline*, accessed 15 August 2020, https://www.pbs.org/wgbh/pages/frontline/shows/future/interviews/shinseki.html.

3. Evans, "How the Engineer School Runs," 13.

4. US Army Engineer School, "Biannual Command History, 1 January 2002–31 December 2003," 1, US Army Engineer School Research Collection.

5. Col. Kenneth J. Crawford, "IED Defeat Gated Training Strategy—A Holistic Approach to Preparing Units and Soldiers for Combat," *Engineer–The Professional Bulletin of Army Engineers* (January–April 2009): 31; and Col. Jeffrey P. LaMoe and Capt. Ted Read, "Countermine Operations in the Contemporary Operational Environment," *Engineer–The Professional Bulletin of Army Engineers* (April 2002): 21–22.

6. Crawford, 31.

7. Joseph M. Donahue, "The US Army's Countermine Training Support Center and Humanitarian Demining Training Center," *Journal of Conventional Weapons Destruction* (April 2001): 102.

8. US Army Engineer School, "Biannual Command History, 1 January 2002–31 December 2003," 2–4.

9. Maj. Iain Church, "Counter Explosive Hazard Center," *Engineer–The Professional Bulletin of Army Engineers* (October–December 2005): 10.

10. Robert G. Baker and Dorian V. D'Aria, "Countering IEDs and Explosive Hazards," *Engineer–The Professional Bulletin of Army Engineers* (January–March 2005): 32.

11. Dorian V. D'Aria, "CEHC Support to COIN Operations," *Engineer–The Professional Bulletin of Army Engineers* (January–March 2007): 18–19.

12. US Army Engineer School, "Biannual Command History, 1 January 2002–31 December 2003," 5; and Baker and D'Aria, "Countering IEDs and Explosive Hazards," 33.

13. Lt. Col. Jack Drolet and Maj. Glen Masset, "Capturing the Lessons of War—The Engineer Perspective on Operation Iraqi Freedom," *Engineer–The Professional Bulletin of Army Engineers* (October–December 2003): 19.

14. Col. Gregg F. Martin, "130th Engineer Brigade Lessons Learned and Recommendations from Operation Iraqi Freedom," *Engineer–The Professional Bulletin of Army Engineers* (October–December 2003): 12–13.

15. Lt. Col. Steven T. Wall and Maj. John N. Carey, "Contracting Officer's Representative Training at the Engineer School," *Engineer–The Professional Bulletin of Army Engineers* (July–December 2008): 25.

16. Troy Messer, "BGE Accomplishments Training and Education Work Group," *Engineer–The Professional Bulletin of Army Engineers* (January–April 2009): 17–19; and Lt. Col. Scott C. Johnson "Officer Professional Development in a BGE World," *Engineer–The Professional Bulletin of Army Engineers* (January–April 2009): 20.

17. Vernon L. Lowrey, "MANSCEN Capability Development and Integration Directorate: A Force of Change," *Maneuver Support* (Winter 2009): 18, 20; and US Army Engineer School, "USAES Annual Command History 2010–2015," 3.

18. Lt. Col. Anthony C. Funkhouser, "FM 3-34, *Engineer Operations*: A Blueprint to Forge our Future," *Engineer–The Professional Bulletin of Army Engineers* (April–June 2003): 20–21.

19. Funkhouser, 20–22; and US Army Engineer School, "Biannual Command History, 1 January 2002–31 December 2003," 36.

20. Benjamin King, *Victory Starts Here: A 40-Year History of the US Army Training and Doctrine Command* (Fort Leavenworth, KS: Combat Studies Institute Press, 2013), 15–16.

21. Johnson, "Officer Professional Development in a BGE World," 20; and James R. Rowan and Ricardo Morales "Transforming the Engineer Force Structure," *Engineer–The Professional Bulletin of Army Engineers* (May–August 2016): 7.

22. Transcript, interview with Col. Bill Rapp, Commander of 555th Engineer Brigade, 17 Oct 2006, 1–2, part of SLA Marshal Videos, Stryker Center for Lessons Learned, Fort Lewis, Washington.

23. Brig. Gen. Anthony C. Funkhouser, "Clear the Way*," Engineer–The Professional Bulletin of Army Engineers* (September–December 2013): 2.

24. Rowan and Morales, "Transforming the Engineer Force Structure," 7–10; US Army Engineer School, "USAES Annual Command History 2010–2015," 18–22, 40.

25. Del Stewart, *Victory Starts Here: A Short 45-Year History of the US Army Training and Doctrine Command* (Fort Leavenworth, KS: Combat Studies Institute Press, 2018), 36–37.

26. Lt. Gen. Mike Lundy, CG, Combined Arms Center, Information Paper, Subject: Army Professional Military Education (October 2018), 1.

27. Lundy, 1.

28. Maj. Niall T. McCracken, Capt. Adam J. Leemans, and John R. Espe, "Training Engineer Leaders of the Future: Engineer Basic Officer Leaders Course Modernization," *Engineer–The Professional Bulletin of Army Engineers* (September–December 2018): 13.

29. McCracken, Leemans, and Espe, 13–15.

30. Lundy, Army Professional Military Education, 2.

31. Lundy, 2–3.

32. US Army Engineer School, "USAES Annual Command History 2016–2019," 5, US Army Engineer School Research Collection.

33. US Army Engineer School, Memorandum for Record, Subject: The United States Army Engineer School and Engineer Regimental Headquarters Terms of Reference (9 October 2019), 1, US Army Engineer School Research Collection.

34. US Army Engineer School, Memorandum for Record, 1.

35. US Army Engineer School, Memorandum for Record, 1–2.

36. US Army Engineer School, Memorandum for Record, 14; and US Army Engineer School, "US Army Engineer School, Annual Post Guide" (final draft submitted to Public Affairs Office, Fort Leonard Wood, MO, 17 August 2020), 1, US Army Engineer School History Office Archives.

37. US Army Engineer School, Memorandum for Record, 13–14; and US Army Engineer School, "US Army Engineer School, Annual Post Guide," 1.

38. US Army Engineer School, Memorandum for Record, 14; and US Army Engineer School, "US Army Engineer School, Annual Post Guide," 1.

39. US Army Engineer School, Memorandum for Record, 14; and US Army Engineer School, "US Army Engineer School, Annual Post Guide," 1.

40. US Army Engineer School, Memorandum for Record, 14–17; and US Army Engineer School, "US Army Engineer School, Annual Post Guide," 1.

41. US Army Engineer School, Memorandum for Record, 17–18; and US Army Engineer School, "US Army Engineer School, Annual Post Guide," 1–2.

42. Memorandum for Record, US Army Engineer School, 16–17; and US Army Engineer School, "US Army Engineer School, Annual Post Guide," 1.

43. Memorandum for Record, US Army Engineer School, 11–13; and US Army Engineer School, "US Army Engineer School, Annual Post Guide," 2.

44. Brig. Gen. Mark C. Quander, "Clear the Way," *Engineer–The Professional Bulletin of Army Engineers* (January–April 2020): 2; Brig. Gen. Robert F. Whittle Jr., "Clear the Way," *Engineer–The Professional Bulletin of Army Engineers* (May–August 2019), 2; Brig. Gen. James H. Raymer, "Clear the Way," *Engineer–The Professional Bulletin of Army Engineers* (May–August 2017), 2; and Maj. Gen. Robert B. Flowers, "Clear the Way," *Engineer–The Professional Bulletin for Army Engineers* (October 2000): inside of front cover.

Appendix A
Engineer School Leadership

US Army Engineer School Commandants

Lt. Col. Jonathan Williams
1802–03, 1805–12

Brevet Brig. Gen. (Col., CoE) Joseph Gardner Swift
1812–17

Col. Sylvanus Thayer
1817–33

Maj. Rene' E. De Russy
1833–38

Maj. Richard Delafield
1838–45

Capt. Henry Brewerton
1845–52

Brevet Col. (Capt., CoE) Robert Edward Lee
1852–55

Brevet Maj. (Capt., CoE) John G. Barnard
1855–56

Maj. (Col. ex-officio) Richard Delafield
1856–61

Capt. Pierre G. T. Beauregard
1861

Maj. (Col. ex-officio) Richard Delafield
1861

Lt. Col. (Col. ex-officio) Alexander H. Bowman
1861–64

Brevet Col. (Maj., CoE) Zealous B. Tower
1864

Brevet Maj. Gen. (Lt. Col., CoE) George Washington Cullum
1864–66

Brevet Brig. Gen. (Lt. Col., CoE) James C. Duane
1866–68

Brevet Brig. Gen. (Maj., CoE) Henry Larcom Abbot
1868–86

Lt. Col. Cyrus B. Comstock
1886–87

Lt. Col. William R. King
1887–95

Capt. William T. Rossell
1895

Maj. John G. D. Knight
1895–1901

Maj. William M. Black
1901–03

Maj. Edward Burr
1903–06

Maj. William Campbell Langfitt
1905–06

Maj. Chester Harding
1906

Maj. Eben Eveleth Winslow
1906–07

Lt. Col. William Campbell Langfitt
1907–10

Maj. William Jones Barden
1910–13

Maj. Joseph Ernst Kuhn
1913–14

Maj. William Preston Wooten
1915–16

Maj. Gustave Rudolph Lukesh
1916

Col. Mason Mathews Patrick
1916–17

Col. Henry Jervey
1917

Col. J. N. Hodges
1917

Col. William Wright Harts
1917

Brig. Gen. Frederic Vaughn Abbot
1917–18

Col. Richard Park
1918

Brig. Gen. Charles William Kutz
1918

Col. Jay Johnson Morrow
1919

Col. Clement A. F. Flagler
1919–20

Brig. Gen. William Durward Connor
1920

Col. Meriwether Lewis Walker
1920–21

Col. Mason Mathews Patrick
1921

Col. James Albert Woodruff
1921–24

Col. Harry Burgess
1924

Col. Sherwood Alfred Cheney
1924–25

Col. Edward Murphy Markham
1925–29

Col. Edward Hugh Schulz
1929–33

Col. George Redfield Spalding
1933–35

US Army Engineer School Commandants (continued)

Col. Julian Larcombe Schley
1936–37

Col. Thomas Mathew Robins
1938–39

Col. James Alexander O'Connor
1939–40

Brig. Gen. Roscoe Campbell Crawford
1940–43

Brig. Gen. Gordon Russell Young
1944

Brig. Gen. Dwight Frederick Johns
1944–45

Brig. Gen. Patrick Henry Timothy
1945-1946

Col. Willis Edward Teale
1946–47

Maj. Gen. William Morris Hoge Jr.
1947–48

Maj. Gen. Douglas Lafayette Weart
1948–51

Maj. Gen. Stanley Lonzo Scott
1951–54

Maj. Gen. A. W. Pence
1954 (died in office)

Maj. Gen. Louis W. Prentiss
1954–56

Maj. Gen. David H. Tulley
1956–58

Maj. Gen. Gerald E. Galloway
1958–60

Maj. Gen. Walter K. Wilson
1960–61

Maj. Gen. Stephen R. Hanmer
1961–62

Brig. Gen. George H. Walker
1962

Maj. Gen. Lawrence J. Lincoln
1962–63

Maj. Gen. William F. Cassidy
1963–65

Maj. Gen. Frederick J. Clarke
1965–66

Maj. Gen. Robert F. Seedlock
1966–67

Maj. Gen. Arthur William Oberbeck
1968

Maj. Gen. George H. Walker
1968–69

Maj. Gen. William C. Gribble
1969–70

Maj. Gen. Robert R. Ploger
1970–73

Maj. Gen. Harold R. Parfitt
1973–74

Maj. Gen. James A. Johnson
1974–77

Maj. Gen. James L. Kelly
1977–80

Maj. Gen. Max W. Noah
1980–82

Maj. Gen. James Neal Ellis
1982–84

Maj. Gen. Richard S. Kem
1984–87

Maj. Gen. William H. Reno
1987–88

Maj. Gen. Daniel R. Schroeder
1988–91

Maj. Gen. Daniel W. Christman
1991–93

Maj. Gen. Joe N. Ballard
1993–95

Maj. Gen. Clair F. Gill
1995–97

Maj. Gen. Robert B. Flowers
1997–2000

Maj. Gen. Anders B. Aadland
2000–02

Maj. Gen. Robert L. Van Antwerp
2002–04

Maj. Gen. Randal Castro
2004–06

Maj. Gen. William H. McCoy
2006–07

Brig. Gen. Gregg F. Martin
2007–08

Col. Robert A. Tipton
2008–09

Brig. Gen. Bryan G. Watson
2009–11

Brig. Gen. Peter A. DeLuca
2011–13

Brig. Gen. Anthony C. Funkhouser
2013–15

Brig. Gen. James H. Raymer
2015–17

Brig. Gen. Robert F. Whittle Jr.
2017–19

Brig. Gen. Mark C. Quander
2019–Present

For purposes of the lineage of the US Army Engineer School dating back to 1802, the listed officers are considered to be "commandants" of the Engineer School. They all functioned as the senior leader at the various educational and training institutions for engineers. The US Military Academy at West Point, New York, is considered the primordial establishment of formal military engineer education in the United States. The US Army Engineer School is proud of the shared heritage and considers the engineer superintendents from 1802–66 as the first commandants of the US Army Engineer School. This historical license has been accepted for many years. In preparing this list, researchers used primary sources such as official annual records, annual command histories, annual historical reviews, appointment memorandums, and General George Washington Cullum's *Biographical Register of the Officers and Graduates of the United States Academy*. Most names on this list have been considered to be commandants for many years; yet, just recently several errors as well as previous unknown commandants were discovered. This list of commandants might have more names added in the future if newly found documents show additional personnel who were considered commandants in the Engineer School's past.

US Army Engineer School & Regimental Command Sergeants Major

CSM Griffith A. Jones
1968–69

CSM M. H. Philips
1969–71

CSM H. Salazar
1971–73

CSM Adriano W. Benini
1973–75

CSM Robert G. Cady
1975–77

CSM Lucion L. Cowart
1977–79

CSM Frederick I. Eisenbart
1979–81

CSM Marvin L. Knowles
1981–82

CSM Orville W. Troesch Jr.
1982–84

CSM Charles T. Tucker
1984–86

RCSM Matthew Lee Jr.
1986–88

RCSM Acie R. Gardner
1986–91

RCSM W. E. Woodall
1991–92

RCSM Richard N. Wilson
1992–93

RCSM Roy L. Burns Jr.
1993–96

RCSM Julius B. Nutter
1996–97

RCSM Robert M. Dils
1997–99

RCSM Arthur Laughlin
1999–2000

RCSM Robert R. Robinson
2000–02

RCSM William D. McDaniel Jr.
2002–03

RCSM Clinton J. Pearson
2003–08

RCSM Robert J. Wells
2008–11

RCSM Terrence W. Murphy
2011–13

RCSM Butler J. Kendrick Jr.
2013–15

RCSM Bradley J. Houston
2015–17

RCSM Trevor C. Walker
2017–18

RCSM Douglas W. Galick
2019–20

RCSM John T. Brennan
2020–present

US Army Engineer School & Regimental Chief Warrant Officers

CW5 Robert K. Lamphear
2007–11

CW5 Scott R. Owens
2011–15

CW5 John F. Fobish
2015–17

CW5 Jerome L. Bussey
2017–19

CW5 Dean A. Registe
2019–present

Appendix B
Insignia of the US Army Corps of Engineers

The Corps of Engineers Castle

The traditional Engineer Corps turreted castle is a highly stylized and conventionalized form without decoration or embellishment. There is no evidence that it was patterned after an actual structure. The castle was associated with one of the Engineer Corps' earliest responsibilities, the construction of coastal defense fortifications. Some of these early fortifications were referred to as castles. US Military Academy cadets wore the castle emblem as early as 1839 when West Point was part of the Corps of Engineers. In 1840, the chief engineer recommended that the castle appear on engineer officer epaulettes and belt plates. Army regulations first prescribed the use of the castle on engineer caps in 1841. Subsequently, the castle appeared on collar ornaments, shoulder knots, saddle cloths, buttons, and more recently as branch insignia on the dress uniforms of engineer officers and enlisted personnel. Although its design has changed over time, the castle has remained the distinctive symbol of the Corps of Engineers since its inception.[1]

Figure B.1. Image of the Corps of Engineers Castle. Source: US Army Engineer School History Office Archives.

Engineer Regimental Distinctive Insignia

The entire US Army Corps of Engineers, as a branch of the US Army, is a regiment in the Army's regimental system. The system is designed to enhance loyalty and commitment, esprit de corps, and combat effectiveness. Established in 1986, the regiment includes engineer officers, enlisted personnel, and civilian employees throughout the Army. The regiment also is closely connected to retired engineer soldiers and civilians and their families. Engineer officers and enlisted personnel wear the regimental insignia on their dress uniforms.[2]

The Engineer Regimental Crest reflects the history and traditions of the Corps of Engineers. The turreted castle has been used by the corps since 1840 and prior to that on the uniforms of the Corps of Cadets at the US Military Academy. The Military Academy was under the control of the

Corps of Engineers from 1802 to 1866. The castle symbolizes the classical role of engineers: building fortifications and breaching their walls. The current design and color of the castle was adopted in 1924.[3]

Scarlet on the shield represents the shared heritage with the Artillery. From 1794 to 1802, the Engineers were part of the Corps of Artillerists and Engineers in the nation's new Army. White is the traditional color of the Infantry. White on the shield represents the Engineers' second role of fighting as infantry. The Corps of Engineers adopted scarlet and white as its colors in 1872.[4]

Figure B.2. The Engineer Regimental Crest. Source: US Army Engineer School History Office Archives.

The Corps of Engineers motto is "Essayons," a French term which means "let us strive" or "let us try." The term reflects the contribution of French engineers to America's struggle for independence and the influence of French engineers on the early development of the Corps of Engineers.[5]

Engineer School Distinctive Unit Insignia

The War Department approved the distinctive insignia for the US Army Engineer School on 27 June 1929, and it has been used on diplomas and stationery since 1924. Personnel assigned to the US Army Engineer School are authorized to wear this emblem as a dress uniform device.[6]

Figure B.3. The US Army Engineer School Distinctive Unit Insignia. Source: US Army Engineer School History Office Archives.

Above the shield is the Lamp of Knowledge. The lamp represents the Engineer School's mission to train and educate. The castle symbolizes the classical role of engineers as those who build fortifications and breach their walls. The castle has been used by the Corps of Engineers since 1840, when it was adopted as a uniform device for US Military Academy cadets. Scarlet and white are the colors of the Engineers. Scarlet represents the shared heritage with the Artillery. From 1794 to 1802, the Engineers were part of the Corps of Artillerists and Engineers. White is the traditional color of the Infantry. Its use on the shield reflects the Engineers' secondary mission of fighting as infantry. Under the shield is the Engineers motto: "Essayons," a French term which means "let us strive" or "let us try." Use of this term reflects French engineer contributions to America's struggle for independence and the influence of the French Engineers on the early development of the Corps of Engineers.[7]

Evolution of the Engineer Button[8]

As with many aspects of military history, the origins and originators of military customs, emblems, and insignia are lost to the mist of the past. This is certainly the case with the distinctive button worn by engineer officers—the Essayons Button. Evidence does suggest that it is the oldest uniform element or emblem unique to the Corps of Engineers.


Figure B.4. The Essayons Button. Source: US Army Engineer School History Office Archives.

The history of the Essayons Button can be traced to the earliest days of the Corps of Engineers. As early as the American Revolution, there was an effort to distinguish the uniforms of the engineers from those of the rest of the Army. However, during the Revolution, officers wore buttons either identifying them with their states, if they were militia, or with "USA," if they were with the regular Continental Army.

In 1794, Congress authorized a regiment of artillerists and engineers that took station at West Point, New York. In time, the officers of this regiment wore a button with an eagle standing on a field piece. Later, the eagle disappeared and the inscription USA&E, for US artillerists and engineers, was placed on the button. In 1802, the artillery and engineers were separated, forming their own independent corps. Once again, efforts were initiated to create something that could distinguish engineer officers from those of other branches or arms.

Sometime between 1802 and 1814, the design for the Essayons Button was developed. At that time, the Corps's primary mission was the construction of coastal fortifications. The first commandant of the United States Military Academy and chief engineer, Maj. Jonathan Williams, was given the freedom to develop uniform items for the Corps and the cadets at West Point. A map of the coastal fortifications at Charleston, South Carolina, drawn in 1806, shows an eagle with a scroll in its beak with the word "Essayons"—the first time that this French word, meaning "we will try"—is found on a formal document produced by the Corps. A map made of the defenses of New York Harbor the following year also had an eagle and the word "Essayons." In addition, it had a water bastion, and rays depicting the rising sun. Therefore, by 1807, all of the elements of the Essayons Button had been adopted and used by officers of the Corps.

Figure B.5. Early Example of Engineer Regiment Button. Source: US Army Engineer School History Office Archives.

The earliest reference to the Essayons Button is found in an account written by General George D. Ramsey. Recalling his days as a cadet in 1814, he noted that "Captain Partridge was never known to be without uniform. . . . His was that of the Corps of Engineers, with the embroidered collar and cuffs and the Essayons Button."[9] Clearly, Major Williams and other officers of the Corps had arrived at a design for a button to distinguish the uniform of the engineer officer. Influenced by the historic ties with French engineers, the leadership of the Corps of Engineers had not only adopted the French term "Essayons" but also had incorporated it into a button showing the principal mission of the engineers—fortification.

In 1840, the War Department officially endorsed the button for the Corps of Engineers. General Orders 7, Adjutant General's Office, dated 18 February 1840, described the button as "an eagle holding in his beak a scroll with the word 'Essayons,' a bastion with embrasures in the distance, surrounded by water, and rising sun." Of interest, the same general order also authorized the turreted castle for wear by engineer officers. Coincidentally, the commanding general of the Army at that time was Alexander Macomb, a former engineer officer.

The Essayons Button was, therefore, uniquely associated with the Corps of Engineers. When the Army adopted a standard button for its uniforms in 1902, the Corps already had almost a century of identification with the Essayons Button. Consequently, the Corps of Engineers was the only branch authorized to retain a distinctive button on the uniforms of its officers.

Other Buttons in the Corps of Engineers History[10]

When the Company of Sappers, Miners, and Pontoniers was authorized in May 1846, new uniforms were created for these enlisted engineers.[11] A simple three-turreted castle was chosen to adorn the button.[12]

The 1846 button was short-lived, as the 1857 uniform regulation called for all enlisted men to wear the same buttons as officers of their respective corps (branches).[13] As a result, enlisted engineers donned the Essayons Button, the same button worn by their officers.

Figure B.6. Original Company of Sappers, Miners, and Pontoniers Button. Source: US Army Engineer School History Office Archives.

The regulation of 1861 called for enlisted men to wear buttons, "the same as is used by the artillery, omitting the letter in the shield."[14] This was known as the General Service button (see Figure B.7). In 1902, the design of the General Service button changed (see Figure B.8). In addition to the change in design, dark or black metal buttons were introduced for field uniforms. At the same time the Army directed that all soldiers to wear the General Service Button with one exception: Engineer officers would continue to wear the Essayons button.[15]

Figure B.7. Pre-1902 General Service Button. Source: US Army Engineer School History Office Archives.

Enlisted engineers would continue to wear the General Service Button until the Army G-1 approved the on 25 April 2016 for enlisted engineers to wear the Essayons button.[16] But that's not the end of the story. On 5 July 1838, the Corps of Topographical Engineers was organized and authorized a unique button. This was a very small unit, with only thirty-six authorizations. It lasted for twenty-five years before being abolished on 3 March 1863.[17]

Figure B.8. Post-1902 General Service Button. Source: US Army Engineer School History Office Archives.

Figure B.9. Corps of Topographical Engineers Button. Source: US Army Engineer School History Office Archives.

Notes

1. *The U.S. Army Corps of Engineers: A History* (Alexandria, VA: US Army Corps of Engineers Office of History, 2008), 273.

2. *The U.S. Army Corps of Engineers*, 274.

3. "Engineer Regimental Crest Fact Sheet," US Army Engineer School History Office, 31 October 2014, US Army Engineer School History Office Archives.

4. "Engineer Regimental Crest Fact Sheet."

5. "Engineer Regimental Crest Fact Sheet."

6. "Engineer School Crest Fact Sheet," US Army Engineer School History Office, 31 October 2014, US Army Engineer School History Office.

7. "Engineer School Crest Fact Sheet."

8. This section is a reprint of Larry D. Roberts, "The Essayons Button," *Engineer–The Professional Bulletin of Army Engineers* (January–April 2009): 77.

9. Raphael P. Thian, *Legislative History of the General Staff of the Army of the United States from 1775–1901* (Washington, DC: Government Printing Office, 1901), 503–4.

10. This section is a reprint of Troy D. Morgan, "The Engineer Button(s)," submitted November 2018 to Idaho State Button Society, 1–3, US Army Engineer School History Office Archives.

11. Thian, *Legislative History of the General Staff of the Army,* 503–4.

12. Ephriam D. Dickson III, "Sappers, Miners, and Pontoniers: Outfitting Company A, Engineer in 1846" *Military Collector & Historian* 70, no. 2 (Summer 2018), 105–14.

13. US Army, *Regulation for the Uniform and Dress of the Army of the United States, June 1851* (Philadelphia: William H. Horstman & Sons, 1851), 6.

14. US Army General Order No. 6, 13 March 1861.

15. William K. Emerson, *Encyclopedia of United States Army Insignia and Uniforms* (Norman, OK: University of Oklahoma Press, 1996), 15–6.

16. Deputy Chief of Staff, G-1, Memorandum to Commander TRADOC, Subject: Recommend Change to DA Pam 670-1, Authorization of Enlisted Engineers Soldiers to Wear Essayons Buttons, 25 April 2016, US Army Engineer School History Office Archives.

17. Thian, *Legislative History of the General Staff of the Army,* 502, 509.

Major Contributors

Elizabeth A. Betterbed

Capt. Elizabeth A. Betterbed, a Fox Island, Washington, native, commissioned into the Engineer Regiment in 2010. She is a student at the US Army Command and General Staff College at Fort Leavenworth, Kansas. Previously she served as a construction engineer for the Defense Threat Reduction Agency, commanded the 2018 Itschner Award-winning 161st Engineer Support Company (Airborne), and served as a platoon leader in the 557th Engineer Company (Horizontal). Betterbed earned a master's in economic and social history from the University of Oxford, England. She expansively supported the writing of the first rough draft manuscript by conducting research in Washington, DC, and New York archives and collecting invaluable historical information in support of this book.

David C. Chuber

David C. Chuber has a bachelor's in history from the University of North Carolina, as well as a MMAS from the US Army Command and General Staff College in Fort Leavenworth, Kansas. He retired from the US Army as a lieutenant colonel and was the command historian at the US Army Engineer School at Fort Leonard Wood, Missouri, from 2013 to 2016. Previously, he was the command historian at the Chemical School for several years before joining the engineer team. Chuber provided contract support and advice on this project throughout the research and the first rough draft manuscript writing stage in 2015 and 2016.

Margaret R. Hawthorne

Margaret R. Hawthorne received her doctorate in history from the University of Kansas. She has more than twenty years' teaching experience in United States and European history. In addition, Hawthorne was the associate director of the Washburn University Institute for the Study and Practice of Leadership. In Afghanistan, she served as an Army civilian social scientist for the Human Terrain System, providing NATO forces with operationally relevant cultural research. She is the vice president of Human Dimension Leadership Consulting (HDLC), a Kansas City, Missouri, leadership consulting and training company. She provided extensive research support on the heavy content editing required for this book's first rough draft manuscript.

Vincent J. Hodge

Vincent J. Hodge has a bachelor's in military history as well as a master's in education and military studies. He began his US Army career in

1988 as an engineer and retired after twenty years of service. He was the deputy historian at the US Army Engineer School in Fort Leonard Wood, Missouri from 2012 to 2015. In 2016, he relocated to San Antonio, Texas, and is a 502nd Air Base Wing historian at Joint Base San Antonio (JBSA), Fort Sam Houston, Texas. As the deputy historian for the Engineer School, he coordinated, researched, and provided logistical and administrative support for the first draft manuscript in 2015.

Hugo N. Magana

Capt. Hugo N. Magana graduated with a bachelor's in business management in 2012, and commissioned with the US Army Reserve as an engineer officer in 2014. He served as a platoon leader and later as executive officer for a vertical construction company from 2017 to 2019. Magana deployed to Iraq during 2007–8 as an enlisted soldier with a vertical construction company. A graduate of the Engineer Captain's Career Course, he provided research support to this book while assigned to the US Army Engineer School History Office in the spring of 2020 before transferring to the 647th Regional Support Group in Wichita, Kansas.

Alex Parra

A Tucson, Arizona native, Capt. Alex Parra has a bachelor's in chemical engineering from the US Military Academy and a master's in global leadership from Tsinghua University in China, where he was a Schwarzman Scholarship winner. He entered the engineer branch in 2016, is a graduate of the Engineer Captain's Career Course, and is currently an Engineer Basic Officer Leadership Course (EBOLC) instructor teaching General Engineering at the US Army Engineer School in Fort Leonard Wood, Missouri. He provided research support to this book while assigned to the US Army Engineer School History Office in the spring of 2020 before becoming an EBOLC instructor.

Jason E. Patrick

Jason E. Patrick is a wing historian for the US Air Force at the 319th Reconnaissance Wing located at Grand Forks Air Force Base, North Dakota. He earned his bachelor's in history from Columbia College in Columbia, Missouri, in 2016. Previously, he was a 919A engineer equipment maintenance warrant officer in the US Army and deployed to Afghanistan with the 10th Brigade Support Battalion, 1st Brigade Combat Team, 10th Mountain Division (Light Infantry) from 2010 to 2011. From 2011 to 2015, he was an instructor and writer to the Warrant Officer Professional Development Branch in support of the 919A Engineer Equipment Maintenance Warrant Officer Basic and Advanced Courses instructed by C Company, 554th Engineer Battalion, 1st Engineer Brigade at Fort Leonard

Wood, Missouri. He volunteered at the US Army Engineer School History Office from 2015 to 2017; his efforts included researching documents and images for the creation of this book.

Samuel D. Roberts

Samuel D. Roberts has been the deputy historian of the US Army Engineer School at Fort Leonard Wood, Missouri since 2016. He earned a master's in organizational security management from Webster University in St. Louis, Missouri, and a bachelor's in history from Drury University in Springfield, Missouri. He retired from the US Army after serving twenty one years as a military police officer. In addition to providing general research support for this book, he made sure that day-to-day US Army Engineer School History Office operations went smoothly and efficiently while other history office personnel worked in support of this book.

Larry D. Roberts

Larry D. Roberts earned his bachelor's in history from Oklahoma State University. He was commissioned as a 2nd lieutenant in the Field Artillery in 1972, and served for four years in a number of assignments at Fort Bragg, Korea, and Fort Sill. He left the service in 1976 and returned to Oklahoma State University to earn his master's and doctorate in history. In 1979, Roberts began teaching history and geography at South Dakota State University. In 1983, he left academia and joined the civil service first as a staff historian at the Strategic Air Command at Offutt Air Force Base, Nebraska, and then at the Combat Studies Institute at Fort Leavenworth, Kansas. In 1989, he accepted the historian position at the US Army Engineer School and Center at Fort Leonard Wood, Missouri. He served as the Engineer School command historian at Fort Leonard Wood for twenty-two years, retiring in 2011. He lives in Rolla, Missouri, and is active in the local historical society, the Rolla Historical Preservation Commission, and his church. He has written articles on engineer history and the Army in the West following the Civil War. Roberts is considered the founding father of the US Army Engineer School History Office at Fort Leonard Wood; this book is only possible because of his tireless dedication to the Engineer Regiment and collecting and archiving of the engineer history. The Engineer School History Office Research Collection wouldn't be as complete without his work. His support of the book included a detailed critique and useful suggestions on the first rough draft manuscript.

Jay C. Shaw

Jay C. Shaw graduated with a bachelor's in history from Columbia College in Columbia, Missouri, in 2016. He is working on his master's in military history from American Military University. He retired in 2016 from the US Air Force as an aerospace ground equipment technician in support of both the C-130 Hercules and the B-1B Lancer airframes. He also volunteers at the US Army Engineer School History Office at Fort Leonard Wood, Missouri. Shaw is married with two children and one granddaughter. He worked more than 350 hours on this book alone—researching sources in support of the heavy content edits required for the first rough draft manuscript.

Christopher S. Sherrill

Capt. Christopher S. Sherrill graduated from Michigan Technological University with a bachelor's in management in 2013. Upon commissioning, he became a platoon leader for the 1430th Engineer Company in the Michigan Army National Guard. After graduating the Officer Basic Course in 2014, Sherrill transferred to the Indiana Army National Guard and worked as the reconnaissance officer and then the executive officer for A/776 Brigade Engineer Battalion. Simultaneously, he was the state's Yellow Ribbon Reintegration Program coordinator. Additionally, he completed a master's in history in 2017 from the University of Indianapolis. Later that year, he transferred to the US Army active component as budget officer for the 20th Engineer Brigade and eventually became assistant to the logistics officer. He graduated the Engineer Captain's Career Course in December 2019 and completed a master's in geological engineering from Missouri University of Science and Technology in April 2020. He volunteered more than 100 hours in support of the heavy content editing for this book.

Jessica G. Sweeney

Maj. Jessica G. Sweeney earned a bachelor's in history in 2005, and entered the US Army as an engineer officer in 2008. She served as a platoon leader for a horizontal construction company from 2009 to 2010, deployed to Afghanistan in 2012, and commanded a combat engineer/bridge crewmember initial entry training company in 2014 to 2015. Sweeney worked in the US Army Engineer School History Office from 2015 to 2016 before transferring to the Civil Affairs branch in 2016. During her time in the Engineer School History Office, then-Captain Sweeney provided research support and, more importantly, detailed copyediting of the first several chapters of the first rough draft manuscript.

David J. Ulbrich

David J. Ulbrich received his doctorate from Temple University, his master's from Ball State University, and his bachelor's from the University of Dayton, all in history. He directs the online MA in history and military history programs at Norwich University. Previously, Ulbrich served from 2009 to 2013 as deputy and later command historian at the US Army Engineer School at Fort Leonard Wood, Missouri. He co-authored the article "Army Engineer Divers: First in Port-au-Prince Harbor," which was published in the 2010 *Engineer Bulletin*. He wrote *Preparing for Victory: Thomas Holcomb and the Making of the Modern Marine Corps 1936–1943* in 2011 and co-authored *Ways of War: American Military History from the Colonial Era to the Twenty-First Century* (2nd ed.) in 2018. In 2015 and 2016, he worked as a contract historian for this book and submitted the first rough draft manuscript of this book to the US Army Engineer School.

Florian L. Waitl

Florian L. Waitl is the command historian at the US Army Engineer School at Fort Leonard Wood, Missouri. He is also an engineer officer in the New Mexico Army National, serving as the State of New Mexico National Guard command historian. He received his master's in military history from Norwich University and has an extensive background in military history, leadership development, team building, and lessons learned programs. Waitl also deployed to Afghanistan on two different occasions as an Army civilian. He facilitated leadership seminars at dozens of universities and various prestigious military leadership institutions such as the US Army Command and General Staff College, the US Army Engineer School, the British Land Warfare Centre, and for the German Führungsakademie der Bundeswehr. He wrote a chapter for and edited *Into the Breach: Historical Case Studies of Mobility Operations in Large-Scale Combat Operations (LSCO)*, which is part of the LSCO book set published by Army University Press in Fort Leavenworth, Kansas, in 2018. He also has written for several other Army and military history publications around the world. Waitl lives in the Kansas City, Missouri, area with his wife and their three children. He revived this book project after arriving at the Engineer School in 2017; following hundreds of hours of work on the first rough draft manuscript, he is responsible for the final published product.

Glossary of Acronyms

AAR	After Action Review
ABV	Assault Breacher Vehicle
AC	Active Component
ACE	Armored Combat Earthmover
ACH	Annual Command History
ADA	Air Defense Artillery
ADCON	Administrative control
AFRICOM	US Africa Command
AGE	Army Geospatial Enterprise
AIT	Advanced Individual Training
ALC	Advanced Leader's Course (see also BNCOC)
ALMC	Army Logistics Management College
AMEDD	Army Medical Department
ANCOC	Advanced Noncommissioned Officer's Course (see also SLC)
AO	Area of operation
AOI	Area of Interest
AOR	Area of Responsibility
APOD	Airport of debarkation
AR	Army Regulation
ARCENT	US Army Forces Central Command
ARCIC	Army Capabilities Integration Center
ARFORGEN	Army Force Generation
ARNG	Army National Guard
ASCC	Army Service Component Command
ASI	Additional Skills Indicator
AVLB	Armored Vehicle Launched Bridge
BC ICDT	Base Camp Integrated Capabilities Development Team-
BCT	Brigade combat team
BEB	Brigade Engineer Battalion
BFT	Blue Force Tracker
BGE	Building Great Engineers
BNCOC	Basic Noncommissioned Officers Course (see also ALC)
BSA	Brigade support area
BSB	Brigade support battalion
BSTB	Brigade Special Troops Battalion

C2	Command and Control
CA	Civil affairs
CAC	Combined Arms Center
CALL	Center for Army Lessons Learned
CAM	Combined arms maneuver
CASCOM	Combined Arms Support Command
CATS	Combined arms training strategy
CBA	Capabilities Based Assessment
CBRN	Chemical, Biological, Radiological, and Nuclear
CCIR	Commander's critical information requirement
CDD	Capabilities Development Division (in CDID)
CEHC	Counter Explosive Hazards Center
CFLCC	Coalition Forces Land Component Command
CG	Commanding General
C-IED	Counter-improvised explosive device
Class III	Petroleum, oil, and lubricants
Class IV	Construction and barrier materiel
Class V	Ammunition
Class VIII	Medical supplies
COA	Course of action
COIN	Counterinsurgency
CONOP	Concept of operations
CONUS	Continental United States
COP	Common operational picture
COTS	Commercial-off-the-shelf
CP	Command post
CPOF	Command post of the future
CRB	Curriculum Review Board
CRC	Continental United States Replacement Center
CSA	US Army Chief of Staff
CSM	Command sergeant major
CTC	Combat training center
CTL	Critical Task List
CTSB	Critical Task Selection Board
CUOPS	Current operations
CW5	Chief warrant officer 5
CY	Calendar year
DA	Department of the Army
DA PAM	Department of the Army Pamphlet

DAGR	Defense Advanced GPS Receiver
DATE	Decisive action training environment
DCG	Deputy Commanding General
DEI	Directorate of Environmental Integration
DIVENG	Divisional engineer
DL	Distance Learning
DOI	Department of Instruction (in DOTLD)
DOTLD	Directorate of Training and Leader Development
DOTMLPF-P	Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, Facilities and Policy
EAB	Echelons above brigade
EAD	Echelons above division
EBOLC	Engineer Basic Officers Leader Course
ECCC	Engineer Captains Career Course
EHCC	Explosive Hazards Coordination Cell
ELM	Experiential Learning Model
ENCOORD	Engineer Coordinator
EOD	Explosive ordnance disposal
EPDO	Engineer Personnel Development Office
EPPO	Engineer Personnel Proponency Office
ERDC	Engineer Research and Development Center
FCS/FBCT	Future Combat Systems/Future Brigade Combat Team
FDU	Force Design Update
FEST	Forward Engineer Support Team
FM	Field Manual
FEST-A	Forward engineer support team-advance
FEST-M	Forward engineer support team-main
FOB	Forward operating base
FOC	Full operational capability
FORSCOM	US Army Forces Command
FP	Force protection
FRAGORD	Fragmentary order
GEOINT	Geospatial Intelligence
GWOT	Global War on Terror
HAZMAT	Hazardous materials
HHC	Headquarters and headquarters company

HHD	Headquarters and headquarters detachment
HQDA	Headquarters, Department of the Army
HQUSACE	Headquarters, United States Army Corps of Engineers
HRC	Human Resource Command
HUMINT	Human intelligence
ICDT	Integrated Capabilities Development Team
IED	Improvised Explosive Device
IEDD	Improvised Explosive Device Defeat
IEDD-T3	Improvised Explosive Device Defeat—Train the Trainer
IET	Initial Entry Training
IGO	Inter-governmental organization
IMCOM	Installation Management Command
IMD	Integrated manning document
IMS	International Military Student
IO	Information operations
IPB	Intelligence preparation of the battlefield
IR	Intelligence requirement
ISR	Intelligence, surveillance, and reconnaissance
JAB	Joint Assault Bridge
JCIDS	Joint Capabilities Integration &Development System
JCR	Joint Capabilities Release
JEOC	Joint Engineer Operations Course
JIEDDO	Joint Improvised Explosive Device-Defeat Organization
JIIM	Joint, Interagency, Intergovernmental, and Multinational
JLLIS	Joint Lessons Learned Information System
JOA	Joint operations area
JP	Joint Publication
JTF	Joint task force
KO	Contracting officer
LD	Line of departure
LN	Local national
LNO	Liaison officer
LOC	Line of communication
LOG	Logistics
LTC	Lieutenant colonel
LZ	Landing zone

MANSCEN	US Army Maneuver Support Center (renamed to MSCoE in 2009)
MCP	Main command post
MDD	Mine Detection Dog
MDMP	Military decision-making process
MEB	Maneuver Enhancement Brigade
METL	Mission essential task list
METT-TC	Mission, enemy, terrain and weather, troops and support available, time available, and civil considerations
MI	Military intelligence
MILCON	Military construction
MIPR	Military interdepartmental purchase request
MISO	Military information support operations
MOPP	Mission oriented protective posture
MOS	Military Occupational Specialty
MOU	Memorandum of Understanding
MP	Military police
MRAP	Mine-Resistant Ambush-Protected
MRBC	Multi-role bridge company
MSBL	Maneuver Support Battle Lab
MSCoE	US Army Maneuver Support Center of Excellence
MSR	Main supply route
MTOE	Modified Table of Organization and Equipment
MWD	Military Working Dog
NCO	Noncommissioned officer
NCOA	Noncommissioned Officers Academy
NGO	Nongovernmental organization
NTM-A	National Training Mission-Afghanistan
OCONUS	Outside the continental United States
OE	Operational environment
OEF	Operation Enduring Freedom
OIC	Officer in charge
OIF	Operation Iraqi Freedom
OND	Operation New Dawn
OPCON	Operational control
OPLANS	Operations plans
OPMG	Office of the Provost Marshal General

OPORD Operation order
OSUT One-Station Unit Training
PCC Pre-Command Course
POI Program of Instruction

R&S Reconnaissance and surveillance
R2C2 Route Reconnaissance and Clearance Course
R3 Rapid runway repair
RC Reserve Component
RCSM Regimental Command Sergeant Major
RCTD Route Clearance Training Division (in CEHC)
RDD Requirements Determination Division (in CDID)
REBS Rapidly Emplaced Bridge System
RFF Request for forces
RFI Request for information
ROTC Reserve Officers Training Course
RSOI Reception, staging, onward movement and integration
RTU Rotational training unit

S-1 Personnel staff section
S-2 Intelligence staff section
S-3 Operations staff section
S-4 Sustainment staff section
S-6 Communications staff section
SCoE Sustainment Center of Excellence
SES Senior Executive Service
SITREP Situation report
SLC Senior Leader's Course
SMA Sergeant Major of the Army
SME Subject matter expert
SOCCENT Special Operations Command Central
SOF Special operations forces
SOFA Status of forces agreement
SOP Standard operating procedure
SPO Support operations officer
SPOD Seaport of debarkation
SPS Standard Procurement System
SSD Specialized Search Dog

TA Training Area
TAA Tactical assembly area
TACON Tactical control
TACSOP Tactical standard operating procedure
TB Technical Bulletin
TCM-Geospatial TRADOC Capability Manager-Geospatial
TDA Tables of Distribution and Allowance
TDY Temporary duty
TEC Theater engineer command
TF Task force
TLP Troop leading procedure
TM Technical Manual
TOE Table of Organization and Equipment
TOR Terms of reference
TRADOC Training and Doctrine Command
TSP Training Support Package
TSWG Training Support Working Group

UAS Unmanned aircraft system
USACE US Army Corps of Engineers
USAES US Army Engineer School
USAF US Air Force
USAR United States Army Reserve
USARCENT United States Army Central Command
USASMA US Army Sergeants Major Academy
USC United States Code
USCENTCOM United States Central Command
USMA US Military Academy
USMC US Marine Corps
USTRANSCOM United States Transportation Command
UXO Unexploded ordnance

VCSA Vice Chief of Staff of the Army
VMMD Vehicle Mounted Mine Detector

WAS Wide area security
WfF Warfighting function
WOAC Warrant Officer Advanced Course
WOAC-RC Warrant Officer Advanced Course – Reserve Component

WOBC	Warrant Officer Basic Course
WOBC-RC	Warrant Office Basic Course – Reserve Component
WOSC	Warrant Officer Staff Course
XBASOPS	Expeditionary Base Operations