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In September 2016, the Commandant of the Marine Corps published The Marine Corps Operating Concept (MOC): How an Expeditionary Force Operates in the 21st Century. The MOC describes in broad terms how Marine Corps forces will conduct the range of military operation in the future operating environment. Critical Task 6.4: Enhance Our Ability to Maneuver has implications for combat engineers in the future as engineer activities have historically been integrate with the maneuver of ground combat forces to assure mobility. In order to support the enhanced maneuver task outlined in the MOC, Marine Corps engineers will need to explore changes to engineer doctrine, organization, and training.

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Preface

The purpose of this study is to look at the evolution of the military engineer and changes in the character of war in order to illustrate how advancements in technology prompted changes in doctrine, organizations, training, and tactical responses. This research is not intended to be a dialogue of history, nor is it intended to be the “silver bullet” solution to the problems engineers will face in the future. It is an effort to provide context to engineer capabilities past and present and highlight the implications associated with the enhance maneuver task presented in the Marine Corps Operating Concept: *How an Expeditionary Force Operates in the 21st Century*. Marine Corps engineers will need to continue to evolve and adjust to the future operating environment of 2025. The hope is to provoke further thought and collaboration in the Marine Corps engineer community to find collective alternatives to meet future challenges. The Office of Naval Research and the Defense Advanced Research Project Agency continually conduct scientific research and experimentation to support the warfighters of the future. Some of their advancements will be outlined in this study. That said, many of the ideas from the aforementioned agencies will not be included.

I would like to express my sincere appreciation to Dr. John W. Gordon for his patience, support, and guidance throughout this process. His meticulousness and attention to detail made this process an invaluable experience and ensured my successful completion of the Master of Military Studies (MMS) Degree requirements. Additionally, I would like to thank my MMS reviewers and committee members—LtCol William Chesarek, Dr. Benjamin Jensen, LtCol Gary Reidenbach and LtCol Michael Kelly—for their continued support and guidance.

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Executive Summary

Title: Combat Engineers for 2025: Evaluation, Implication, Future

Author: Major Derek George, United States Marine Corps

Thesis: In order to support the enhanced maneuver task outlined in the Marine Corps Operating Concept, Marine Corps engineers will need to explore changes to engineer doctrine, organization, and training.

Discussion: Throughout history, engineers have played a vital role in combat operations and will continue to be a significant asset in the future security environment. As early as AD 122, the Roman Empire employed engineers to design and build fortifications in order to protect Rome from its enemies. These early engineers set a high standard of achievement and were integrated into combat operations similarly as they are today. The French assisted with the organization of the first engineers in the United States. These engineers were organized into three small companies during the Revolutionary War and followed the model of constructing field fortifications. In 1802, an act of Congress created the present-day Army Corps of Engineers, which seeded the development of engineers in the United States military.¹

In 1896, the United States Marine Corps' strength was approximately 2,600 and grew to 6,062 by 1899.² The need for engineers became evident when Major Allen C. Kelton led a battalion of Marines on the island of Guam to carry out the mission of garrisoning a newly established naval station.³ Major Kelton was assigned as the Public Works Officer where he installed a sanitary water supply system, built roads, erected a sawmill and ice plant, and improved general sanitation.⁴ All that Major Kelton's battalion accomplished was secondary to his main job of force protection. Those efforts on Guam more than a century ago evolved into today's Marine Corps combat engineer. This study seeks to examine the evolution of the combat engineer and use an interpretive historical context to recommend informed changes to engineer doctrine, organization, and training to support the enhanced maneuver task outlined in the Marine Corps Operating Concept.⁵

Conclusion: Understanding the past provides invaluable insight to future. Combat engineers will continue to play an integral role in fighting our nation's battles. The Marine Corps Operating Concept provides the framework and innovative research, debate, and discussion will continue to improve engineer capability in the Marine Expeditionary Forces to enhance maneuver.

INTRODUCTION

History extends beyond just being a descriptive discipline; interpretive history can stimulate factual information and provide invaluable insight.⁶ Thomas Kohn states, “history, if viewed as a repository for more than anecdote or chronology, could produce a decisive transformation in the image by which we are now possessed.”⁷ Attempting to display the historical integrity of a profession relative to time presents a vantage point in which problems can be framed and courses of actions can be explored to generate appropriate solutions.⁸ Sometimes normal problems that ought to be solvable by known rules and procedures that members of a professional community can competently employ do not produce results aligned with professional expectations. When anomalies subvert the existing traditions and practices, extraordinary investigations begin leading the profession to a new set of rules and procedures.⁹

That said, adopting new rules and procedures cannot take full effect until the professional community as a whole has re-evaluated traditional procedures, altered its perception of familiar entities, and shifted the science that has guided the community through recent successes.¹⁰ In a professional community deeply rooted in tradition, this paradigm shift may be more difficult. In more technologically driven communities, paradigm shifts are likely more fluid due to the speed in which technology advances. What about communities comprised of both deeply rooted traditions and the need for technological advances? Can a historical study affect the conceptual transformation? If a historian traces the traditions and paradigm shifts of any related community backward in time, it is likely that some minor variant of a pattern will be encountered.¹¹ The same approach can be taken when considering changes to a military organization.

This study seeks to examine the evolution of the combat engineer from an interpretive historical context and not just as a descriptive chronology. The goal is to find various potential

patterns that could inform what changes to engineer doctrine, organization, and training may be required in order to enhance combat engineer capabilities in the Marine Expeditionary Force to ensure readiness and relevance in the future security environment. A combat engineers—also known as Sappers—is a military engineer that performs a variety of construction and demolition tasks under combat conditions. Most Marine Corps combat engineers—myself included—like to refer to themselves as “a jack of all trades, but a master of none.” The Marine Corps Operating Concept (MOC): *How an Expeditionary Force Operates in the 21st Century* broadly describes “how Marine Corps forces will conduct the range of military operations in accordance with our Title 10 responsibilities” in the future operating environment.¹² The framework outlined in the MOC will be the guide throughout this study.

SECTION 1: BACKGROUND INFORMATION

Marine Corps Operating Concept 2025

Combat engineers must clearly understand the complex problems presented by the future operating environment and prepare to adjust current operating procedures. The United States Marine Corps is currently conducting extraordinary investigations aimed at navigating through these complex problems in order to operate, fight, and win in 2025 and beyond.¹³ The MOC is a foundational document that outlines in general terms how the Marine Corps will evolve to deter and defeat future threats. Marines must be prepared to quickly transition from a crisis response situation to sustained combat. Marines will need to remain agile, flexible, and adaptive as conflicts will rapidly scale up and down the range of military operations. Marines will need to stay ahead of the enemy’s decision cycle, and as an institution, the Marine Corps must innovate faster than rapidly evolving adversaries. Simply stated, Marines must learn to operate in chaos, without operating chaotically.¹⁴

While the nature of war will not change, technology and tactics continue to make the future operating environment more violent and complex. It is vital to innovate and adapt to the five key drivers of change: “complex terrain, technology proliferation, information as a weapon, battle of signatures, and increasing contested maritime domain.”¹⁵ One critical task outlined in the MOC is to enhance the Marine Corps’ ability to maneuver.¹⁶ Marine Corps doctrine defines maneuver warfare as “a warfighting philosophy that seeks to shatter the enemy’s cohesion through a variety of rapid, focused and unexpected actions which create a turbulent and rapidly deteriorating situation with which the enemy cannot cope.”¹⁷ Clearly, engineers have played a vital role in maneuver warfare for centuries. Mobility, counter-mobility, survivability, and general engineering continue to be the four functional areas of Marine Air Ground Task Force (MAGTF) Engineers. Engineers are charged with increasing the rates of advance, modifying terrain, providing critical ground support, participating in deception activities, and increasing force survivability and sustainability. In the future operating environment, carrying out these functions will remain unchanged; however, how engineers are manned, trained, and equipped will require a close look at doctrine, organization, and training.

Infantry Assault Marines

Before exploring the potential variant of patterns from an interpretive historical context for combat engineer enhanced maneuver support in the future, it is important to preface this discussion with a brief analysis of the current state of the Infantry Assault Marines. Infantry Assault Marines employ rockets, the Anti-Personnel Obstacle Breaching System (APOB), and demolitions.¹⁸ They provide rocket fire against fortified positions in support of the rifle squads, platoons, and companies within the infantry battalion.¹⁹ Additionally, Infantry Assault Marines employ breaching and infiltration techniques to facilitate infantry maneuver in the offense, and

demolition and expedient counter-mobility measures in the defense.²⁰ Infantry Assault Marines are organic to infantry rifle companies and serve in the assault section of weapons platoons.

Why is this important to discuss?

The Marine Corps is exploring options to phase out this particular military occupational field. There have been several factors that have contributed to this decision. For many years, the combat engineer community has argued that many of the tasks performed by Infantry Assault Marines are redundant. Traditionally, engineers serving in direct support of an infantry battalion train Infantry Assault Marines on basic demolitions and breaching techniques. Changes in force structure increased the size of infantry units but not engineer units. During combat operations, engineers are the main effort in urban breaching missions augmented by Infantry Assault Marines. The more crucial problem is that infantry formations at times employ Infantry Assault Marines to perform specialized demolition tasks without formally trained engineers in the lead, which is a dangerous course of action. Furthermore, Infantry Anti-Tank Missile Marines have also been employed to perform demolition tasks. Their primary responsibilities are the tactical employment of the M220E4 TOW2 Weapon System and M98A1 Javelin Weapons System providing anti-armor fire in support of infantry battalions, LAR battalions, tank battalion, and the MAGTF.²¹ Many infantry officers have acknowledged that they employ their Infantry Assault Marines and Infantry Anti-Tank Missile Marines to perform breaching tasks in order to support mobility and maintain momentum. While deviations from the established engineer mobility doctrine for maneuver purposes can be appreciated, the deviations highlight why it is important to enhance combat engineer capability in the MEF and ensure that the general and direct support relationships are understood and properly implemented. Now that a foundation has been

established, the interpretive historical context will be reviewed to determine what the options are to address these anomalies.

SECTION 2: INTERPRETIVE HISTORY OF MILITARY ENGINEERS

Throughout history, military engineers have played a vital role in combat operations and will continue to be a significant asset in the future operating environment. As early as AD 122, the Roman Empire employed engineers to design and build fortifications in order to protect Rome from its enemies. During the eighteenth century, military engineers primarily built and attacked fortifications. These early engineers set a high standard of achievement and were integrated into combat operations similarly as they are today. The French and Soviet Union are two foreign militaries that achieved success integrating engineers into combat operations. Capturing lessons learned from these two countries are important as they too had to evolve due to radical changes in military technology and what was then considered a complex future operating environment.

Foreign Service Military Engineers

French Military Engineers

The universal influence of French military engineering has been felt from West Point to St. Petersburg.²² The nature and role of military engineers in the French military was twofold: 1) insert military values into engineering in general, and 2) insert engineering values into the military establishment.²³ The Royal Corps of Military Engineering of the French Army were men of the Enlightenment during a time where technology was evolving rapidly. By the end of the eighteenth century, French military engineering corps had increased in size, but lost its centrality in strategic thinking.²⁴ The engineering corps did achieve a degree of stability, but gunpowder weapons grew more effective and posed a new problem. New bastioned artillery

fortifications were in high demand, and the French military engineers were at the center of building such fortifications.²⁵ Improvements in the employment of gunpowder as a propellant and as an explosive in mines coupled with more mobile and rapidly firing guns led to the transformation of traditional fortifications. Walls were designed much thicker, ditches became wider, and obstacles were covered by fire. Layered defensive perimeters in depth became more prevalent and more effective than defense in height. The history of artillery fortifications suggests a simple scenario of technological challenge and response.²⁶

Sebastien Le Prestre de Vauban was a Marshal of France and the foremost military engineer of the eighteenth century. He not only designed fortifications, he also specialized in siegecraft. Vauban's literary legacy of the eighteenth century consisted of a treatise on siegecraft, defense of fortresses, and a short work on mines.²⁷ Because warfare during the seventeenth and eighteenth centuries appeared to be an interminable succession of sieges, Vauban's works highlighted the most important aspects of war during this time. The reduction of enemy fortresses and the protection of their own were the principle objectives. The French employed effective siege cannons and emphasized defensive geometry rather than robust structures.²⁸ Geometry was perceived to give certainty to fortifications and to cover dead space. Defensive positions began to be designed as polygons to provide better gorge angles and facilitated the ability to attack an adversary's flank. Vauban's early system of siegecraft was designed to use temporary fortifications, trenches, and earthworks to protect advancing troops.²⁹ By protecting the troops as they advanced, the ground forces were able to penetrate the adversaries' defense which facilitated successful sieges. His thoughts continued to evolve more in favor of fortified points/zones and encampments with more emphasis on the fortress to enable the army's offensive actions vice emphasizing the fortifications themselves.³⁰ Vauban's thought

provoking ideas, letters, and manuscripts were analyzed and published by scholars in the nineteenth and twentieth centuries.³¹ His works left room for interpretation and individual judgment similar to how the framework of the MOC is intended to generate professional debate and discussion about the future challenges.³²

Soviet Military Engineers

A more modern aspect of foreign military engineers is the post-World War II Soviet Union engineers. Soviet engineers played a vital role in ensuring the viability of combined arms operations for the Soviet Army. Soviet military doctrine set conditions for efficient performance of the combat engineering tasks: maintain high operational tempo, increase spatial scope of tactical operations, and combat the threat of sophisticated conventional weapons and weapons of mass destruction.³³ To the Soviets, the greater the increase in mobile warfare, passible terrain, powerful modern weapons, the more difficult it was for Soviet troops to protect against them.³⁴ The Soviets understood that denying the enemy mobility would give them the tactical advantage. Furthermore, the Soviets recognized they needed to conduct these in a shorter timeframe. Because of the requirement of performing these tasks often ahead of the main body forces, Soviet military theorists increasingly viewed engineers as special combat troops within the combat arms.³⁵ Soviet doctrine stressed maximizing tactical and operational flexibility and utilizing engineer assets as part of the overall tactical plan. All tank and motorized rifle units down to the regimental level had organic engineer elements. Soviets had two types of combat engineer units: engineering special/technical and general purpose sapper units.³⁶ Soviet combat engineer tasks are similar to US military engineer tasks (i.e. engineer reconnaissance, road and route preparation, field fortification, bridge construction, obstacle construction and removal, and mine clearance). The Soviets performed these tasks under fire or well in advance of the main

body. The Soviet's doctrine, training, and an organizational structure of its combat engineers would be tested during conflict in Afghanistan.

In December 1979, Soviets began to land airborne troops at key points in Afghanistan. Nearly fifteen years prior to the invasion, Soviet military advisors had assisted the Afghan Armed Forces and built numerous lines of communication in northern Afghanistan.³⁷ The geography, climate, and mountainous terrain were very familiar to the Soviets. Combat engineers were employed to ensure mobility as three to four motorized rifle divisions moved to occupy population centers. As the divisions traveled over routes, trafficability began to present problems for movement; the Soviets underestimated the effects of traveling these routes with a sizable motorized force. Soviet forces attempted to improve the routes, but were met with mining and ambushes by the Afghan freedom fighters. Soviet "engineer sappers" conducted countermine operations, counter-mobility to cut off mujahideen supply routes, force protection of Soviet bases and outpost, and area denial to resistance forces and civilians.³⁸ Mujahideen employed sophisticated devices to impede Soviet troop movement. The Soviets were not prepared to deal with these devices. Mines and IEDs were detonated by a pressure-activated electric switch, reinforced wire-controls, electric switches hidden in the bottom of water filled tanks, and other anti-handling devices.³⁹ Mines were placed on the shoulders of roads, approaches, and in landing zones. Mines were also wrapped in cellophane and sprinkled with oil to avoid detection by mine-sniffing dogs.⁴⁰ Areas were prepared beforehand with wire so that mines could be quickly emplaced as units approached. The effective employment of the mines and IED shaped the Soviet activities and at time completely halted movement. The effective use and threat of mines that the Soviets faced during the occupation of Afghanistan was far greater

than anticipated. In order to overcome such a threat, the Soviets needed to study the anomalies that subverted its doctrinal approach and re-evaluate its methods of employing engineers.

The Soviet Army conducted trend analysis and created substantial material on mines and IEDs studying the nature, size, effects, and methods to interrogate and reduce. The Soviets also studied the historical context of the Falklands conflict and examined the difficulties that mines presented for the British. Furthermore, the Soviets looked back at their experience during the World War II, Berlin Operation capturing difficulties that engineers faced in urban terrain.⁴¹ Furthermore, new technological developments by the US and North Atlantic Treaty Organization (NATO) forces presented a formidable threat to Soviet offensive operations.⁴² The Soviets studied US and NATO forces' ability to rapidly emplace dense minefields across broad areas, barrier emplacement, obstacle construction and breaching, and choke point generation and avoidance.⁴³ The Soviets began to use this data to develop tactics, techniques, and procedures (TTPs) to counter the future threat posed by US and NATO forces. The TTPs were later taught to new Soviet engineers during basic skills training. The changing environment forced the Soviets to affect change in their operations. Lessons learned from past conflicts were analyzed and made the Soviets more prepared to face future conflicts in Europe. In the cases of both the French and the Soviets, technology forced a paradigm shift and conceptual transformations occurred leading to changes in doctrine, training, and organization. Similarly, the United States military has an interpretative history that produced decisive transformations in engineer employment.

United States Military Engineers

Army Corps of Engineers

The US Army Corps of Engineers can credit its existence to General George Washington. As the Commander, Continental Army in 1775, General Washington sought to strengthen his army and confine the British to Boston.⁴⁴ The defensive nature of the war convinced General Washington that he needed trained engineers. During this time period, knowledge in siegecraft and field fortification was not resident in America. Many of the best officers were knowledgeable in field artillery but lacked experience in field fortifications. Colonel Richard Gridley was General Washington's first Chief Engineer, sixty-five years old, and an artillery veteran of the colonial wars.⁴⁵ General Washington was not enthused about his chief engineer; Gridley's command of the Continental Artillery distracted him from focusing on engineering.⁴⁶ Washington was able to commission a few volunteers as engineer officers; however, this was not enough. Congress sent an agent across the Atlantic to recruit engineers from France. The French engineers were highly skilled at military engineering and specialized in field fortifications—just what Washington needed as the battle against the British continued. Most of the French engineers that served in the Continental Army were well versed in Vauban's field fortification and besiege doctrine.

In 1780, Congress commissioned the last of the French engineers. Washington argued that he needed more to conduct reconnaissance and mapping of roads, rivers, and bridges. Furthermore, he needed Army men with the capability of fording and mountain passing. Colonel Rufus Putman proposed the establishment of a corps of engineers as a permanent branch of the army arguing that artificers, sappers, and miners were essential to effectively execute fortifications.⁴⁷ The French engineers assisted with the organization of three small companies

known as the Corps of Engineers. As the Revolutionary War continued, the Corps of Engineers continued to grow. A new organizational structure was proposed, and doctrine was established to support of the employment Corps as an independent branch of the Army. By war's end, there were advocates for a united department of artillery and engineering. The Continental Army began to downsize, and the Corps of Engineers was reduced to one regiment of artillerists and engineers.⁴⁸

In 1802, Congress created a separate regiment of engineers which are the present-day Army Corps of Engineers.⁴⁹ General Washington was persistent and continued to evaluate what engineer capabilities were needed to support the success of the Continental Army. Understanding that the French possessed the most talented military engineers of this era, General Washington was able to alter Congress' perceptions and convince them to take extraordinary steps to bring military engineers versed in Vauban's field fortification and siege doctrine to America in support of the war efforts. This decision transformed the US military engineer and paved the way for future re-evaluations and shifts in engineer doctrine.

Army Combat Engineers "Sappers"

The term Sapper originated in the early 1500's in Siege of Rouen during the French Wars.⁵⁰ In the US Army of today, Sappers are the combat engineers of the Army Corps of Engineers that are on the front-lines with the infantry to ensure mobility and conduct counter-mobility operations. Breaching operations to reduce mines, improvised explosive devices, and nonexplosive obstacles are synchronized in support of a combined arms maneuver force. Sappers are manned, trained and equipped to operate as a mechanized force armed with rifles, light and heavy machine guns, demolition material, and antitank weapons. Army Sappers can also reorganize and fight as infantry.

The Army Corps of Engineers continued to play a vital role in combat operations throughout American history. During the Civil War, there were four companies that built pontoon and railroad bridges, constructed forts and batteries, and conducted demolition raids on enemy supply lines.⁵¹ It was not until World War I did the Corps of Engineers grow from 2,500 to almost 300,000 men.⁵² During the Great War, Army engineers conducted topographical surveys, built roads and bridges, conducted countermine operations, and dug trenches and survivability positions. Army engineers were essential to both offensive and defensive gas attacks. They constructed gas proof shelters and launched gas attacks. During World War II, Army engineers' role expanded even more in support of amphibious operations.⁵³ Engineer troops prepared beaches for assault landings, both in Europe and the Pacific. On the beaches of Normandy, engineers destroyed mine-bearing steel structures emplaced by the Germans clearing lanes for landing craft while under heavy enemy fire.⁵⁴ Bulldozers created roads up the narrow draws through the cliffs lining the beaches. During the Battle of the Bulge, engineers destroyed critical bridges in order to impede the German advance setting conditions for counterattacks.⁵⁵ There are numerous examples during both World Wars where Army engineers were employed to meet technological changes and the emergence of lethal threats. As the role of the Army Corps of Engineers continued to evolve from the Civil War through the World Wars, the scope of World War II also expanded the role of engineers in the US Navy.

Navy Seabees

The naval construction force was established in January 1942 in order to meet the critical need for builders who were organized, trained, and equipped to perform construction tasks and defend themselves at the same time. The construction of large naval bases throughout the Pacific was necessary to support amphibious operations during World War II. As Chief of the Bureau of

Yards and Docks, Rear Admiral Ben Moreell was given the authority to recruit and assign men to a Naval Construction Regiment (NCR) with three battalions from the civilian construction industry.⁵⁶ The battalions were commanded by officers from the Navy's civil engineer corps. The enlisted sailors of the NCR were called "Seabees." By the end of World War II, the Seabees reached approximately 325,000 in strength. They constructed more than 400 advanced bases in support of the war. In the Pacific, Seabees built 111 major airstrips, 441 piers, 2258 ammo magazines, storage tanks for 100 million gallons of fuel, and billeting for more than 1.5 million men.⁵⁷ Seabees changed the footprint abroad, and the advanced naval bases were essential to the success in the Pacific.

Today, Naval construction forces also enhance MAGTF survivability and support mobility. During MAGTF offensive operations, Seabees are essential to interior lines of communications and rear area operations. Seabees construct and improve roads and harden expeditionary bulk fuel storage sites. During MAGTF defensive operations, Seabees serve as advisors and assist in force protection measures by constructing field fortifications and are trained in small arms and defensive tactics to serving as part of the interior guard force. Furthermore, Special Naval Construction Units specialize in underwater construction and amphibious construction capable of employing self-propelled floating pontoon barges in support of ship to shore logistics.⁵⁸ Seabees are versatile and versed in bridging and more permanent structure repair and construction; however, Seabees are not trained in all combat support tasks. In the naval services, Marine Corps engineers conduct explosive breaching, mine and countermine operations, and other combat engineering tasks.

Marine Corps Combat Engineers

During the early years of the Marine Corps, a relatively small force of Marines existed with service aboard ships as its main function; there was no requirement for Marine combat engineers to exist at the time. It was not until the US assumed the role as a world power and assigned the organization of advance base functions did the Marine Corps begin to grow.⁵⁹ In 1896, the United States Marine Corps' strength was approximately 2,600 and grew to 6,062 by 1899.⁶⁰ The need for engineers became evident when Major Allen C. Kelton led a battalion of Marines on the island of Guam to carry out the mission of garrisoning a newly established naval station.⁶¹ Major Kelton was assigned as the Public Works Officer where he installed a sanitary water supply system, built roads, erected a sawmill and ice plant, and improved general sanitation.⁶² All that Major Kelton's battalion accomplished was secondary to his main job of force protection.

At the turn of the twentieth century, the Marine Corps underwent several organizational changes that affected engineers. In 1913, the Advance Base Regiment was organized in Philadelphia, Pennsylvania comprised of an engineer company and a machine gun company.⁶³ The following year, the Advance Base Regiment grew to the Advance Base Brigade and began advance base maneuvers where the engineer company prepared gun pits, weapon magazines, and built light docks for unloading supplies.⁶⁴ In subsequent years, the engineer company was redesignated as the Fifth Company and served a rifle company in Vera Cruz, Haiti, and Santo Domingo.⁶⁵ During World War I, the Army Corps of Engineers conducted combat engineer operations; therefore, the Marine Corps did not expand its engineer capacity. In February 1921, an engineer battalion was organized in Quantico, Virginia, consisting of Fifth and Twelfth engineer companies. Marine Corps downsizing disbanded the battalion, but the two companies

remained active as separate units. The Fifth Company of engineers was sent to China to protect American lives in 1927. While in China, the Fifth Company constructed temporary bridges and a permanent “Butler Bridge” named after Major General Smedley D. Butler.⁶⁶ Fifth Company returned from China in 1929 and was disbanded in 1932.⁶⁷ The remaining Twelfth Company of engineers continued to perform duties similar to Major Kelton’s battalion on Guam. The need for a permanent engineer battalion had not yet manifested in the Marine Corps.

Over the next three decades, the Marine Corps’ thinking with respect to engineers began to evolve. In 1933, the Navy Department General Order 241 was published establishing the Fleet Marine Force in Quantico, Virginia.⁶⁸ Marines now served with the United States Fleet and had the mission of effectively extending its capabilities ashore.⁶⁹ In April 1935, a force engineer company was organized at Quantico, Virginia.⁷⁰ In the 1940s, the Fleet Marine Force began organizing into Marine brigade and division task forces. Marine engineers were required to produce maps and water, clear beach obstacles and egress routes, construct piers, grade airfields, and employ demolition.⁷¹ Engineer battalions were soon established to support each task force. Officers and enlisted Marines initially attended Army Engineer Schools adopting the training, procedures, and equipment from the Army Corps of Engineers.⁷² In November 1940, an engineer training center was established at Quantico offering specialized demolition, camouflage, and Quonset hut erection courses.⁷³ On May 8, 1941, an Engineer School was established at Quantico to meet the increasing need for qualified Marine Corps engineers.⁷⁴

After World War II began, prewar landing operations and the beach and shore party requirements outlined in the *Tentative Landing Operations Manual* revealed several problems with material handling ashore.⁷⁵ The Marine Corps created a new pioneer battalion to serve as the shore party in support of amphibious operations. Four engineer regiments were formed; each

consisting of a pioneer battalion, engineer battalion and naval construction battalion in support of each Marine Division. Due to distributed operations in the Pacific, each regiment was task organized to provide cross-sectional support. In addition, separate engineer battalions had to be created in order to support airfield operations. The Marine engineers of World War II were truly combat engineers and served in the capacity of both infantry and engineers conducting engineer operations under intense fire.⁷⁶ The Marine Corps as an institution increased in size, evolved its doctrine, and experienced many organizational changes. Combat engineers successfully performed functions of mobility, counter-mobility, survivability, and general engineering in the anti-access/area denial environment in the Pacific theater and continued the same successes in a similar operating environment during the Korean War.

The need for Marine combat engineers was also important during the Vietnam War. In February 1965, the Marine Corps increased its participating in the Vietnam War. Engineers from Company C, Seventh Engineer Battalion reinforced with two platoons from Third Engineer Battalion deployed to Vietnam in support of light antiaircraft missile batteries in Da Nang.⁷⁷ The engineers constructed roads, cleared mines and booby traps and operated water supply points. As more engineers arrived, the Land Mine Warfare and Demolition School was established in Vietnam training more than 5,000 Marines in the nature, operation, and avoidance techniques for booby traps.⁷⁸ The operating environment in Vietnam presented new challenges for the engineers. Rice paddies, jungle, and tunnel complex served as hide sites for the Viet Cong. Teams of engineers—better known as “tunnel rats”—were tasked with searching underground hide sites and locating enemy supplies and destroying the enemy.

During the remaining years of the war, more engineer battalions were activated making noteworthy contributions in Vietnam. When the Seventh Engineer Battalion enter the fight, they

conducted 24-hour river ferry operations in Da Nang.⁷⁹ In the summer of 1966, the Seventh Engineer Battalion constructed a 1,478-foot floating bridge over the Da Nang river capable of handling heavy loads in support of the III Marine Amphibious Force.⁸⁰ The Ninth Engineer Battalion was activated in 1965 and deployed to Chu Lai. While in Chu Lai, the Ninth Engineer Battalion performed tasks including mine clearing, ferry operations, and built the Dickey Chapelle Memorial Dispensary to serve the Vietnamese people.⁸¹ The Ninth Engineer Battalion also worked closely with the Korean Marine Brigade and the Korean Marine engineers in the Binh Son area.

In 1967, the Eleventh Engineer Battalion conducted Operation Dye Marker in Dong Ha, Vietnam. The battalion—led by Commanding Officer, Lieutenant Colonel V. A. Perry—completed numerous mobility, counter-mobility, and survivability tasks. Lieutenant Colonel Perry’s personal account of the situation in Dong Ha describes “big problems with the rotation of key people.”⁸² In an effort to stabilize his unit and mass engineer capabilities, Lieutenant Colonel Perry assumed operational control Companies D and A from the Ninth Engineer and Seventh Engineer Battalions respectively.⁸³ The battalion was repeatedly engaged by enemy indirect mortar and artillery fires, 122mm rockets, landmines, and ambush attacks.⁸⁴ Eleventh Engineer Battalion constructed more than 100 bunkers, laid 14,150 meters of double apron barbed wire, laid 5,100 meters of German Steel Tape, emplaced 62,000 mines, and dug 3000 meters of trenches. Furthermore, the battalion constructed more 25,000 meters of all-weather, class 60, one lane road and upgraded the Cam Lo river bridge for use as a main supply route.⁸⁵ The battalion maintained two water points at the operating base producing more than 15 million gallons of potable water.⁸⁶ The Eleventh Engineer efforts maintained lines of communication,

improved defensive positions, and enhanced mobility in the Third Marine Division's area of operations.

During the Vietnam War, the irregular warfare waged by the Viet Cong presented challenges that gave little distinction between the forward edge of the battlefield and the rear area. Combat engineers performed tasks in all functional area, and their duties expanded into civil action programs which enhanced the support of the Vietnamese population. Over the next 25 years, the Marine Corps would disband some and activate other engineer units and made changes to the organizational structure of the force as a whole. Engineer doctrine and training remained relatively stable for decades. Many lessons learned from past wars especially the war in Vietnam were studied and used in training scenarios. The character of war changed once more in the late 1970s and early 1980s as terrorist attacks began at the height of the Cold War.

SECTION 3: DISCUSSION, EVALUATION, AND RECOMMENDATIONS

On September 11, 2001, terrorists attacked the US nearly twenty years after the Gulf War sparking the Global War on Terror. The Gulf War was a conventional fight, and combat engineers conducted countermine, bridging, and other engineer functions. Over the last sixteen years, the US was consumed by wars on two fronts during Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF) in Afghanistan. The operating environment in Iraq was mostly in urban terrain and in close proximity of the populace similar to the fight in rice paddies, villages, and Hue City during Vietnam. In Afghanistan, the operating environment was almost identical to what the Soviets faced in 1979. Looking back at combat engineer experiences in Vietnam and the Soviet-Afghan War, common threads can be extrapolated.

During the OIF and OEF, combat engineers were vital in support of mobility and survivability. Bridge, road, and airfield repair and construction were also critical tasks that engineers performed and remain viable for future conflicts. The IED threat in both Iraq and

Afghanistan became increasingly complex and more lethal inflicting the most casualties on US and coalition forces. The IED threat resulted in a significant increase of Marine Corps' footprint on the battlefield. Large, survivable mine resistant protective vehicles (MRAPs) were commonly used for mobile patrols and logistics convoys. In 1979, the Soviets faced the same IED threat. The insurgency employed IEDs using the similar yet constantly evolving methods during OIF and OEF. If leaders at the tactical and operational levels had studied the operational picture during Soviet-Afghan War, TTPs could have been developed in anticipation of this lethal threat.

As IEDs became the weapon of choice for insurgents, US forces, specifically combat engineers, became focused on deliberate route and area clearance missions both mounted and dismounted. Engineers also conducted force protection, survivability, and general engineering in support of regimental combat teams. Furthermore, engineers conducted combat operation as provisional infantry, performed priority engineer projects under the operational control of naval construction regiments, and attached engineer companies to combat logistics battalions. The combination of the complex operating environment during OIF and OEF and shortfalls in engineer capacity led to changes in engineer doctrine, organization, and training.

Current Marine Corps Engineer Doctrine, Organization, and Training

In 2008, Marine Corps Interim Publication (MCIP) 3-17.01 established doctrine for IED defeat operations. The publication was developed from lessons learned during US combat operations in Iraq and Afghanistan and complemented the fundamentals of assured mobility (i.e. gap crossing, assault breaching, countermine/counter-obstacle, and combat roads, trails, and forward operating base construction).⁸⁷ After several revisions, *MAGTF Counter-Improvised Explosive Device Operations* was published. Commanders and staffs now had guidance on how to form and train a CIED cell, roles and responsibilities of a CIED working group, methods of

attacking the network and training the force, and IED defeat procedures across the range of military operations.⁸⁸ CIED operations also led to changes in engineer organizational structure.

Currently, combat engineers serve primarily in all four elements of the MAGTF: staff officers in the Command Element (CE), Engineer Support Battalions (ESB) in the Logistics Combat Element (LCE), Combat Engineer Battalions (CEB) in the Ground Combat Element (GCE), and Marine Wing Support Squadrons (MWSS) in the Aviation Combat Element (ACE). Naval construction forces and installation facilities maintenance have also integrated engineers to link appropriate capabilities and concentrate resources. The supporting relationship is normally general support to the Marine Expeditionary Force (MEF) and direct support to elements of the MEF. Task organization is the primary tool used to satisfy support requirements. CEBs and ESBs are the main engineer units tasked with assured mobility. Accordingly, the remainder of this discussion will be focused specifically on these units. Figure 1 depicts the current structure of combat engineer battalions.⁸⁹

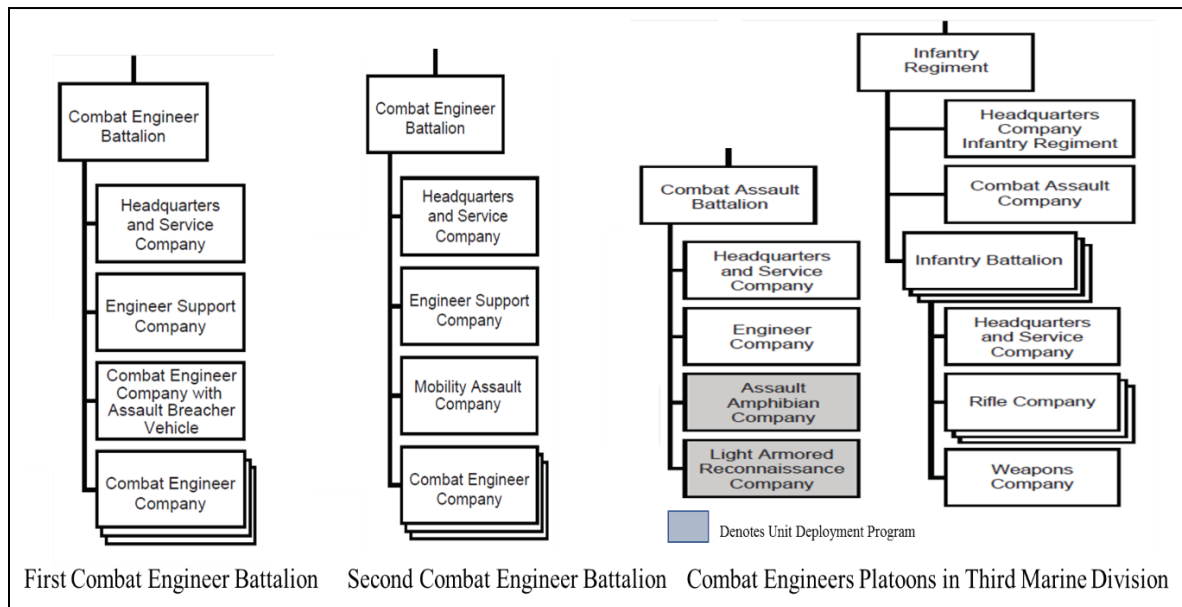


Figure 1: Current Structure Engineer Support Battalion

As shown in Figure 1 above, each combat engineer battalion has a different internal structure depending on which Marine division (MARDIV) it is organic to. First CEB and Second CEB are organic to First MARDIV in Camp Pendleton, California; and Second MARDIV in Camp Lejeune, North Carolina, respectively. Third MARDIV combat engineers only have platoon sized elements in Combat Assault Battalion (CAB) in Okinawa, Japan and Combat Assault Company (CAC) in Hawaii. In 2007, Third CEB, First MARDIV was reactivated in Twenty-Nine Palms, California. The battalion was deactivated again in 2014—just as many other engineer units in the past. The Marine Corps is forced to economize engineer forces due to personnel shortfalls and limited resources such as the Assault Breacher Vehicle and mechanized route clearance vehicles which support mobility and enhance maneuver. Engineer support battalions also support mobility operations and are structured differently depending on which marine logistics group (MLG) it is aligned under as seen in Figure 2 below.⁹⁰

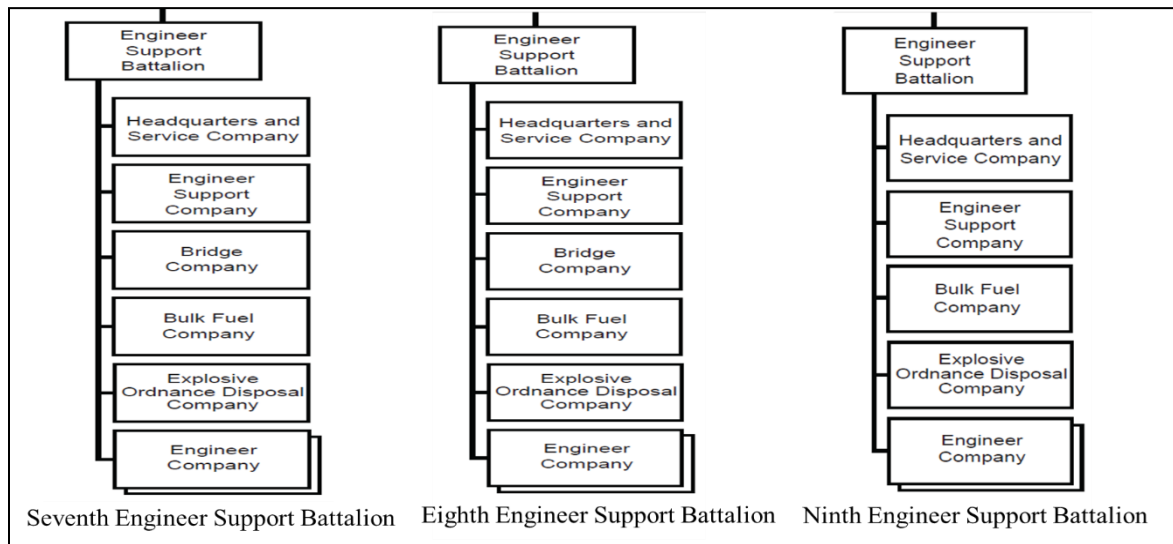


Figure 2: Current Structure Engineer Support Battalion

Seventh, Eighth, and Ninth ESBs are located in Camp Pendleton, California; Camp Lejeune, North Carolina; and Okinawa, Japan respectively. The main difference between the ESBs is the presence of a Bridge Company. Each unit has bridging assets; however, Ninth ESB

does not have a Bridge Company. Manpower and equipment shortfalls produce the same outcome as with the CEBs with one caveat. Ninth ESB is considered a battalion minus even though the battalion is forward deployed in the Pacific area of operations. Ninth ESB's supporting relationships are general support to III MEF and direct support to adjacent units within Third MLG. Ninth ESB support every Pacific Combatant Command and Marine Forces Pacific named exercise. The battalion is also the major support in crisis response and foreign humanitarian assistance mission in the area of operations. The battalion commanders of both CEBs and ESBs have the flexibility to organize their battalions as they see fit in order to provide the highest levels of support. Therefore, combat engineers must be proficient at performing all mission essential engineer tasks regardless of which type of engineer unit they are assigned.

Engineer battalion commanders must develop effective and efficient training plans that cover all functions of engineer operations. Engineer battalions' core mission essential tasks must be completed annual, evaluated formally and informally, and reported accurately and timely to meet training and readiness standards. Individual combat engineers receive qualifying and advanced training at Marine Corps Engineer School in Camp Lejeune, North Carolina. Engineer battalions are responsible for individual and collective unit sustainment. The battalions achieve annual training requirements by creating realistic training events in local training areas and by participating in named annual exercises. Engineers took advantage of white space during the OIF and OEF predeployment training programs to rehearse theater specific tasks prior to deployment. Most of the training conducted by combat engineers is completed within the battalion and is not integrated with the supported unit. It is imperative for engineers to understand how the future operating environment will impact engineer operations and actively seek integrated training opportunities in order enhance maneuver.

Future Operating Environment

The future operating environment is expected to be a complex battlespace, including dynamic actors that may be acting outside the MAGTF's area of operations but have the capability to project influence into the MAGTF's battlespace.⁹¹ Conflicts will last as long if not longer than the current conflicts in Iraq and Afghanistan. The Marine Corps will need to rely on joint and coalition forces to increase operational tempo across a geographically extended battlespace and to extend operational range. Integration of lethal and non-lethal fires will be required more than ever before. The cyber and information domains add two more tiers to the fight. Furthermore, future adversaries will have the ability to persistently observe friendly movements and engage friendly forces using commercial-off-the shelf intelligence, surveillance, reconnaissance (ISR) and unmanned and advanced weapon systems.⁹² Just as in Vietnam, Iraq, and Afghanistan, adversaries are expected to be non-state actors with armed sympathizers that blend into the civilian populace and uncover from hide sites to engage coalition forces at the last possible moment. State actors with conventional forces have increasingly funded and provided weapons to proxies who have launched guerilla style attacks on sovereign states.

Employing local proxies prior to engagement by conventional forces is an effective ambiguous warfare strategy. Marines need to understand this hybrid/ambiguous environment and ensure that training exercises include a combination of conventional and guerrilla force. Lessons learned during counterinsurgency operations in Iraq and Afghanistan are still viable. Adversary's ability to rapidly mass artillery and multiple launched rocket systems (MLRS) onto targets makes the future operating environment less survivable. Persistent observation using unmanned systems makes forward operating bases vulnerable and near obsolete. Tactical dispersion, camouflage, and concealment are fundamental defensive tactics that facilitate

survivability and are reemerging as key protective measures for personnel and equipment. Combat engineers must employ advanced technology during breaching operations to ensure the maneuver force can maintain speed and momentum. Marines will need to train to combat this strategy, and engineers will need to evolve TTPs and review engineer doctrine to effectively support the maneuver force.

Landmines, IEDs, and booby-traps will continue to be employed to inflict the highest number of casualties on US and coalition forces. Conventional forces with MLRS capable of emplacing scatterable mines will directly impact mobility and achieving catastrophic kills on tanks and MRAPs. IEDs and victim operated grenades emplaced by proxy forces will be a significant threat on main routes and in urban areas. Depending on the terrain in the theater of operations, mechanized force may choose to travel off road avoiding IEDs along main routes. The hybrid threat of the future operating environment will have implications for combat engineers in support of maneuver.

Recommended Changes to Marine Corps Engineer Doctrine, Organization, and Training

Combat engineers must invest the time and effort now to review and update engineer doctrine in anticipation of future conflict. CIED will remain a key task as the devices are becoming more sophisticated, and the employment techniques continue to evolve. Engineer planning, equipment, and training must also evolve in order to support a lighter, faster maneuver force. Without adjustment, maneuver forces will either lose speed and momentum or develop a tendency to always bypasses obstacles which will quickly become hazardous once the adversary learns the technique. The Marine Corps understands that robust engineer capabilities must be developed in the MEF in order to enhance maneuver in the future operating environment.

Growth in engineer capability can be achieved by either reactivating battalions or by increasing the manning levels of the current force structure. Third CEB should be reactivated and aligned under III MEF in either Okinawa, Guam, or Hawaii. Tables of organization and equipment can be developed by mirroring all CEBs under the structure shown in Figure 3 below.⁹³ Partial manning can be achieved by consolidating the combat engineers assigned to CAB in Okinawa and CAC in Hawaii followed by lateral move and transition of Infantry Assault Marines to the combat engineer occupational field. Furthermore, mechanized route clearance equipment is still viable in support of open ground maneuver as well as in urban environments.

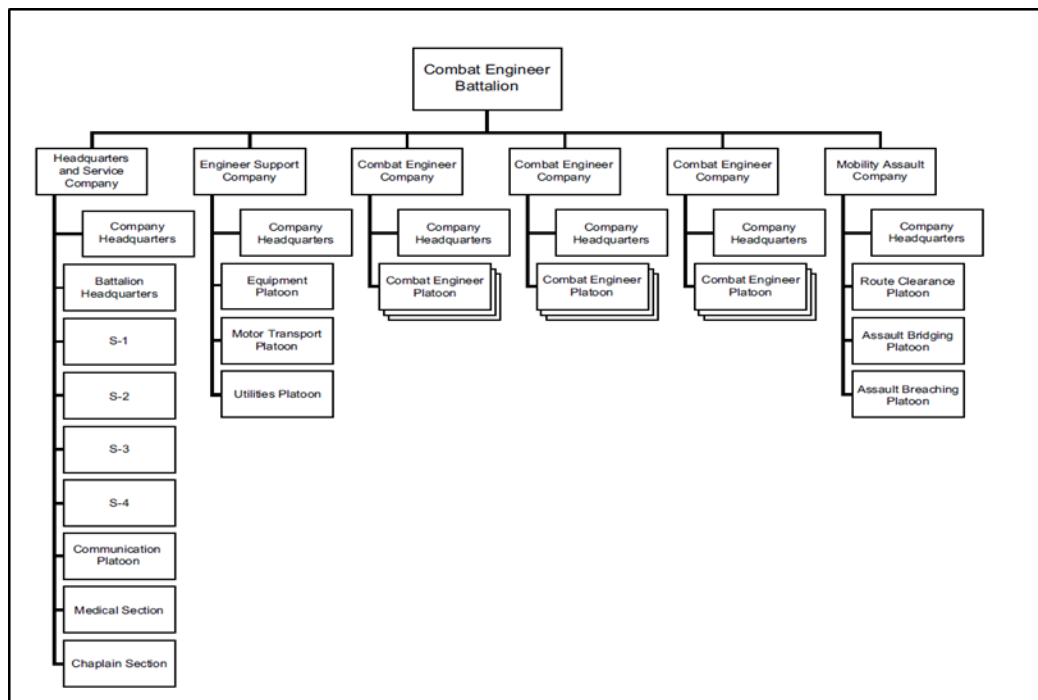


Figure 3: Mirrored Combat Engineer Battalion

The IED threat has overshadowed the mine threat for more than 16 years. Engineers must develop TTPs incorporating advanced technology to combat the evolving more sophisticated mine and IED threat. Combat engineers need to conduct more countermine training and maintain the same level of proficiency in CIED training. Within the current inventory, MAGTFs have MK 154 mine clearing line charges (MICLICs) mounted on

Amphibious Breaching Vehicles (ABVs) and Amphibious Assault Vehicles (AAVs) to clear and proof lanes in minefields. Intermediate mine clearing vehicles need to be developed to replace or augment the current inventory of MRAPs to enhance the speed and momentum of the maneuver force. These intermediate vehicles combined with UAS Swarms capable of locating, interrogating, and reducing mine and IEDs will clear and proof lanes faster and reduce mines and IEDs from a safe distance. Furthermore, advanced technology such as electromagnetic pulse weapons to detonate mines and IEDs should be developed and integrated.

The bridging support for gap-crossing operations is critical to the maneuver. The Marine Corps' inventory currently has limited standard and floating bridging assets to span large gaps. Even with additional assets, time on station requirements to employ them creates a vulnerability in the future operating environment. Typically, tactical bridging (Armored Vehicle-Launched Bridge, Wolverine, Rapidly Emplaced Bridge System) are employed for hasty gap crossings 65 feet or less in width. Accurate and timely reconnaissance of the damaged bridges and dry and wet gaps sets the condition for proper employment of bridging assets. Engineers must integrate manned and unmanned system teaming to conduct good and timely bridge and gap reconnaissance for successful operations. Additional support from CEB, Mechanized Assault Companies and ESB, Bridge Companies are necessary. Planning efforts must include positioning the assets at the right time and place. Lighter expeditionary bridging assets must be developed to support the maneuver force's ability to maintain speed and momentum. Furthermore, inflatable floating bridges capable of supporting a mechanized force must be explored for wet gap crossing.

Because of the light, flexible maneuver force that the MOC outlines, maneuver forces will likely look to locate and use bypasses to overcome damaged bridges and gap obstacles to

maintain tempo. Bridging assets require a significant number of trucks or aircraft for transportation increasing the size of logistic trains or using a large number of sorties. Air assaults facilitate quick insertion of distributed forces which is consistent with the MOC's subtasks of avoiding the disadvantage of mass and employing units with smaller size and footprint. Bridging operations will be reserved to support follow on forces are not developed. The Marine Corps should ensure that each ESB is mirrored and structured with a fully capable Bridge Company as depicted in Figure 4 below.⁹⁴ This structure will ensure that each MEF and MLG are manned, trained, and equipped to enhance maneuver and provide timely and effective support across the range of military operations.

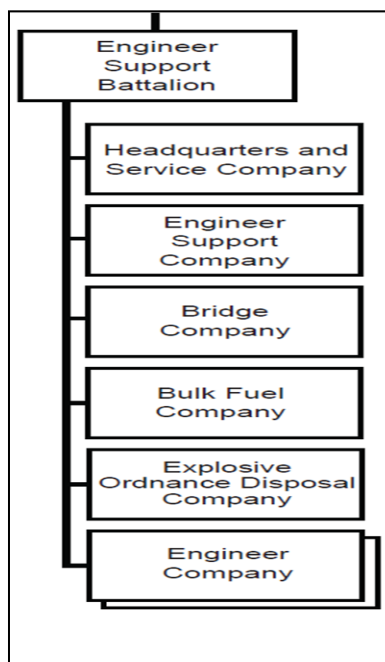


Figure 4: Mirrored Engineer Support Battalion

CONCLUSION

In order to support the enhanced maneuver task outlined in the Marine Corps Operating Concept, Marine Corps engineers will need to explore changes to engineer doctrine, organization, and training. The future operating environment presents the combat engineer with anomalies that subvert the existing traditions and practices in which a new set of rules and

procedures may need to be adopted in order to successfully meet its functional support requirements.⁹⁵ The engineer community as a whole must participate in re-evaluating traditional procedures, alter its perception, and prepare to shift the science that has guided the community through recent successes. In the future, combat engineers will continue to perform the core functions of mobility, counter-mobility, survivability, and general engineering. The doctrinal support relationship between combat engineers, the MEF and elements of the MEF in particularly Marine Divisions must be properly established and understood by all. The engineers will need to continue to task organize elements to provide general and direct support as well as maintain the flexibility to mass engineer efforts. From a planning and training perspective, combat engineer companies should maintain a traditional direct support relationship with an infantry regiment or a regimental landing team enabling each engineer platoon to regularly support an infantry battalion or battalion landing team. The establishment of habitual relationships is key to proper employment and effective support. Combat engineers must deploy as a battalion under the operational control of the battalion commander.

Engineer Operational Advisory Groups meet annually to discuss current and future engineer operations. The complexity and lethality of the future operating environment must be an agenda item during these discussions. It is imperative for the community as a whole to understand how the current doctrine, training and organization will be affected in the future and prepare for the imminent paradigm shift. Military engineers have a vast archive of historical example that can be studied to gain an appreciation of how engineers have evolved. There is no doubt that Marine Corps combat engineers will continue evolve and enhance maneuver for centuries to come. Finally, the opinions and recommendations presented in this study are intended to contribute to the larger community discussion and should be viewed as such.

Notes

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- ² Ralph W. Donnelly, *A Brief History of U.S. Marine Engineers*, Washington, D.C., Historical Branch, G-3 Division, Headquarters, US Marine Corps, April 1968, 1.
- ³ *Ibid.*
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- ⁶ Thomas S. Kuhn, *The Structure of Scientific Revolutions*, 2nd ed. (Chicago: The University of Chicago Press, 1962), 8. Citations refer to Foundation of Unity of Science edition.
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- ⁸ *Ibid.*, 3.
- ⁹ *Ibid.*, 6.
- ¹⁰ *Ibid.*, 7.
- ¹¹ *Ibid.*, 11.
- ¹² Headquarters, U.S. Marine Corps. *Marine Corps Operating Concept*, i.
- ¹³ *Ibid.*, 4.
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- ¹⁵ *Ibid.*, 5.
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- ³⁵ *Ibid.*, 2.
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⁴² *Ibid.*

⁴³ *Ibid.*

⁴⁴ Paul K. Walker, *Engineers of Independence*, 1.

⁴⁵ *Ibid.*, 4.

⁴⁶ *Ibid.*

⁴⁷ *Ibid.*, 29.

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⁷⁷ *Ibid.*, 12.

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