Is It Time To Give The U.S. Engineer Battalion (Combat) (Heavy) A Facelift?

A MONOGRAPH
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14. ABSTRACT

This monograph focuses on a construction unit in the United States Army, the Engineer Battalion (Combat) (Heavy). The Engineer Battalion (Combat) (Heavy) is the main organization, providing the U.S. Army the bulk of its heavy construction capability. This monograph specifically examines the organization and capabilities of the battalion and determines if the U.S. Army should make changes to the battalion organizational structure to make it a more effective combat multiplier for full spectrum operations in the 21st century. The concept of modularity is defined from doctrinal sources and an assessment is made to determine if the battalion configurations affords the flexibility required to achieve this. There is a tendency to look to civilian models, which generally have functionalized companies, when recommending changes to military construction organizations. This monograph examines the differences between operating environments of civilian construction firms and military construction units and assesses how this might impact the organizational design of a U.S. Army troop construction organization. The monograph briefly covers the history, employment and reasoning for the present organization of the battalion. Case studies of the use of combat heavy engineer battalions in Operations Desert Shield/Desert Storm (1990-1991), and operations in Bosnia (1995-2000) are examined to determine the battalion?s overall effectiveness in providing general engineering support to these operations. These case studies provides a basis for examining the use of the battalions in Major Theater War (MTW) operations of short duration in a relatively mature theater, and Stability and Support Operations (SASO) of long duration in an immature and battle damaged theater. Additionally, the present organizational structure of the troop heavy construction organizations in the U.S. Navy and the U.S. Air Force are analyzed to determine if there are any lessons the Army can apply to the organization of the U.S. Army Engineer Battalion (Combat) (Heavy). The author determined that overall, the present battalion structure does not fully meet the criteria established at the beginning of this monograph and requires organizational changes to make it a more effective combat multiplier for the full spectrum of operations in the 21st Century. This determination was made after reviewing the case studies of the battalion?s performance in supporting combat operations in the Gulf War and SASO operations in Bosnia. Both case studies indicate that the battalion was effective, but has some capability shortfalls. The U.S. Army requires two heavy construction organizations, as suggested in the 1985 Carlisle study referenced in the monograph, to address these differences. One organization is tactically focused to support the heavy horizontal construction requirements at the division level and below and would be titled an Engineer Battalion (Combat) (Heavy). This would retain the old name but have a new organizational structure. The second battalion would be a construction battalion and would have an operational focus on infrastructure development. This organization would support operations at the corps level and above and would generally be found in the rear areas. The organizational configuration would be similar to the current combat heavy battalion. The results of this study are important to the future of the Corps of Engineers because there are more Engineer Battalions (Combat) (Heavy) in the engineer force structure than any other type of battalion. Engineers play a critical role in supporting maneuver forces on the battlefield. The Engineer Battalion (Combat) (Heavy) is the most versatile construction capability in the U.S. Army. Changes to this organization could severely impact how well engineers can support maneuver forces on the future battlefield and must be properly tailored to support the full spectrum of military operations in the 21st century.

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Abstract

IS IT TIME TO GIVE THE U.S. ARMY ENGINEER BATTALION (COMBAT) (HEAVY) A FACELIFT? By MAJ Anneliese M. Steele, USA, 97 pages.

This monograph focuses on a construction unit in the United States Army, the Engineer Battalion (Combat) (Heavy). The Engineer Battalion (Combat) (Heavy) is the main organization, providing the U.S. Army the bulk of its heavy construction capability. This monograph specifically examines the organization and capabilities of the battalion and determines if the U.S. Army should make changes to the battalion organizational structure to make it a more effective combat multiplier for full spectrum operations in the 21st century.

The concept of modularity is defined from doctrinal sources and an assessment is made to determine if the battalion configurations affords the flexibility required to achieve this. There is a tendency to look to civilian models, which generally have functionalized companies, when recommending changes to military construction organizations. This monograph examines the differences between operating environments of civilian construction firms and military construction units and assesses how this might impact the organizational design of a U.S. Army troop construction organization.

The monograph briefly covers the history, employment and reasoning for the present organization of the battalion. Case studies of the use of combat heavy engineer battalions in Operations Desert Shield/Desert Storm (1990-1991), and operations in Bosnia (1995-2000) are examined to determine the battalion's overall effectiveness in providing general engineering support to these operations. These case studies provides a basis for examining the use of the battalions in Major Theater War (MTW) operations of short duration in a relatively mature theater, and Stability and Support Operations (SASO) of long duration in an immature and battle damaged theater. Additionally, the present organizational structure of the troop heavy construction organizations in the U.S. Navy and the U.S. Air Force are analyzed to determine if there are any lessons the Army can apply to the organization of the U.S. Army Engineer Battalion (Combat) (Heavy).

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The U.S. Army requires two heavy construction organizations, as suggested in the 1985 Carlisle study referenced in the monograph, to address these differences. One organization is tactically focused to support the heavy horizontal construction requirements at the division level and below and would be titled an Engineer Battalion (Combat) (Heavy). This would retain the old name but have a new organizational structure. The second battalion would be a construction battalion and would have an operational focus on infrastructure development. This organization would support operations at the corps level and above and would generally be found in the rear areas. The organizational configuration would be similar to the current combat heavy battalion.

The results of this study are important to the future of the Corps of Engineers because there are more Engineer Battalions (Combat) (Heavy) in the engineer force structure than any other type of battalion. Engineers play a critical role in supporting maneuver forces on the battlefield. The Engineer Battalion (Combat) (Heavy) is the most versatile construction capability in the U.S. Army. Changes to this organization could severely impact how well engineers can support maneuver forces on the future battlefield and must be properly tailored to support the full spectrum of military operations in the 21st century.

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INTRODUCTION AND METHODOLOGY

CHAPTER 1

> Up she went in rainbows and thunder, an expert, beautiful demolition job. Peiper could only sit with leaden heart and face the fact that time and his luck had entirely run out on him…And he could only sit helplessly, pound his knee and swear bitterly, 'The damned engineers! The damned engineers![1]

These were Colonel Jochen Piper's words as his attack was stopped by the well timed bridge blowing of the engineers in the Battle of the Bulge during World War II, where the Allied Forces defeated the German Army in December of 1944. [2] The efforts of U.S. Army engineers stopped Piper's German Armor Group, which was the main effort for a German attack into Allied lines on the Western Front. The failure of Piper's attack proved decisive to German defeat. In 2000 the "damned engineers" still remain a vital force multiplier in the full spectrum of military operations. U.S. Army engineers serve throughout the world supporting both combat and peacekeeping operations. The primary focus of engineers in the Army at the beginning of the new millennium is to provide mobility, countermobility, survivability, topographic engineering and general engineering to combat forces.[3]

Many different engineer organizations exist in the Army designed to execute specialized engineering tasks. Some units have habitual relationships with combat forces and strictly execute what is known as "combat" engineering. Combat engineers are normally found with the fighting infantry and armor units. These offensively oriented engineers breach obstacles, support mobility for the movement of combat units across the battlefield, use demolitions as necessary, place mines, place other expedient structures to impair enemy movement, provide limited survivability support, provide limited mobility support for river crossing operations and provide limited general engineering. In order to keep pace with maneuver forces during offensive operations, combat engineers are lightly equipped and require augmentation from other engineer units for operations of longer duration such as defensive operations.

The other type of engineer is the combat "construction" engineer. This type of engineer unit normally has more heavy equipment and predominately executes general engineering tasks and augments the "combat" engineer units with mobility, countermobility, survivability and general engineering support. Construction capable units operate throughout the depth of the area of operations. These units normally build, repair and maintain the infrastructure required to support operations. This thesis specifically examines the organization and capabilities of the Engineer Battalion (Combat) (Heavy), the main organization, which provides the Army the bulk of its heavy construction capability[4], and determines if the Army should make changes to the battalion organizational structure to enhance its overall effectiveness as a combat multiplier for full spectrum operations in the 21st century.

"Full spectrum operations include offensive, defensive, stability, and support operations."[5] Offensive operations generally involve the use of attack to destroy or defeat the enemy. Defensive operations serve to blunt the enemy attack and establish conditions on which to launch a counterattack against the enemy. Stability operations promote and protect U.S. national interests by influencing the threat through a combination of diplomatic, informational, military and economic operations.[6] Finally, support operations "employ Army forces to assist civil authorities, foreign or domestic, as they prepare for or respond to crisis and relieve suffering.[7]" This new full spectrum focus appeared after the end of the Cold War.

The Cold War occurred between the U.S and the Soviet Union, from 1945 until 1991, when they were both peer competitor super powers. In 1991, the Soviet Union imploded and the military tensions between the United States and the Soviet Union came to an end. With this end of tension came the end of the U.S. military's preoccupation with war in Europe, against a massive conventional Soviet force. Suddenly the U.S. military was fighting in Iraq during the Gulf War instead of Europe. After the end of the Gulf War in 1991, many small regions in

Central and Eastern Europe, impacted by the fall of the Soviet Union, started to have extensive civil unrest and incidents of ethnic cleansing. Also, there were problems all over other parts of the world spurred by an outbreak of famine. The United States decided to respond to these volatile situations by projecting military forces into these third world countries. In response to this increased operational tempo, the Army realized it had to transform its present structure in order to be more responsive to the changing operational environment.

The Cold War army was proving to be too heavy and outdated. It took too much time to deploy this cumbersome force, which required an "iron mountain" of supplies to support. The military started explore options to lighten up the heavy forces and add more firepower and survivability to the light forces.[8] The military realized it must change its force structure and doctrine in order to be more viable in the 21st century.

One catalyst of change was the development of the *Joint Vision 2010.* The Chairman of the Joint Chiefs of Staff developed the Joint Vision for the Army, Navy, Air Force and Marines. *Joint Vision (JV) 2010* is the blueprint for how the United States military directs the innovation of soldiers and civilian to leverage technology to enhance the overall effectiveness of military force. In 1996, the Army developed an *Army Vision 2010,* which outlined how the U.S. Army would use the land component of military force to become an effective member of the joint warfighting team within the construct of *JV 2010*.[9] The Engineer Branch of the U.S. Army in turn developed *Engineer Vision 21*.

Engineer Vision 21 declares that new technology, reduced resources and a continental United States (CONUS) based power projection force will require the Army to modify the way it conducts operations. The document outlined how the engineers will accomplish their mission in support of the Army and presents a framework for future operations. The U.S. Army Engineer school predicted that future operations would require engineers to cover longer lines of communication (LOCs) and greater areas with less capability. Engineer must be capable of covering the full spectrum of operations from major theater war to Stability and Support

Operations (SASO) for both contiguous and noncontiguous environments. Forces must be ready to deploy to all parts of the world, including both developed and undeveloped infrastructures. Finally, engineers will support combined arms, joint and multinational teams.[10] Armed with a new engineer vision, the Corps decided it was time to reevaluate organizations to determine if they were still viable in light of the changing environment.[11]

This changing environment has proven challenging for engineers. The Army designed a new division called Force XXI, the "digitized division." In 2001, the Army will complete the fielding of a "digitized" division, the 4th Infantry Division at Fort Hood, Texas. Third Corps will be digitized after by 2005. The digitized division structure is based on the concept of network-centered warfare. The extensive use of computer technologies will allow for parallel planning and instantaneous communications both vertically and horizontally on the battlefield. All military platforms, from infantrymen to helicopters, are electronically linked and there theoretically is perfect knowledge of the location of all friendly forces at any given time. This will generate what is known as a "common operating picture" for friendly forces across the battlefield. The new division actually has a reduction in maneuver forces, but because of enhanced information gathering capabilities, covers fronts of greater distances with less combat power. In this environment, tracked and wheeled vehicles still must drive on the ground.

The digitized division, on the future battlefield, will rely on information superiority to give the U.S. forces enough of a advantage in time that friendly forces can quickly reposition from one location to another to attack the enemy with mass. The ability to reposition means there must be solid roads to support this movement and the engineers must be able to maintain the same pace as the maneuver forces. The engineer force structure for this new division allocates no increases in capabilities to address this issue. If the Corps of Engineers must make force structure adjustments to support this new digitized force, it must make those adjustments using existing engineer end strength and standard grade ratios. The Engineer School assessed that "Army XXI has left some gaps in engineer heavy division capabilities. This requires a review of Echelons Above Division (EAD) organizations supporting the divisional fight."[12]

Since engineer organizations exist to support military maneuver forces, the United States Army Engineer School developed a new Operational Concept for Military Engineering Operations based on *Joint Vision 2010* and *Engineer Vision 21.* This concept is the foundation for engineer operations into the 21st Century and will be the cornerstone for the formation of doctrine, training, leader development, organizational structure, and materiel (DTLOMS).[13] In conjunction with the development of the operational concept, the U.S. Army Engineer School formally decided to study the engineer organizations to assess their ability to support operations in the future because of the schools concern that there was a gap in the ability of the current engineer organizations to support Force XXI.

11 February 1998, the Director of Combat Developments at the U.S. Army Engineer School approved the Theater Support Engineer Operations Integrated Concept Team Charter. The purpose of the team was to "look at the required missions for the EAD … engineers, to determine the adequate engineer structure required, and develop the optimal mix of engineer units."[14] This team is chartered to develop an "operations and organizational concept for EAD engineering to support Army military operations for the 2010-2015 timeframe.[15] One of the organizations specified for examination on this charter was the Engineer Battalion (Combat) (Heavy). Officers in the Engineer Branch also refer to these battalions as "combat heavy " battalions.

The combat heavy battalion is presently a critical battalion. There is more of this type of battalion allocated than any other engineer battalion in the current engineer force structure. As a minimum, the Army allocates one combat heavy engineer battalion per U.S. Army division. There is also an estimate made of the number of battalions needed to support operations above the division level. The number of additional battalions above and beyond the divisional requirements is based on the engineer workload man-hour (MH) estimate and comes from the theater engineer estimate based on the specific conditions and requirements identified following an engineer survey of the proposed theater.[16]

The major purpose of the combat heavy engineer battalion is to provide general engineer for the Army and support the maneuver forces. The battalion has a mix of both vertical (structures) and horizontal (earthmoving) construction capability. The battalion structure allows for the flexibility to augment combat engineer battalions at the division level and below with mobility, countermobility, survivability and general engineering support.

The combat heavy engineer battalion is the Army's most substantial general engineering capable unit.

> General engineering helps establish and maintain the infrastructure necessary for sustaining military operations in theater. General engineering tasks may include construction or repair of existing logistics-support facilities, supply routes, airfields, ports, water wells, power plants, and pipelines. It may be performed by a combination of joint engineering units[17], civilian contractors, and host-nation (HN) forces and usually requires large amounts of construction materials, which must be planned and provided for in a timely manner.[18]

The engineer school identified the critical tasks the general engineering units must be capable of for Force XXI. Force XXI, while innovative, still required support for the forward projection of forces. A forward projected force is dependant upon a basic infrastructure to support its deployment in to theater, staging of equipment for movement and subsequent onward movement away from the ports to the area where military action is necessary. In theory supplies will move more quickly to units and there will be less requirements for storage area, not a complete elimination of storage areas.[19] Additionally, the LOCs will be extended and even more critical to the success of a forward projected and mobility based Army, because the ability to quickly reposition forces is integral to the success of the overall operation. The major tasks identified which the troops construction capability must support are construct/upgrade strategic entry locations, construct lodgment areas, conduct split based operations, maintain/upgrade airfields and LOCs, and build, acquire and operate infrastructure to support the force.[20]

The engineer requirements identified in this new operational concept are not different from the tasks identified in former capabilities assessments.[21] The new doctrine seeks to reduce the logistical footprint, yet the requirements must be met. They cannot be dismissed because a new Army vision dictates this. The assessment of what is feasible is important. Transferring construction responsibilities to contract and host nation support still will require the movement of assets to accomplish the construction. Both the U.S. military and the contracted construction agent will compete for the same infrastructure support and will need the same equipment. Additionally, even though there is a perception that contracted construction is cheaper, there are a number of documented examples, which prove that the use of troop construction capability is significantly cheaper than the use of contracted construction. [22] As long as the U.S. military deploys soldiers and equipment, the requirement for an infrastructure capable of supporting that force will remain. Therefore, a study of the effectiveness of the present organization in recent combat and SASO is a reasonable starting place to begin the examination of the overall organization effectiveness of the battalion. Assessment of the battalion's ability to support current operations will be valuable in determining where the engineer school must look to implement potential changes to improve the battalion.

In the October 2000 edition of *Engineer, the Professional Bulletin for Army Engineers*, addressing the engineer future, a lieutenant colonel in the U.S. Army advocated a change to the combat heavy engineer battalion. This change involved the complete dismantling of the battalion and formation of a multifunctional engineer battalion. The article's author contended that six platoons of combat engineer with a little bit of coaching from one platoon of vertically skilled soldiers can get any general engineering task done. The lieutenant colonel goes on the say:

> Corps battalions must be versatile-capable of both combat and construction missions. The current combat-heavy battalion with its six vertical-construction platoons is difficult to employ efficiently once combat starts (except in and around rear-area bases). The Army is attempting to reduce our deployed footprint by maximizing use of host-nation and contract engineers. This plan directly threatens the need for our current number of combat-heavy battalions (42 active and reserve). Similarly, corps mechanized battalions (14 active and

> reserve) have almost no capability to maintain and repair MSRs or to support rear area bases.[23]

In the article, the author proposes elimination of the current corps level battalions identified in the charter for study by the engineer school and advocates creation of separate horizontal and vertical companies that would be attached to the multifunctional battalions as mission requirements dictated. This senior engineer officer advocated creation of a battalion with three line companies in it that have one horizontal platoon and two combat platoons apiece. The Headquarters and Headquarters Company (HHC), would have a vertical platoon and one construction management section in the battalion. This organization, in essence, would allow for task organization of platoons from the functional companies as needed.

The article presented in the *Engineer* magazine is reflective of the debate, which is on going amongst the officers in the Corps of Engineers. There is an indication that some officers in the Corps of Engineers believe a combat heavy battalion is not needed. These officers believe that the Army can have organizations of combat engineers who are capable of executing construction tasks. There are many officers, like the author of this October 2000 article who believe the combat engineer can sufficiently accomplish all the construction requirements within a theater and the need for an organization completely tailored specifically for construction with skilled tradesman is not necessary. Advocates of this position surmise that the contractor and host nation support should be sufficient to cover specific skilled construction shortfalls. In light of the debate, thought, the engineer school does not appear to be reducing the combat heavy engineer battalions in their Total Army Analysis (TAA) process. This thesis explores the implications of functional companies verses the present functional platoons in the combat heavy engineer battalions and determines what is more feasible. All involved in the debate agree that the capability to construction is critical. The issue is who should construct and how should they be organized.

Force XXI places minimal heavy engineering capability in the combat engineer units at the division level and below. The EAD (Echelon Above Division) units provide a vital augmentation to the divisional engineers' mobility, countermobility, survivability and general engineering.[24] The decisions made pertaining to the force structure of the combat heavy engineer battalion could have a major impact on the overall ability of the engineers to meet general engineering requirements across a theater of operations. What the engineers do with this organization could have major impacts on the Army's ability to receive, stage, deploy, and sustain combat forces in the full spectrum of operations. This thesis examines the effectiveness of the organizations in past operations to determine organizational effectiveness in future operations.

Methodology

The concept of modularity is defined from doctrinal sources and an assessment is made to determine if the battalion configurations affords the flexibility required to achieve this. There is a tendency to look to civilian models, which generally have functionalized companies, when recommending changes to military construction organizations.[25] This thesis examines the differences between operating environments of civilian construction firms and military construction units and assesses how this might impact the organizational design of an Army troop construction organization. The thesis briefly covers the history, employment and reasoning for the present organization of the battalion. Case studies of the use of combat heavy engineer battalions in Operations Desert Shield and Desert Storm, and operations in Bosnia are examined to determine the battalion's overall effectiveness in providing general engineering support to these operations. These case studies provides a basis for examining the use of the battalions in combat operations of short duration in a relatively mature theater, and Stability and Support Operations of long duration in an immature and battle damaged theater. Additionally, the present organizational structure of the troop heavy construction organizations in the U.S. Navy and the U.S. Air Force are analyzed to determine if there are any lessons the Army can apply to a the organization of the Army Engineer Battalion (Combat) (Heavy).

To answer the research question, “should the U.S. Army redesign the Combat Heavy Engineer Battalion?” the current organization of the battalion is compared against the following criteria as established in the Organizational Concepts for Military Engineering Operations.

> Engineer Organizations will be modular and easily tailorable, retaining the versatility to conduct: engineer combat operations in a Major Regional Conflict (MRC), or Joint Task Force (JTF); and provide engineer stability and support operations (SASO) in a contingency environment…. Fielding to support contingency operations is an absolute necessity…[26]

Doctrinally, design refers to “reworking or organizing to perform specific functions.” This may or may not create new capabilities.[27]

The results of this study are important to the future of the Corps of Engineers because there are more Engineer Battalions (Combat) (Heavy) in the engineer force structure than any other type of battalion. Engineers play a critical role in supporting maneuver forces on the battlefield. The Engineer Battalion (Combat) (Heavy) is the most versatile construction capability in the U.S. Army. Changes to this organization could severely impact how well engineers can support maneuver forces on the future battlefield and must be properly tailored to support the full spectrum of military operations in the 21st century.

MODULARITY AND ORGANIZATIONAL CONSIDERATIONS

CHAPTER 2

The criteria established for comparison of the battalion includes the concept of modularity and the ability of the battalion to support operational requirements unique to the military. The concept of modularity is not new. In the civilian world the concept is evident in the prefabrication of homes, and modern office workspaces. The idea has been around for a long time. The concept of modularity comes from commercial industry. "For example, the General Motors family of automotive products is modular by definition."[28] The U.S. Army integrated the concept into force design. In 1995 the U.S. Army TRADOC (Training and Doctrine Command)[29] published *TRADOC Pamphlet 525-68 Military Operations Concept for Modularity,* which included the Army's doctrinal definition for modularity. This definition will be presented in this chapter. Additionally, the author will discuss the basic differences between civilian and U.S. Army construction organizations and how this impacts on the overall design of the combat heavy engineer battalion.

Modularity

TRADOC Pamphlet 525-68 outlines the concept of modularity for military operations.

> Modularity is a force design methodology, which establishes a means of providing force elements that are interchangeable, expandable, and tailorable to meet the changing needs of the Army. Modularity will provide tailored functions and capabilities needed by force projections forces across the range of military operations. Modularity will provide the methodology for the Army to achieve a force structure that will optimize rapid assembly of mission-oriented contingency forces that are effective and efficient. Modularity will provide a means of rapidly identifying, mobilizing, and deploying doctrinally sound, sustainable, and fully mission-capable elements/organizations capable of operating in a joint and combined environment.[30]

The performance of the combat heavy battalions will be compared against this standard to determine if the present structure adequately facilitates achievement of modularity. Modularity allows the military the flexibility to support a number of varied operations in potentially diverse environments. Organizations are therefore optimized to provide flexibility first and then if possible, efficiency. There are other considerations unique to Army construction support that can impact how the Army organizes its foundational construction organization.

Military Construction Organizational Considerations

The intent of the battalion is to meet the wartime construction standards needed to support forces in a wartime and SASO environment. *FM 5-104, General Engineering*, outlines Army construction criterion. The criteria are:

- Make maximum use of existing facilities.
- Modify existing facilities rather than undertake new construction.
- Use austere design and construction techniques.
- Minimize US engineer troop construction effort.
- Reduce protective construction. Employ passive protection through dispersion of facilities and equipment to reduce the need for protective construction.[31]

These criteria help to determine what amount of construction is sufficient. The criteria were developed to ensure moderations in the use of construction assets. In a military environment, there is a never-ending demand for construction support. The question must be asked, "Is this militarily necessary and will this enhance the quality of life and infrastructure support process?" The doctrine directs the Army to assess existing facilities in the area first and use or modify them if possible. If a new structure is needed, it will be austere and designed to use the simplest construction techniques. The use of host nation support and contract labor is preferred, especially in a peacetime operation where this construction effort can provide jobs and help stimulate economic growth. "Use of contract labor frees engineer troop units to move forward and reduces engineer force structure requirements in theater."[32] Regardless of the asset used, minimal construction standards are sufficient. As a result of this, military construction units do not need to be as specialized as some the organizations found in the civilian world. When new construction is required, the U.S. Army has a basic rule of thumb developed to determine what standards should be used.

There are two different standards. The first is called the initial standard. This is an austere construction standard and generally requires minimal construction effort. This effort will allow for the construction of facilities, which can quickly support units upon their arrival in theater. Generally these standards are only used for one to six months. The second standard is the temporary standard. This requires minimum facilities needed to ensure appropriate logistical infrastructure to enhance the efficiency of operations. Usually the structures are designed to last two years.[33]

Construction standards are the top priority when considering the design of any Army troop construction organization. The use of the battalion during current peacetime support of military posts required it at times to construct to the more precise civilian coded construction standards of commercial construction. While the battalion proved capable of constructing to a permanent construction standard, rough construction in an austere environment for temporary and semi-permanent construction is the standard the battalion must be capable of executing. The Army is not looking to build something that will last for years to come, only for the length of the operation. [34]

Doctrine also specifies construction principles for a theater of operations, which are economy, flexibility, decentralization of authority and establishment of priorities. Speed is achieved by using existing facilities, standardizing materials and plans, simplicity of design and construction, and only construction of the "minimum necessities." Conserving manpower, conserving equipment, and conserving materials achieve economy. Flexibility is key because the military situation is always subject to change, depending of the progress of the operation. Structures built are designed to accommodate multiple operations, if need be. "For example, a standard building plan may be easily adapted to be used as an office, barracks, hospital ward, or mess hall."[35]

Finally, the establishment of priorities is absolutely necessary in situations where there are limited resources. "By category of work for war-essential missions, theater engineer efforts will generally give first priority to damage repair of air bases and other critical facilities, second priority to LOC repair and third priority to restoration or renovations of other necessary facilities."[36] These principles shape how military construction organizations should be organized.

Many in the Corps of Engineers take note of the specialized, functional companies in the civilian construction industry and believe this is a viable model for U.S. Army construction units. One characteristic of the commercial construction industry is specialization. There are some advantages to specialization brought on by repetition of familiar tasks. The contractor only hires on the crew needed, when needed and then releases it when services are no longer required. Additionally, contractors can rent or lease equipment as required. A contractor decides which jobs to do and can reject jobs.[37]

The U.S. Army does not have this flexibility. It must anticipate future missions to ensure the engineer battalion is trained and equipped to carry out a variety of tasks. This is further complicated by the location where construction occurs. Contractors can pick and chose the location and buy only equipment needed to accommodate the weather in the area. U.S. Army engineers could end up anywhere. The terrain is diverse and the environment unpredictable. The author, in the last ten years, personally operated in the desert, a tropical environment and the Balkan winter with combat heavy engineer battalions.

Additionally, army construction engineers face an uncertain enemy, scattered across the battlefield or area of operations, which is often not easily identifiable and can strike at any time. The army construction engineer battalion and its members must be prepared to defend themselves at all times. This may alter how the structure of the organization is developed. Training becomes challenging because commanders must always try to balance training on construction skills with basic individual combat survival skills.

Day to day operations in military engineer units differ significantly from civilian construction firms because the requirements can potentially change on a moments notice. The civilian construction firm generally hires project managers who plan out every detail of the construction process to maximize assets and minimize construction costs. Generally construction firms bid for a project and can be extremely deliberate and detailed in the construction planning process. For the military, in an operational environment, this is not as common. In war, for instance, the way the overall conflict progresses will alter the construction requirements. It is not uncommon for units to begin construction on a facility and then to stop midstream because there is no longer an operational requirement for it. The circumstance of the conflict and operation are subject to change daily based on the changing military, economic, diplomatic and informational climate. The impacts of these changes were evident during Operations Desert Shield and Desert Storm. A civilian contractor bid and was awarded a contract to build certain specified logistical bases in support of operations in the desert. As the operation progressed, the decision was made to hook maneuver units around to the Western flank of the Iraqi defense instead of attacking frontally. Forces moved at a greater speed into Iraq than originally anticipated. The contractor continued to build the six bases even though the requirement no longer existed for them because this was specified in the contract.[38] The need for responsiveness and flexibility at this extreme level is unique to the military and generally not found in the civilian construction industry. Contracting forms the basis of civilian construction and requires a specific methodical process that does not lend well to significant adjustments.

The elaborate and time-consuming process involved in contracting can significantly reduce flexibility in a military operation. The contracting process and specialization in the civilian construction industry makes for enhanced productivity and efficiency. Civilian construction firms are thus able to plan months in advance and know what requirements they will have in the long term. The Army does not have this level of predictability and organizations must be designed to accommodate the need for multiple capabilities at the company level. Once a requirement is identified, there is limited time available to coordinate for the appropriate assets and companies may be operating at significant distances from their battalion headquarters. Therefore,

> More than the productivity and efficiency of a particular mix of men and equipment must be considered in evaluating the level of functionalization best suited for a military construction unit. The military unit must be organized and equipped for its normal mission and not the exception. Very few projects can be classified as primarily vertical or horizontal type construction. For example, the construction effort to build a road requires both horizontal and vertical effort**,** as does the construction of buildings with only the proportion of vertical and horizontal effort changing. In order to provide a unit capable of fast and responsive support in an environment of changing priorities the military construction unit should have organic both vertical and horizontal capabilities.[39]

In the U.S. Army, construction battalions generally break down into companies and support various units within a division. It is not unusual for one construction company to be assigned to a brigade sized force or smaller to support the general engineering requirements. The combination of horizontal and vertical capability within a company gives the organization the flexibility to execute a vast array of projects without having to coordinate at the battalion level. This organization therefore can be more responsive to a rapid and changing environment. The company also has the flexibility to quickly execute, for example, a road-building project and emplace culverts for drainage with the vertical construction tradesmen simultaneously. This is the type of flexibility needed in army construction organizations that is generally not found in the civilian world.

Another important difference between military and civilian firms is that the Army is not organized for profit. Soldiers cannot be contracted for, used and sent on their way when the mission no longer requires their services. The U.S. Army maintains soldiers and construction capabilities. Soldiers must have a place to sleep, food to eat and be properly trained to execute a variety of construction tasks sufficiently. Soldiers, who serve in construction battalions, ultimately must be willing to give their life in defense of their country, if need be. Since serving in a military unit may require the members of that unit to fight and defend themselves, the leader must have a relationship with the soldiers. A company structure best achieves this. It forms a bond, unique to the military. Team building is the essence of military success. Unit cohesion is paramount. Placing equipment aside, the soldier is really the most important part of military success. Janice Giles expressed it eloquently in the book, *The Damned Engineers*. This book was written after World War II and tells the story of an engineer battalion's experiences during the Battle of the Bulge.

> True, they were all split up. Companies were spotted here and there and platoons and squads were distributed around over a fifty-mile radius. But as long as the basic unit, the platoon and its squads, was relatively intact the men did not feel dislocated. The company was the integral unit, but within it the squad was the family and the platoon was its home.[40]

Additionally, the military develops its own leaders internally. Seasoned leaders mature in the organization and cannot be hired after gaining leadership and technical experience with a civilian corporation. The company structure allows soldiers to specialize in their occupational specialty but then execute other skills across the vertical and horizontal requirements found in the platoon. This develops them for the future where they can supervise companies and platoons with multiple skilled occupational specialties. "The multicapable company will be able to more quickly change jobs as they will be capable of execution of a major portion of their missions without the addition of other personnel and equipment."[41]

The ability to construct facilities and improve the operational environment is a critical capability for any force, which must survive in concert with nature, on the ground. The U.S. Army is a ground force and must live and move in varied and trying environments. The unique environment in the U.S. Army requires a construction capable unit that has the flexibility at the company level, to construct a wide variety of projects. The company should be able to operate independently, at multiple construction sites, without major coordination with the battalion. Since military construction organizations must be competent at construction and self-defense, a company structure with functional platoons best achieves this. A reduced footprint may be desired, but the basic support requirements must still be met. The U.S. Army needs troop construction assets that and responsive and do not require extensive contracting procedures which are time consuming and rigid.

HISTORICAL DEVELOPMENT OF THE ENGINEER BATTALION (COMBAT) (HEAVY)

CHAPTER 3

The U.S. Army formed a construction battalion toward the end of World War II to provide a capability to execute the heavy construction requirements emerging during the war. Initially the battalion mission focused on limited field engineering in support of tactical and logistical operations. The battalion proved too limited in construction capability to meet the heavy construction demands of the war. [42] As the war progressed, the development of machines to fight war evolved and requirements for construction increased with these changes. Significant construction requirements came with the need to develop bases to support the air corps, port facilities and petroleum pipelines.

The U.S. Army originally designated the combat heavy battalion as an Engineer Construction Battalion. In 1974, the Secretary of the Army renamed the organization the Engineer Combat Battalion (Heavy) to give it an enhanced *combat construction orientation*. In the early 1990s, the Army again changed the name to Engineer Battalion (Combat) (Heavy). This chapter discusses the development of the battalion, the changes that were made to it over the years, and why.

The debate of how to organize combat and construction capabilities generated much speculation in the early 1970s and continues today. In 1972, a student at the Command and General Staff College in Fort Leavenworth Kansas conducted a study, at the request of the Corps of Engineers, to determine if the engineer construction battalion and the combat engineer battalion could be made into one "universally capable" engineer battalion. The decision to consider the creation of a universally capable battalion was driven by feedback received from

After Action Reviews (AARs) from the Vietnam War. These AARs generated a great deal of discussion about the organization of engineer battalions and their respective capabilities. During the Vietnam War, engineers noted that the combat engineer battalions often constructed base camps and other support facilities that required a greater degree of technical expertise and equipment than they was authorized on the Table of Organization and Equipment (TOE). Additionally, many construction battalions executed combat support type missions on the front lines and they were not properly armed to defend themselves in this environment. The study determined it was not feasible to combine the requirements of the two battalions and make one battalion capable of performing a composite of the missions of both units.[43] The combat and construction battalions focused on different missions and training for competency in both would be overwhelming. This was not the only study conducted in the early 1970s.

In 1970, the United States Army Combat Developments Command conducted a study on the Engineer Construction Battalion. The study tended to prefer the functional platoon level organizations presently in the battalion. However, a study by a board of five officers entitled "Engineer Troop Organization Review Board" submitted a proposal to change the organization of the battalion to functionalized companies as opposed to the current functionalized platoons and mixed capabilities at the company level. This functional battalion, in theory, would increase productivity and save manpower because it consolidated personnel by skills and was similar to the organizations used by civilian contractors. The major outcome of these two studies was a recommendation to form a test battalion at Fort Carson, Colorado to determine the use and effectiveness of off the shelf commercial construction equipment and a radical change of the company organization to functional companies instead of platoons.[44]

The field evaluation of the Engineer Construction Battalion determined that the functionalized organization was "considered superior"[45] to the old organization, but still had some deficiencies and did not maximize the engineer resources available. The study recommended adopting the functionalization at the company level, increasing the overall earthmoving capabilities and creating vertical construction squads composed of a mix of carpenters, electricians, plumbers and a helper. Centralized communications caused many problems during the evaluation, but the report recommended this anyway. The consolidated mess was outstanding because it allowed for a reduction in personnel. Centralized supply operations were viewed as viable. The planning, scheduling and coordination of construction assets for this new organization now occurred at the battalion level instead of the company level.[46] According to the report,

> Functionalized companies do not have the capability to independently accomplish most engineer tasks with organic resources and must rely on support from another functionalized element in the battalion. The loss in flexibility is compensated for by the efficient utilization of skills and equipment throughout the battalion.[47]

The report also documented a "lack of command attention to construction operations by company commanders caused by the functionalized design."[48]

At the same time the study above concluded, the nation sought to balance a shrinking budget with a desire to achieve a better "tooth to tail" ratio for the General Purpose force structure. The "tooth to tail" ratio compares the combat forces to those in the sustainment structure needed to support them. In 1975, engineer combat battalions were factored into the tooth portion of the ratio and the construction battalions fell under the tail. The Nun Amendment[49] directed the US Department of Defense to improve the "tooth to tail" ratio in Europe in FY 1975 in favor of the tooth, or combat forces. The construction battalion was about to fall prey to the cuts coming as a result of this Amendment. Category II units are combat service support type units. The battalion was a Category II unit. The classification and unit name caused force structure analysts to overlook the battalion capability and historical use in performing combat engineering tasks as well as heavy construction missions. In numerous After Action Reports (AARs) leaders recorded many examples of the battalion's versatility where it actually performed the combat tasks more efficiently then the combat battalions.[50] This concern resulted in the implementation of a greater combat focus to the battalion.

The engineer force structure planners realized that by augmenting the battalion with enhanced individual and crew served weapons systems and training, the battalion could execute the additional combat engineering tasks, specifically to fight as infantry, in the defense, as missions required. There was no way to work around the limitation for use of the battalion in offensive operations. The battalion was too heavy and did not have the time to conduct detailed training to develop the individual skills required to execute the complex, offensive type combat engineering missions.[51] In September of 1974, the Army Chief of Staff approved and implemented the name change of the construction battalion to Engineer Combat Battalion (Heavy) and added the task of performing defensive operations as infantry, when required, to the battalion's task list.

The Engineer School reviewed the old TOE for the battalion and determined that the lack of squads in the organization hindered the transformation of the battalion to fight as infantry. In September of 1974, platoons were made up of specialized sections. For instance, the line companies within the battalion had a vertical construction platoon with a woodworking section, and a support section. The second platoon in the company was a specialized skills platoon with an electrical section, plumbing section and heating and cooling section. The Engineer School modified the unit's vertical platoons to squads, as recommended in the Fort Carson field study, and added 50 caliber machine guns, 40-millimeter grenade launchers, demolition sets, mine detectors, radios, speech security equipment, telephone equipment, and the Dragon, an antitank weapon. This new structure resulted in a change of the classification category to I. The "tooth to tail controversy" also caused the Corp to decide to retain the flexibility of functionalized platoons instead changing to functionalized companies, as recommended by the results of the field study conducted in 1974. A more civilian type organization with functionalized companies, verses one designed for combat is less likely to survive the tooth-to-tail debate.[52] The engineers decided to create a "multi-functional" battalion capable of both construction and combat. This was embodied in the Combat Engineer Battalion (Heavy).

Not much literature exists analyzing the combat heavy structure again until the early to mid 1980s. By this time, the new battalion was in place for a while and members serving in the organization began to express some concerns about its structure. These concerns were summarized in a study conducted by a group of U.S. Army War College students.

In 1985, a group of former engineer battalion commanders, while attending the U.S. Army War College, put together a study project and proposed *A Combat Engineer Force Design for 1995*.[53] This group designed their study to focus on the concerns of what they saw in the field. The study covered all the various types of engineer organizations in the force structure. This thesis only addresses the War College study observations pertaining to the combat heavy engineer battalion.

The new designs proposed by the study for the combat heavy engineer battalion considered criteria such as maximizing support to the combat mission, ensuring adequate command and control mechanisms, consolidation of specialized skills in functional units, and minimization of infrequently used equipment in forward units. In their discussion, combat engineers focused on supporting maneuver units, and combat heavy engineers focused on repair and rehabilitation.[54]

In the study, the group highlighted that the combat heavy engineer battalion was the most controversial of all the battalions in the engineer force structure. According to the study, in 1985, the senior leadership in the Corps of Engineers questioned if troop construction capability was even a force structure requirement. Many senior leaders in the engineer branch cited the extensive improvements in the infrastructures of Korea and Europe as nullifying the need for any organic construction capability and contractors were assumed to be able to cover the shortfalls, if necessary. Additionally, engineer leaders were trying to decide if the battalion should be all construction or a mix of construction and combat capability. Finally, the engineer leaders grappled with where the battalion would be used on the battlefield.[55]

The study group debated these issues as part of their study and concluded that war dictated a critical need for a unit capable of conducting general engineering/combat construction tasks.

Most of these tasks would be horizontal in nature (e.g., roads, landing strips, heliports, storage hardstands, etc.) in direct support of combat operations. These experienced engineer commanders believed that most of these missions must be executed forward of the corps area. The amount of exposure to danger would make it infeasible for execution by host nation support and civilian contractors.

Based on analysis of survey's sent out to all ranks in the combat heavy engineer battalions across the force, and their individual experience in the field, the study group determined:

> The current mission is too broad. It should be refocused on combat construction, emphasizing repair, rehabilitation and modification of existing facilities. It should not be used for traditional "combat engineer" tasks except for those involving moving large quantities of earth (e.g., antitank ditches, protective berms, etc.). The unit should not be expected to reorganize to fight as infantry but only to provide limited self-defense. The proposed organization of the battalion essentially doubles its horizontal construction capability; reduces its vertical capability approximately 60 percent; and organizes the horizontal and vertical elements into functional companies-two Combat Earthmoving Companies and one Combat Construction Company. The Direct Support Maintenance capability is increased to service the increased density of heavy engineer equipment.[56]

The report goes on to conclude that the battalion should have support prioritized and requires organizational changes. The first priority should be in support of divisions, corps, the theater, Army and Air Force. Emphasis should be placed on damage repair, rehabilitation, rubble clearance, antitank ditch construction, etc. verses new construction. The second priority should be toward the execution of combat engineering tasks and new construction tasks in support of the Army and the Air Force. The third priority should be toward the performance of only defensive infantry and rear area protection tasks. The organization needs increased horizontal construction capability and a reduction in vertical construction capability. Additionally, the mobility of the battalion must improve. Also, the study recommended two options. The battalion can be maintained as is with a greater orientation toward horizontal missions or two types of battalions can be formed. The "combat heavy" would support corps and division area operations and another construction battalion would support the COMMZ (Communications Zone).[57]

Past studies can help officers sift through the debates and come to resolution on issues. The previous studies are valuable in determining what should be done today. The issues already addressed in this historical analysis are the viability of "multifunctional" battalions, functionalized construction companies, options to consider for the reorganization of combat heavy engineer battalions and the implications of contracting and host nation support reliability on combat heavy capability requirements.

The battalion leading into Desert Storm and in 2000 only differs from the 1985 battalion in that the headquarters and the equipment maintenance companies are now combined into one company called the Headquarters Support Company (HSC) and the unit was changed to a category II unit again after the secondary combat engineer mission of fighting as infantry in the defense was removed from the mission. Additionally, skilled laborers such as structures specialists, material quality specialists, and exterior electricians, are no longer on the TOE. Skills such as construction surveyors and draftsman were removed from the line companies and are now in the headquarters support company, as are the food service support, and communications support personnel and equipment.

Many issues presented in this chapter are being discussed amongst senior engineer leaders in 2000. The similarities of the issues in the 1970s and today are astounding. In light of examining the historical development of the battalion, it became apparent that the recommendations for the restructuring of engineer forces in 2000 are eerily similar to those proposed in the 1970s and 1980s. The study of the history of an organization and the field tests and debates is valuable when proposing changes to organizations in light of changing visions in the Army. For example, proposing functionalized construction companies and multifunctional battalions without researching to see if these ideas have already been tried and tested seems to be the standard. The issues faced today pertaining to the combat heavy engineer battalion are not new. Knowledge of previous studies helps to place all the debates and proposals for organizational change into perspective.

The first issue is the viability of “multifunctional” engineer battalions. The author realized, while researching the battalion, that the multifunctional battalion concept found in literature at the beginning of the 21st century is basically a product of the same thought process that resulted in the “universal” battalion concept and the conversion of the construction battalion to a combat heavy with a greater combat focus in the 1970s. Designers must have a solid grasp of the evolution of an organization over extended time to gain an appropriate perspective of it.

Studying the concept of multifunctionality from the broad perspective of sixty years results in the unveiling of a true dichotomy. In the 1970s and 2000s officers tried to develop an engineer organization that is “multifunctional” and capable of performing both combat and construction missions. The 1970 proposal sought to achieve this by increasing the combat capabilities of the construction battalion. The 2000 proposal reverses this by seeking to achieve multifunctionality by increasing the construction capability of the combat battalion. These studies seek to address the same multifunctional problem by changing the construction battalion in the 1970s and the combat battalion in 2000.

The U.S. Army converted the combat heavy engineer battalion in 1974 in order to make it more multifunctional. Surveys issued to members of the battalion in 1985 resulted in the determination that the expanded multifunctional mission was too broad to sufficiently train the unit. The results of surveys in the 1985 study conducted by the War College students indicates that there is a great likelihood that the “multifunctional” engineer battalion proposed in 2000 may experience the same problems with a mission that is “too broad” that the combat heavy battalions experienced from the mid 1970s to the early 1980s, following the conversion of the construction battalion to a more “combat” focused organization. The combat heavy engineer battalion already is “multifunctional” in its construction capability; the combat battalion is already multifunctional in its combat capability. A further mixing of the two organizations may not be feasible due to the already high level of complexity of executing tasks required in each organization and the high level of training needed to perform these tasks.

History indicates there is a training threshold on trying to mix the training of all the combat tasks required for a combat engineer battalion with all the construction tasks required for the development of construction skills. In peacetime, construction battalions do practice their construction skills. This ensures soldiers are prepared to execute their missions in wartime. Based on the experience of two commands of combat heavy line companies totaling forty months of command and two battalion-sized deployments overseas with this organization, the author agrees that combining training on combat and construction would be difficult. There is a degree of competency developed through the repetition of construction related tasks, even though soldiers in the battalion received rudimentary training on the respective construction trades prior to assignment to the battalion. Without the training and experience received by executing construction projects in garrison, the soldiers in the company the author commanded would have had a difficult time executing the tasks assigned to them in Bosnia. As an example, the line platoons laid extensive formwork for concrete wash racks. The experience from a state side construction project with extensive formwork requirements contributed to the unit's ability to construct this complicated structure. The engineers today may already have achieved their maximum degree of multifunctionallity for the present engineer force structure.

The second issue is that of forming functionalized companies. The field test results state that the functionalized companies are more efficient, but less flexible. The most important characteristic of engineering organizations in 2000, as stated in the engineer operational concept, is "flexibility." The field test, conducted in the early 1970s shows an Engineer Corps that was willing to commit resources, time and effort to test the concept of functionalized companies and documents the results. The results of this study indicate that the functionalized platoons are the more flexible structure for combat heavy engineer battalions and are more consistent with the *Engineer Vision 21* than functionalized companies.

Another interesting proposal came out of the 1985 study done by the War College students. Engineers in the field recommended the possibility of developing two organizations instead of just having one combat heavy. The officers in the 1985 study presented this as a possible solution, but did not propose what the two organizations might look like. Assessments of the demands for engineer assets in the case studies following give some indications on what the two organizations might look like. This is a viable option for redesign that comes to light in studying the history of the organization.

Current engineer doctrine speaks of maintaining a balance between troop construction capability and contractor and host nation support.[58] Again, this is not a new concept. Many involved in force design in 2000, believe this is a solution to all of the budget problems. The case studies can confirm or deny how viable contract construction is and help to determine what the implications are on combat heavy organizational design.

From World War II to the dawn of the new millennium, the construction engineer proved decisive. During this time, the battalion underwent surprisingly few changes as it endured the test of study after study. Every organization committed to the service of a nation is subject to change as the direction of policy in the nation changes. Knowledge, of the sequence of events and thoughts of how to organize engineering capability, which brought the U.S. Army to the present combat heavy battalion structure, is beneficial to the establishment of an understanding of what issues the engineers have already addressed in the quest to set on a course to improve the organization. This knowledge will help avoid making repetitive changes that may not be successful and can prevent a waste of time and valuable resources in the future.

PRESENT ORGANIZATION STRUCTURE

CHAPTER 4

A brief description of the battalion's present organizational structure is necessary to provide the reader familiarity with the organization, and to facilitate understanding of the recommendations to the organizational structure presented in the case studies and final conclusions in this thesis. An understanding of the organizational structure allows for the ability to compare it with the construction organizations in the other services. This organizational description will help those unfamiliar with engineer organizations to understand how the capabilities in the battalion are packaged.

The battalion is arrayed with a headquarters and support company and three general construction line companies. The headquarters and support company includes the command group section and the headquarters company. The headquarters company has the U.S. Army standard set of staff sections headed by a commissioned officer to ensure the administration of the organization. The command group is led by a lieutenant colonel that is an engineer officer. The staff sections include the S-1 (personnel), S-2 (intelligence), S-3 (operations/construction management), S-4 (supply), communication section, medic section, unit ministry team (chaplain), an equipment platoon, and an organizational maintenance platoon, which can perform two levels of maintenance. The maintenance platoon can conduct organizational maintenance (parts changing) and direct support maintenance (changing out major assemblies as part of the repair process).

The construction specific capabilities of the headquarters and support company are found in the S-3 section and the equipment platoon. The S-3 section has a civil engineer who is the battalion construction officer. The S-3 is usually a major and has oversight of the construction officer and the soils and survey section. The soils and survey section conducts soils testing, surveying for the battalion and quality control inspections. These sections are now starting to integrate Computer Aided Design (CAD) and upgrading their equipment on an individual basis. Additionally the company has an equipment platoon, which generally supports the projects in the line companies with equipment that is not used as much as that found in the line companies but is vital for support when needed. This platoon can oversee quarry hauling operations if need be with its five cubic yard scoop loaders and nine twenty ton dump trucks. It also has material handling equipment (MHE) for the operation of a battalion construction material yard.

The equipment platoon is broken down into a platoon headquarters, a construction equipment section, asphalt and concrete section and a dump truck section. The construction equipment section provides heavy lift, pile driving and structure demolitions capability to the battalion. The asphalt and concrete section has limited capability. It is not equipped to produce asphalt and crushed aggregated. The platoon does not have the ability to blast rock at a quarry site to create aggregate. The asphalt capability is limited to distribution of hot oil emulsions for hot landing strips and patchwork on roads for potholes. The battalion requires augmentation of an asphalt detachment to run full-scale asphalt production and road paving operations. The asphalt and concrete section does have concrete mobiles, which are self-propelled concrete mixers. The dump truck section has the greatest capacity dump trucks in the battalion, twenty-ton dump trucks. The major heavy-duty hauling production comes out of this organization. The line companies only have five-ton dump trucks and are not nearly as productive as the twenty-ton dump trucks. Extensive hauling missions require the use of eight personnel from each vertical platoon to man the potential eight dump trucks that could support hauling operations. However, if the line platoon has the vehicles committed to moving squads for other missions, the hauling capability may be reduced due to competing commitments. In multiple operations, the battalion resorted to hauling scrapers on small, poorly maintained theater roads.[59] Overall, the platoon has the ability to run limited quarry operations. They can oversee the material displacement, loading and hauling operations, but cannot blast rock or sort. They require a link up into an already existing quarry structure and supplementation of scoop loaders from the line companies to run twenty-four hour operations. The breakdown and major equipment found in these organizations are shown in figures one through five.[60]

The three line companies all have the same configuration. The companies have vertical construction, horizontal construction and organizational maintenance capability. The line companies are functionalized at the platoon level with two general construction platoons (vertical construction), one horizontal construction platoon, one headquarters platoon, and one maintenance section. The horizontal construction platoon has a platoon headquarters, an embankment section, an excavation section and a grading and compaction section. The general construction platoons have a platoon headquarters, and three construction squads. The three construction squads have carpentry and masonry specialists, plumber/pipe fitters, and interior electricians. The squads have mixed trades in them to allow for cross training to accomplish the construction tasks, whatever they might be. The platoon also have four five-ton dump trucks, which are used to move personnel, haul construction tools and materials, and augment hauling operations to support the earthmoving operations. The general construction platoons build structures and the horizontal platoon builds roads and conducts earthmoving operations in support of the vertical construction. The organizational structures and equipment are shown in figures six, seven and eight.[61]

The combat heavy engineer battalion is a versatile organization specifically designed to execute construction missions and provide a command and control structure for additional specialized engineer companies and detachments. The battalion is capable of self-defense and has a limited combat engineering capability. Since the mid 1980s, the current battalion structure has been effective at providing general engineering support for numerous deployments in support of military operations across the globe. The combat heavy battalions have worked together with contractors and other sister service construction organizations on the same projects. An examination of some of the other sister service construction organizations provides perspective and a comparative framework.

JOINT ENGINEERING ORGANIZATIONS

CHAPTER 5

"Since Desert Storm, the U.S. military has operated as a joint force in nearly every significant operation-whether it was a regional contingency, humanitarian relief, disaster recovery or nation assistance scenario."[62] The operational environment of the 21st century requires engineers from different services to work together to accomplish construction missions for the U.S. military. Outlined below is a brief orientation for the reader of the troop construction capabilities found in the U.S. Navy and U.S. Air Force. These are the two services, which most frequently work with the U.S. Army. The study of these organizations allows for the consideration of alternative ways of configuring military construction capability.

Each service developed construction capabilities at different times. The Naval Mobile Construction Battalion (NMCB) originated in WWII as a result of shortfalls in U.S. Army construction capability. The U.S. Air Force gained construction capability in 1965. The U.S. Army has some critical capabilities, in specialized companies, that are all in the reserve force structure, which the sister services have in their active duty construction organizations. Unlike the Army construction battalions, both the Navy and Air Force have rapidly deployable detachments, which are self-contained and capable of supporting construction requirements for initial entry of forces into a theater.

The main construction capability in the U.S. Navy is the Naval Mobile Construction Battalion (NMCB). The sailors in this battalion are also called "seabees." For planning purposes, this battalion is considered equivalent to the capability found in the combat heavy engineer battalion.

Experience in operations with the organizations side by side indicates that the naval battalion actually has more vertical construction (structure building) capability than the combat heavy engineer battalion. The combat heavy engineer battalion, however, has more horizontal (earthmoving) construction capability and is more mobile. The NMCB battalion has an air detachment composed of one hundred personnel, which provides the organization flexibility at the beginning of operations. Engineer planners view this battalion as the asset of choice for joint construction capability.

The NMCB has four or five companies and is functionalized at the company level. A full battalion has over seven hundred seabees, six hundred and five on active duty and one hundred and thirty five in the reserves. The battalion is easily task organized into two smaller units, depending on mission requirements. Two companies are capable of vertical construction, one company has horizontal and maintenance capability and one is administrative. Each company has two rifle platoons and one weapons platoon, except for alpha company and the headquarters company. The headquarters company has two rifle platoons and a mortar platoon. The alpha company has three rifle platoons and a weapons platoon. Some battalions will have an extra company, a delta company, which is the same as charlie company. Often in support of operations, the battalion will create a new company or detachment headquarters and place a combination of horizontal and vertical assets in the company to deploy a versatile organization to support missions.[63]

Alpha company is the largest in the battalion with approximately one hundred and twenty soldiers and is a horizontal construction company. This company does all the large earthmoving, grading, excavation, paving, hauling, pile driving, well drilling, heavy lifting, blasting and demolition projects. They also are responsible for operation and maintenance of automotive, construction and material handling equipment.

Bravo Company is the naval construction force camp maintenance company. The company works in the naval camps and serves on other contingency operations assigned to the battalion.

The company has many varied trades including utilities men (UT), construction electricians (CE), builders (BU) and steelworkers (SW). It specializes in maintenance and repair of facilities and camps and helps defend the battalion during wartime. The company also installs electrical distribution systems similar in size to what a small town would need.

Charlie company performs the bulk of the vertical construction tasks for the battalion's main body. The company has a mix of skilled tradesman attached and they include BU and SW capable of carpentry, masonry, concrete finishing, interior finishing, roofing, welding, structural steel erection, sheet metal fabrication, timber construction and rigging. This company is referred to as the general contractor of the battalion and oversees the construction project management in the battalion. This company builds permanent and semi-permanent structures.

Lastly, the headquarters company supports the line companies. The company handles administration, quality control, engineering, computer and information services, supply, materials coordination, disbursing, food service, tool room operations, storage room operations, automotive repair parts, the armory, the communications shop, information technology, electronics technicians and public affairs specialists.[64]

The battalion also has a self-contained air detachment, approximately one hundred seabees strong, that deploys ahead of the main body and can act independently. They are trained to operate in hostile environments. Generally the detachment is task organized to meet mission requirements. It is limited to two hundred and fifty to three hundred short tons, which usually comprises fourteen C-141 loads. The detachment normally has a supply support, horizontal construction and general construction section. Air detachment equipment can include any of the equipment shown in table one.[65]

The U.S. Air Force has two primary organizations, which conduct construction. The organizations are the Prime Beef Force and the Air Force Red Horse Squadron. The Prime Beef Force is a civil engineering squadron composed of one hundred and forty three personnel and supports air force wings when deployed. The squadron responds within twenty-two hours of notification and can go anywhere in the world to support contingency and major theater war operations. The squadron is composed of five elements: a firefighting team, a craftsman team, an ordinance disposal team, a disaster preparedness team and a personnel services team. The organization does not have any heavy equipment. The air force generally prepositions heavy construction equipment in the theater and sends operators to fall in on the equipment. The Prime Beef is an initial bed down capability for one thousand and two hundred personnel, and provides maintenance support for airfield facilities for up to twenty-four tactical aircraft.[66] Prime Beef lacks sufficient capability to respond to heavy bomb damage and cannot provide major bed down and repairs.

Red Horse stands for Rapid Engineer Deployable Heavy Operational Repair Squadron. The Red Horse squadron is a mobile, self-contained force composed of four hundred airmen capable of executing medical, food service, vehicle and equipment maintenance and supply operations. The organization provides combat engineering support to U.S. Air Force tactical units in wartime theaters of operations. The organization provides heavy engineering capability and executes force bed-down, heavy damage repair, bare base development, and heavy engineering operations. Capabilities include airfield lighting, concrete operations, explosive demolition operations, aircraft arresting system installation, material testing, quarry operations, rapid runway repair, revetment construction, water well drilling, mobile facility assets construction using automatic building machines, emplacement of expedient fuel systems, facilities hardening activities, expedient pavement expansion, utility system repair, force bed down, heavy earthwork, road construction, power generation plant installation and operations, command and control, engineering design and, base denial operations. The unit is capable of self-defense and has machine guns, and grenade launchers. They can also provide convoy security. The squadron has some supportability issues and developed organic ration supports in the event of deployment to austere locations, a war readiness spare kit containing sixty days of organic capability to support vehicles and equipment assigned to the unit.[67]

The Red Horse Squadron is composed of three organizations, RH-1, RH-2 and RH-3. The RH-1 is a platoon-sized element capable of deploying in twelve hours. RH-1 can prepare bed-down plans, estimate facility and material requirements for bed-down, operate independently for five days, and establish site layout for the follow-on RH-2 force. RH-2 is a company-sized element, which deploys within forty-eight hours of notification. Mission capabilities include land clearing, site stabilization, area drainage earthwork, rapid runway repair, bomb damaged facility repair, civil engineering estimation for other operations, water well drilling, demolition operations and independent operations up to sixty days. The RH-3 unit is a company-sized element capable of deploying six days after notification. Capabilities include heavy bomb damaged facility repair, mineral production plant operations, explosive operations, independent operations of base support and rapid runway repair. Table two shows the organizational equipment found in the Red Horse Squadron.[68]

The organizations in the sister services have similar capabilities to the combat heavy engineer battalion. Each differs because of the unique mission of their respective services. The NMCB is arrayed to provide robust construction support and also has functionalized companies, which are often task organized to form an additional company with both vertical and horizontal capabilities that subsequently deployed to support contingency operations.[69] The NMCB is used basically to construct robust naval bases off shore in support of both naval and marine operations. The requirements for mobility are not as great as those found for construction organizations in the U.S. Army and the NMCBs do not have as much transport capability as that found in the combat heavies. NMCBs have a great self-defense capability and tend to be the preferred organization for peacekeeping operations because of the great combination of robust construction capability and self-defense capability. The U.S. Army deployed a number of NMCBs in support of contingency operations in the Bosnia. The NMCB works well in support of U.S. Army contingency operations.

The Red Horse Squadrons are the premier rapid deployment construction capability. They are designed to support the air force and provide a great joint engineering capability for the first units arriving in theater. Air Force assets are usually the force of choice when the requirement for quick responsive engineering support exists.

Both of the organizations examined here have rapidly deployable packages, which are task organized for initial entry construction support. The U.S. Army has no construction capability that is rapidly deployable but often has ground forces in theater, which require initial entry construction support. The NMCB is a good model to start from for the design of a rapidly deployable construction capability for the U.S. Army. The Red Horse Squadron is too specialized for army operations and the army can coordinate with Red Horse assets upon arrival into theater if there is an air movement in support a deployment.

HISTORICAL OPERATIONS

CHAPTER 6

Operations Desert Shield/Desert Storm presented the first opportunity to examine the organizational effectiveness of the combat heavy battalion in support of combat operations since the Vietnam War. Nine active duty combat heavy engineer battalions deployed to support the operations in the Gulf. Additionally, throughout the 1990s, the battalion continually deployed as a whole and in force tailored packages in support of operations around the world, specifically in Bosnia. These operations provide us insight to how effective the present organization of the battalion is in meeting mission requirements across a full spectrum by providing examples of both combat and peacekeeping support.

Case I: Desert Shield/Desert Storm, 1990-1991

The nation deployed over 530,000 U.S. forces to support the Persian Gulf War to a theater in Saudi Arabia that was relatively mature, but still extremely demanding. This is equivalent to sending a city the size of Cleveland, Ohio across the world to Saudi Arabia. Soldiers needed food, water, shelter, power, and maintenance support. The total construction effort in theater cost $298.7 million for construction of facilities such as base camps, sanitation facilities, airfield pavements, roads, bridges, warehouses, wash racks, hardstands, sunshades, equipment leasing and other support facilities.[70] The desert is a harsh and challenging environment, void of material resources and water. Material resources and water are vital to successful engineer construction support.[71] All these factors made the Persian Gulf War demanding for combat construction capability.

The theater was relatively mature. Great investments were made into it the years prior to the conflict. This host nation allowed the U.S. to use ports, modern airfields and modern facilities that were the result of a fifty-year upgrade effort, supported by the U.S. Corps of Engineers and the U.S. Air Force.

The knowledge that the theater was mature yet still demanding for construction effort provides value to planners and a warning to be careful about eliminating organic infrastructure support capability in the armed forces. As a case study, Operations Desert Storm/Desert Storm probably ranks toward the minimum end of construction facilities requirements and yet it was still demanding. Fortunately for the United States, the Kingdom of Saudi Arabia had a number of unused facilities spread through the area of operations, which significantly eased the troop billeting requirements for arrivals of new troops in theater.[72] Other theaters probably will not have these fortunate circumstances.

Engineer officers deployed in support of this operation voiced their concerns that history may provide a justification for reduction of combat support requirements based on this deployment without taking into account the maturity of the theater. One U.S. Army officer working for the Corps of Engineers put it aptly when he said, one "should not be lulled to sleep in future force structure and contingency planning by the wealth of facilities…found in Saudi Arabia…. the military needs to be able to project force around the world, regardless of the infrastructure one finds in the Area of Operations (AO)."[73] The colonel went on the say that expectations of the speed with which the U.S. projected forward was aided by the mature theater and other areas will not prove so conducive to quick operations.

Leaders for the Gulf War were committed to avoiding excess construction beyond that which was absolutely necessary. For example, General H. Norman Schartzkopf, the Commander of Army Central Command for the Gulf War, ensured this operation would not be a repeat of Vietnam and the base camp mentality. To avoid the association, the term "base camp" became replaced by the term "life support area" (LSA). Schwartzkopf realized the tempo of operations would make the projected locations of troops hard to determine and did not want to generate wasted construction effort. He directed units to live in the desert, in dispersed tents. Based on the General's experience in Vietnam, the Commander believed big base camps attracted enemy attacks and posed a threat to soldiers.[74] The commander established a conservative climate for construction and subordinate organizations complied with this intent.

In accordance with the desire to keep construction effort at a minimum, the Army Central Command (CENTCOM) initially leased many existing facilities. This became expensive and the command decided to upgrade all construction standards to temporary and construct additional base camps to reduce the dependence on leased facilities. The three methods of accomplishing construction in theater were the use of host nation support, contract construction and military troop labor. A number of prefabricated modular buildings were constructed. Contractors and military personnel worked side by side to get the construction completed as quickly as possible.[75]

The Engineer School study on the use of combat heavies in support of operations in the Gulf War determined that deploying battalions, as a whole, was difficult because of the extensive space requirements consumed by the battalion. Maneuver priorities caused planners to scrap combat heavy engineer battalions from the deployment orders. The lighter airborne construction equipment companies, CSE (combat support equipment) companies[76] and corps combat battalions (airborne) did not have enough horizontal capability to meet initial theater requirements for construction of division MSRs (Main Supply Routes) and logistics base construction support. To offset space limitations on ships, planners deployed the combat heavy engineer battalions in companies and united the battalions once all elements were in theater. The organizational structure allowed the battalion to deploy versatile construction capability in company-sized modules. U.S. forces occupied the desert on 8 August 1990, but the first complete combat heavy engineer battalion did not arrive in theater until 16 October 1990.[77] As a lesson learned from the Gulf War, engineer planners assessed the need for at least one combat heavy engineer battalion immediately for initial deployment operations in theaters.[78] The combat heavy engineer battalion has critical and unique construction capabilities that even the combination of combat platoons and horizontal functional companies cannot match.

Once the first battalion arrived, there was a noticeable improvement in mobility support. The lead maneuver brigades could now move to required locations. Poor roads hindered any movement prior to this. The combat heavies rapidly improved road networks and made logistical supply systems more effective. This served as a major combat power multiplier.

Planners initially projected requirements of five combat heavy engineer battalions for EAC, two for VII Corps and two for XVIII Corps. However, shortfalls started to occur.

> Military leaders decided to place the limited heavy construction assets forward with the corps engineer brigades and risk shortfalls at the echelons above corps because of the well developed infrastructure in Saudi Arabia and the availability of contractors and host nation support. Combat heavy engineer battalions were normally assigned at echelons above corps and did not support the corps, but the corps needed their horizontal construction capabilities. The first combat heavy battalions in the theater went directly into the desert to support the 20th Engineer Brigade. Ultimately, four combat heavy battalions supported the XVIII Airborne Corps, three supported VII Corps, and only two supported echelons above corps.[79]

Operations in the Gulf War indicate that reliance on host nation support and contracted construction is not sufficient to meet the demands in support of operations in a major theater of war. Planners were forced to shift the combat heavy construction battalions and had to accept construction shortfalls in the corps and rear areas of the theater.

The Corps of Engineers historical record of Desert Storm made this surprising assessment.

> In future contingencies in austere theaters, the Army must deploy engineers for tasks at echelons above corps concurrently with maneuver forces. The Army must identify early-deploying "packages" at echelons above corps to provide facilities for soldiers. The Joint Staff's engineer, U.S. Air Force Colonel James E. Jenkins, agreed. The Air Force, he noted, had organic Prime BEEF teams for its forces and the Navy provided organic Seabee battalions to support the Marine Expeditionary Force. But the Army had no troop construction capability in the theater during the initial phase. As a result, combat engineer battalions were diverted from operational and training missions. Jenkins recommended that the Army have a combat support element organic to the deploying engineer force. The Army needed to identify organic construction assets in its engineer force for deliberate support of the contingency.[80]

This shortfall had consequences. In the engineer lessons learned portion of the ARCENT records from the BG Scales paper, the Office of the Chief of Engineers released a concerning memorandum. The topic of this memorandum discusses the perception by U.S. Army soldiers that their quality of life was significantly less than other services. The memorandum identifies the U.S. Army as having the worst quality of life standards in theater of all of the services. The memorandum was drawn up to document this. The Army built facilities to an austere standard with basic rough construction, tent pads and burnout latrines. The Air Force, on the other hand had rapidly deployable packages called Harvest Eagle. The construction of living facilities for the Air Force, Navy and Marine Corps exceeded that of the Army.[81] These lessons should not be forgotten. The U.S. Army continued to draw down its construction capability following the Gulf War and should be cautious not to cut these assets too deeply in light of the lessons learned in the Gulf War. Even though combat heavy construction assets were short, the units, which did deploy, performed well.

The Army engineer school AAR concluded the battalion "demonstrated outstanding utility and flexibility."[82] Overall, the Engineer School decided to assess the current mix of vertical to horizontal assets as sufficient and did not echo the 20th Engineer Brigade AAR remarks, which recommended reconfiguring the organization to more horizontal and less vertical capability.[83] The brigade noted that as the deployment length increased, the demand for vertical construction grew, but concluded that combat engineers were more than capable of meeting these minimum construction requirements. Their final recommendation was to restructure the line companies of the combat heavy engineer battalions with one vertical platoon and two earthmoving platoons.[84]

The battalions executed a number of diverse and demanding missions. Many of these missions were executed in front of the forward most combat troop units on the borders of Iraq, in Kuwait, as units moved forward and extended their lines of communications. Major missions included construction support to airheads, railheads, ports and marshalling areas.   Units were responsible for troop bed down facilities, MSR construction and maintenance from the Port of

Dhahran to logistic bases deep into Iraq, asphalt paving operations, enemy prisoner of war camps construction (capable of housing 24,000 prisoners), petroleum pipeline construction (a combat heavy battalion had augmentation from two pipeline construction companies), logistic base construction, LSA construction, airfield construction, hazardous waste site cleanup in support of redeployment operations, construction of refugee relief facilities in Iraq and Turkey, Kuwait damage assessment, and removal of rubble in Kuwait.[85] Many of the structures built by the battalions were lightweight and pre-fabricated.

One structure, called a K-Span, is a metal building, big enough to be an aircraft hanger or major maintenance facility. This structure uses an Automatic Building Machine (ABM)[86] and requires a crew of approximately twenty-two personnel to construct. The Corps of Engineers rented the machine during the Gulf War. The equipment is slated for force development and will be integrated into construction units in the future. These new lightweight structures require emphasis on steelworkers and welding trades. The combat heavy vertical platoons currently do not have soldiers skilled in these areas. Future operations will continue to lean towards this capability and the battalion should be enhanced.

Combat heavy engineer battalions had some mobility challenges. One example cites that the 43rd Combat Heavy Engineer Battalion took a month to completely move all their equipment two hundred and fifty miles forward. The 411th Engineer Brigade commander assessed that the combat heavies needed to increase their mobility to support a maneuver capability that was faster and capable of fighting longer distances in shorter spans of time.

The 411th Brigade commander went on to say "Army Commanders also found that combat heavy battalions did not have enough horizontal construction capability."[87]

About $4.5 million worth of heavy construction equipment was purchased or leased locally (paid for by the government of Japan) and issued to the engineer units to augment their own equipment. The quality of equipment furnished under this agreement was not high, and there were problems in obtaining contractor maintenance.[88]

The Army contracted for more road graders because they were critical and short. To complicate matters, getting repair parts for equipment that was not in the Army supply system proved challenging. Additionally, soldiers had to learn how to operate this new equipment. The only exception was leased compaction equipment and generators.[89] A redesign of the combat heavy engineer battalion should include an increased horizontal construction capability.

The Army engineer troop construction capability also had limited asphalt production capability. To support the extensive level of traffic in theater, high quality roads were needed which were paved with asphalt. Hot mix asphalt was not an option because there are no longer any active U.S. Army units with patch plants, which make the asphalt. The asphalt must stay warm, so batch plant location is critical. There was a lack of this batch plant capability. Engineers opted to overcome this shortfall by using cold mix paving, because it could be hauled long distances. The Army resorted to building the base course of the roads with troop construction and paving with contractor support. EAC units constructed 1,133 kilometers of roads and contractors constructed over 3,209 kilometers of roads. Despite this noble effort, the quality of the roads was still poor and proved inadequate to support the volume of military traffic. Rain often damaged roads upon completion.[90] Effort was duplicated because roads only lasted short periods of time. The ability to construct and repair better roads would have saved effort in the end. The Army needs an asphalt production and capability in its active duty force structure. This capability is presently in the reserve force structure and is not responsive enough to meet rapid deployment support requirements.

The Engineer School AAR made a collective assessment of organizational equipment and issues that became apparent as a result of Desert Storm support.[91] This paper contains the critical ones, which have not been corrected since 1991, in appendix F. The recommendations in the conclusion of this thesis incorporate some of these recommendations from the Engineer School AAR. The focus of the Engineer School AAR was specifically on the combat heavy engineer battalion. There are also valuable lessons to be learned by examining the use of contractors in theater. Does the Gulf War support the premise that contractors can cover shortfalls resulting from a decrease in U.S. Army troop construction capability?

Contractor and Host Nation Support

Contractors did the bulk of the construction in theater and this operation does provide a good testing ground for Army construction doctrine. The assessment of the use of contractors had mixed reviews. The Army could not have executed the operation without the contractors, but Army commanders viewed the contractor as slow and unreliable. When the war started, contractors stopped working and left hazardous areas for large period of time. The troops construction units had to come complete the projects. Contractors abandoned rental equipment on sites and soldiers took over their equipment. Some commanders even restricted contractors from working in their areas.[92] The results of the Gulf War seem to support the views of those officers concerned in 2000 over the hazards of removing organic combat support and service support capability on the premise that contractor support can meet all these requirements.

Research uncovered an assortment of thoughts expressed by commanders during the Gulf War in regard to the use of contract construction. Contracting is good for repetitive low-tech construction, such as building latrines and washbasins, or for sophisticated one-time projects relying heavily on local materials and practices. Overall, commanders saw the contracted construction effort as a good supplement to troops construction efforts but wanted to gain more command and control of the contractors. They wanted to prevent contractors from walking off the project sights in combat areas. Additionally, contractors were inflexible and demanded completion of projects, once funded, even if the operational mission no longer required the facility. Contractors completed construction of six LSAs, which went unused as a result of this when the U.S. Army repositioned forces in preparation for the launching of offensive operations prior to the execution of the ground phase of the war.[93] These thoughts provide fuel for an assessment of the current doctrine addressing the use of contractors.

The response to the shortfall of Army troop construction capability was contractor support. In the end, engineer leaders determined that contractors and host nation support should supplement troop construction capability, not replace it. Contractors worked well for troop support. It did, however have some problems. Troops demonstrated greater flexibility and were more prone to use expedient construction techniques. Additionally, troop construction assets did not require a long and complicated contracting process either. [94] The observations of the Gulf War indicate that placing too much reliance on contractor support to replace army troop construction capability limits flexibility to support maneuver forces.

Host Nation contracting was complicated. This process did save the U.S. money but it took longer to execute the missions. The 411th Engineer Brigade Commander observed, "in a theater that moved as rapidly as we did…you can make a case that time was more valuable than the money in many instances."[95] Ironically, the placement of army troop construction capabilities low in the deployment order caused the U.S. Army to rely on the doctrine of using contractors and host nation support to the maximum extend possible.

The U.S. Army may espouse the usage of contractor construction assets. The desire of the national leaders appears to be to draw down the "tail" of the U.S. Army to achieve better ratios for combat forces, the Army must also be able to support those combat forces. "Tooth to tail" ratios overlook the support requirements. Armies should not be structured on a pipedream of reduced logistics. Planners must look at the reality of what the requirements are and design forces to support those requirements. The use of contractors could potentially only complicate military combat operations because the army is deploying and dependant on civilians who indirectly work for them and are not trained to fight. The whole purpose of an army is to fight and win this nation's wars, not provide opportunities for increased deployment of civilians to hostile theaters. Engineer and U.S. Army doctrine should reexamine the integration of contractors. It should be done in moderation to supplement Army capability as opposed to replacing it.

Joint Construction Asset Usage

The final discussion of Desert Storm addresses joint considerations. Each service had unique requirements for construction support in theater. The U.S. "Navy stayed basically afloat and operated from established permanent bases in Bahrain and had little demand for field engineering or new construction."[96] The Marine Corps had a great demand for construction support for its coastal operations. The U.S. Air Force used existing airfields but required capability to construct bed-down facilities. The U.S. Army initially used a developed infrastructure, but when it deployed and extended the lines of communications, requirements increased for housing and operations of units throughout the theater.[97] The overall assessment of the joint engineers in theater was that "the Army had the most demanding engineering requirements and deployed the largest force of engineers to meet them."[98]

The U.S. Air Force deployed approximately three thousand seven hundred engineers. The engineers built air-conditioned tents, dining facilities, showers, and latrines; established water and electrical systems; constructed air traffic control structures and aircraft shelter; and extended runways, ramps and aprons. They built over five thousand tents, paved more than two million square feet, thirty-nine munitions storage, maintenance and other facilities.[99] "The Air Force deployed a Prime Beef team with almost every flying squadron, with the engineer teams arriving at the same time or shortly after the squadrons. The teams were supplemented in the theater by RED HORSE civil engineering squadrons to perform larger missions beyond the capability of PRIME BEEF teams."[100] Additionally they had three hundred million dollars worth of warehouses built to store equipment required for sustainment pre-positioned through the years leading up to the conflict.[101]

The U.S. Navy deployed four mobile construction battalions. MARCENT (Marine Corps Army Central Command) commanded them. They built expanded airfields, set up berthing facilities, built ammunition storage banks, and constructed roads and defensive barriers. The construct totals were fourteen mess facilities, six million square feet of parking aprons for aircraft, four ammunition supply centers, and four thousand seven hundred and fifty other buildings. They maintained two hundred miles of unpaved four-lane highways in the desert. The Marine Corps had extensive engineering requirements. However, the Marines had three naval transport squadrons with enough pre-positioned equipment and supplies to support the Marine Expeditionary Force (MEF) for thirty days.[102]

The Persian Gulf War validated the need for combat heavy engineer battalion construction capability. The battalion proved versatile enough to support combat operations. This was a mature theater with a well-developed road network and facilities infrastructure already in place. A less developed theater will require more combat heavy engineer battalions earlier.

The lessons from the Gulf War are valuable in considering design possibilities for the combat heavy engineer battalion. Combat heavy engineer battalions were effective in support of Army operations in the Persian Gulf War but there were some equipment and organizational shortfalls. The battalion was not mobile enough and did not have a rapidly deployable package designed to support initial entry operations like the sister services. Additionally, U.S. Army commanders oncluded that host nation support and contracting can only serve to augment, not replace combat heavy engineer battalions. These were the major lessons learned in examining a combat operation in a major theater of war, of short duration, with a mature theater infrastructure. The second case study, operations in Bosnia, examines operations in a SASO environment, of long duration, with a war torn and immature theater infrastructure.

CASE II: SASO Operations in Bosnia-Herzegovina 1995-2000

In December of 1995 U.S. forces deployed to Bosnia–Herzegovina to perform covering force operations and establish a Zone of Separation (ZOS) between warring parties in the region in accordance with the Dayton Peace Accord. "The complexity of Operation Joint Endeavor (OJE) has taxed engineer capabilities and resources, demanding more versatility than any other combat support force in theater."[103] An engineer force of 2,400 soldiers deployed with U.S. forces to support this operation and comprised over ten percent of all U.S. forces in theater.[104] This engineer force overcame significant challenges.

"The greatest single engineer challenge … was the crossing of the Sava River near Zupanja, Croatia. This mission was the largest operationally required river crossing since World War II."[105] The harsh winter conditions made the crossing extremely challenging. A sudden thaw, of the initially frozen river, caused swelling of the banks from three hundred to six hundred meters. This resulted in extensive flooding of the pre-positioned equipment planned for use in support of the river crossing. The engineers had to rebuild the approaches. The total project required a thousand hours to complete. After the floodwaters receded, engineers constructed a roadway across the flood plain. A combat heavy engineer battalion was there to support the river crossing operation.

The second biggest challenge was the establishment of a base of operations to support U.S. forces in Bosnia. The U.S. Army had to quickly develop a long-term logistical infrastructure. Bosnia had significant war damage and the quick insertion of forces into this war-torn environment required military troop construction capability. The areas proved cold, wet, muddy, covered with mines and lacking in the infrastructure needed to support soldiers.

The Center for Army Lessons Learned (CALL), in their initial impressions assessment report concluded:

> The joint use of Army, Air Force, and Navy engineers, along with civilian contractors to construct the life support for the forces has been a tremendous success. No one individual service can provide the capability that the combined effort of all the engineer assets did for the operation. Even in a totally land-locked area of operation, a key division sustainment challenge was met through a joint effort.[106]

Joint engineer forces became critical to mission success at the start of Operation Joint Endeavor in Bosnia. United States Army Europe identified a vertical construction shortfall because the 94th Engineer Battalion was the only combat heavy in Germany and only had two line companies, and a combat support equipment company (CSE)[107] instead of the three line companies as prescribed by the TOE. The mission required at least two more battalions. The command requested more combat heavy battalions but was denied because the units would have to deploy from stateside. The short time lines in Bosnia did not allow for usage of these assets.[108]

The majority of the Army's construction capability is in the reserve component, or in the continental United States and requires extensive time to mobilize, prepare and move. The deployment of other construction battalions from the United States was too costly in money and time compared to the option of using U.S. Air Force, U.S. Navy and troop construction assets available in theater. The U.S. Air Force had preposition equipment in Italy and the Navy had a construction unit in Spain. The United States Army European Command could quickly deploy these assets for base camp construction and redeploy them to meet anticipated force caps upon completion of the construction missions.[109] The use of contract construction capability would also help offset force cap limitation.

Doctrine calls for a balance of contract and troop construction capability. The U.S. Army had "LOGCAP" (Logistics Civil Augmentation Program).[110] "Under this program, a civilian contractor provides logistics and engineering services to deployed forces."[111] The U.S. Army formalized LOGCAP in 1994 during military operations in Haiti, and subsequently used the program in Bosnia.[112] In Bosnia, LOGCAP significantly enhanced construction operations, but had some limitations. The limitations demonstrated caused military leaders to rethink U.S. Army doctrine on the use of contractors.

The General Accounting Officer published a *Report to Congressional Requesters* addressing the use of LOGCAP in Bosnia. In this report, government officials expressed concern over the escalating cost of contracted services. In 1997, when the report was published, estimates of LOGCAP costs were 32% higher than original estimates submitted in December of 1995. Contractors were proving to be inefficient and ineffective.[113] The report states "according to the Army, use of the contractors is the choice of last resort but necessary in these missions because of troop ceilings, unavailability of host nation support, and the need to keep military units available to respond to a major regional conflict."[114] The doctrine pertaining to the use of contractors in support of SASO operations may be evolving based on the operational experience gained by U.S. military leaders in Bosnia.

Brown and Root, the LOGCAP contractor in Bosnia, experienced challenges it did not anticipate. Estimates projected that it might take contractors thirty to forty-five days to get basic tools into the theater. They competed for the same assets that U.S. forces needed to conduct a force build up. The United Nations units did not sell LOGCAP the equipment they had in country prior to the arrival of U.S. forces. This required the contractor to bring in more equipment than anticipated. The poor conditions of the road infrastructure and economics made access to local labor and materials difficult. Also, extensive background check requirements slowed the hiring process of local personnel.[115] In this type of environment, LOGCAP has difficulty establishing their initial base of operations and was not responsive to military needs. LOGCAP is more effective as an initial entry capability if the infrastructure is mature and the local economy strong. Neither of these two conditions existed in Bosnia. After the initial base construction occurred, LOGCAP easily took over base maintenance.[116] Based on observations made of operations in the Bosnia, the Center for Army Lessons Learned determined that "LOGCAP is not always an initial entry capability."[117]

The U.S. Army needs "an initial entry vertical construction capability to offset LOGCAP deployment limitations"[118] such as those experienced in Bosnia. Contractors were not available until fourteen days after the mission started and proved to be more expensive than originally thought.[119]

> U.S. Army alternatives for base camp construction are limited. Engineer force structure has been moved to the Reserve Components and lacks the responsiveness of active units (compounded by the additional approval process by the President for PSRC), Combat Heavy Engineer Battalions in the active force are all short one company and are organized primarily for horizontal construction. Base camp development draws heavily on the vertical trades. We used RED HORSE and Seabees because they have robust vertical capability.[120]

Operations in Bosnia validated the Army's need for active component, skilled construction engineers to open LOCs, and build base camps. An Army AAR assessed that tailored packages of engineering air detachments from the U.S. Navy worked extremely well in support of military units in Bosnia. The seabees proved capable of self-defense and sustainment of operations in a hostile environment.[121] AAR comments urged engineers to examine how combat heavy engineer battalions are organized and employed.[122]   The U.S. Army relied significantly on sister services assets to meet the intensive initial entry general engineering requirements for OJE.

The initial troop construction forces brought into Bosnia were a Red Horse Squadron and a Naval Mobile Construction Battalion (NMCB). Both force structures support rapid deployment exceptionally. The Red Horse is typically the lead troop construction asset in the military forces. The Red Horse Squadron responded well to rapid deployment requirements. Red Horse assets have great technical skills but have less capability and self-defense than the seabees.[123] The Red Horse Squadron constructed two base camps in Tuzla using U.S. Army Force Provider[124] modules. The Air Force has a similar system called Harvest Eagle and was familiar with this process. The seabees constructed a staging area in Croatia and then moved into Bosnia to build additional base camps.[125] "Navy Sea Bee Companies are more robust in capabilities than Army Combat Heavy Engineer Battalions and CSE companies."[126]

Combat Heavy engineer battalions followed the sister service assets into theater. The efforts of the combat heavy battalion supplemented the other sister services by constructing base camps and other sustainment engineering tasks, which supported base camp development. Missions included: access road upgrades, logistic area development, site drainage development, and force protection construction.

Once the infrastructure matured, the issue of who did what became a problem. The Army construction units faced the possibility of getting the missions the contractor did not want to do. By 1999 the process matured in form.

> Each base camp provided a list of new projects based on the CGs (Commanding General) guidance. If it was determined that a project could be built by soldiers, then it would be assigned to them…. If it was beyond their capacity in terms of scope or expertise, then the project was given to the BRSC (Brown and Root Service Contract). Some projects were completed by the combined efforts of BRSC and troop labor.[127]

Combat heavy engineer battalions in conjunction with joint, multinational and contracted engineer support executed a number of missions in Bosnia. They improved base camp facilities, assessed and repaired MSRs, built force protection structures, built aircraft facilities, built rail lines, built utility lines, built weapons range, built training facilities,[128] and built extensive permanent bridging.[129] Some of the bridges were complex with piers, multiple spans, steel stringers, and concrete abutments. Additionally units constructed twenty-three semi-permanent base camps in Bosnia,[130] and then tore down eleven base camps when the mission transitioned to a smaller force in October of 1996. Other missions included material recovery, quality of life enhancement, MSR construction, hospital construction, SEA-hut construction, and asphalt road repair. Lastly, throughout the deployments engineers were integral in conducting environmental restoration operations. The standards were similar to those found in the Continental United States.[131] Operations in Bosnia exercised the full construction capability of the battalion. There are some lessons learned from these operations, which should be considered in a redesign of the battalion.

An examination of the deployment history of combat heavy construction force packages from 1995 to 2000 for operations in Bosnia, demonstrates the organization is capable of forming modular packages to meet mission requirements in support of SASO operations. A chronological listing of the construction engineer force packages deployed to Bosnia is in table four.[132] One particular force package combined one vertical construction platoon from the combat heavy line company with three horizontal platoons in a CSE company.[133] The CSE company headquarters commanded and controlled this organization. This force package proved to be a versatile and responsive general engineering capability design for support of a brigade combat teams (BCT).[134]

Brigade combat teams normally have a combat engineer battalion habitually associated with them to provide combat engineering support during combat operations and require augmentation for general engineering support. In Bosnia, the BCTs carried out peacekeeping missions and discovered the one organic combat engineer battalion did not have sufficient construction capability to support their general engineering requirements. The combat engineer battalion assets were fully committed to execution of combat engineering missions such as observation of mine removal by the host nation. The BCT needed augmentation of specialized construction engineers. Based on their operational experience engineers in Bosnia advocated retention of specialized engineer units and task organizing them to meet mission requirements instead of trying to be a "jack of all trades."[135] Subsequently, theater engineers developed a standard operating procedure for task organizing construction capabilities to the BCTs.

> The BCT (Brigade Combat Team) is supported by an engineer task force based on its habitually associated engineer battalion. Attached to the engineer task force is a construction unit, either a combat heavy or a combat support equipment company (CSE), which provides the capability to maintain, constructs and protect Task Force Eagle's infrastructure…. Present requirements are for a combat heavy company consisting of only one of its two vertical construction platoons. The company is augmented with assets from the HSC to provide engineer direct support maintenance, a survey and quality control capability. The combination of a combat heavy engineer vertical platoon attached to a combat support equipment company provides a similar capability.[136]

This rule of thumb for providing responsive general engineering support proved effective in operations in support of maneuver brigades in Bosnia and has potential for an overall organizational redesign of the combat heavy engineer battalion.

Overall the use of military engineer capability proved effective in supporting SASO operations, of a long duration, in Bosnia. The battalion is capable of forming modular packages to meet mission requirements as demonstrated by the employment history of the battalion assets throughout the operation. At the operational level, the U.S. Army engineers identified intial entry deployment package and vertical construction shortfalls needed to meet the infrastructure requirements inherent in SASO operations of a longer duration. Brigade level SOPs developed in theater indicate that an organization designed similar to one vertical platoon and three horizontal platoons is effective in supporting a tactically focused brigade combat team effectively. Just as with Operation Desert Storm, commands at the tactical level demonstrate different concerns than those at the operational level in regard to their assessment of the effectiveness of the design of the combat heavy engineer battalion. Finally, the evaluation of the use of contractors in Bosnia proved to have limitations, similar to assessments found in the Gulf War Study. Contracting construction support is expensive and not as reliable as initially believed and should only supplement military troop construction capability, not replace it. This holds for both combat and SASO operations.

Both case studies in this thesis provide valuable information on how to most effectively improve the design the U.S. Army's main construction organization. The diverseness of the missions executed in both MRC and SASO operations by the combat heavy engineer battalions demonstrated that the capabilities identified in the TOE of the battalion are appropriate to the tasks encountered in the full spectrum of military operations. The battalion is presently supporting the mission requirements for full spectrum operations in the 21st century but with some design changes engineer leaders can improve the effectiveness of the organization.

CONCLUSIONS AND RECOMMENDATIONS

CHAPTER 7

Engineer Vision 21 directs the Corps of Engineers to seek ways to improve engineer organizations in order to meet the engineering combat support challenges facing the U.S. Army in the 21st Century. The Engineer Battalion (Combat) (Heavy) is the most versatile general engineering support organization in the U.S. Army and must be structured to accomplish all the operational construction requirements in support of future Major Regional Conflicts and Support and Stability Operations. The author determined that overall, the present battalion structure does not fully meet the criteria established at the beginning of this thesis and requires organizational changes to make it a more effective combat multiplier for the full spectrum of operations in the 21st Century. This determination was made after reviewing the case studies of the battalion's performance in supporting combat operations in the Gulf War and SASO operations in Bosnia. Both case studies indicate that the battalion was effective, but has some capability shortfalls.

The battalion demonstrated in both operations that it is modular in design. During Operation Desert Storm and Operations in Bosnia, the battalion was broken down into deployable company sized packages to meet space limitation on ships and mission requirements. The company design of both horizontal and vertical capability, with functionalized platoons, proved versatile. The company could execute complete projects and did not require coordination at the battalion level to execute a variety of construction missions. The additional strength of the present organization is that there is not a constant change over of leadership. The soldiers in the battalion deploy with a company commander and platoon level leadership that they know and have trained with. The author discovered that often the NMCB must form new detachments and companies solely for support of a specific operation, which is task organized with a mix of vertical, horizontal, maintenance, and construction administrative capabilities to support contingency operations. The combat heavy engineer battalion already has these deployable mixed capability company packages.

Both case studies give evidence that there is a variance in opinion of what the proper mix should be of horizontal to vertical assets in the combat heavy engineer companies. Tactically focused organizations want more horizontal capability, operationally focused organizations want more vertical capability. Following the Gulf War, the Engineer School AAR, which combines the evaluations of units at all levels, concluded that the combat heavy engineer battalion "demonstrated outstanding utility and flexibility. From an operational perspective the battalion was sufficient. However one dissenting opinion came from the 20th engineer brigade, a unit that was immersed in tactical movement and support requirements.

There is evidence of the same debate in the SASO case study. During Bosnia the operational concerns were more focused on a lack of vertical construction capability and there is a demonstrated tendency to rely on the more robust NMCB when intensive base camp construction is required.[137] Operational level AAR comments say the U.S. Army engineer force structure needs more combat heavy engineer battalions.[138] Many of the operational level assessments determined that the battalion lacks sufficient vertical construction capability. Yet, the engineers in theater developed a policy that construction companies in support of brigade operations require only one vertical platoon and heavier horizontal assets.

The debate is a by-product of a branch struggling to defend its very existence. There are two perspectives in the branch. Some engineer officers serve in construction units their entire career and some serve in mostly combat units. There is a tendency to defend an officer's favored area of expertise of either construction or combat instead of looking out at the needs of the Army. This debate is a result of a split between a tactical focus verses an operational and strategic focus.

Both case studies presented in this thesis demonstrate the need for the U.S. Army to have some internal heavy construction capability. History also indicates that it is best to allow construction units to specialize in construction skills training and combat units to specialize in combat breaching skills training. Trying to attain proficiency in both proves unfeasible. The U.S. Navy, by virtue of its mission, does not appear to be mired in debate like the U.S. Army and has committed to having a robust construction capability.

The U.S. Navy, even though it is predominately sea-based, still funds eight active duty mobile construction battalions, which are more robust than the U.S. Army's construction battalions. Army units at the operational level also prefer these battalions because they are more robust in vertical capability. The U.S. Army only has seven combat heavy battalions on active duty. This is deceiving thought because the number of personnel available in each active duty battalion is well below that found in the NMCBs. Research in this thesis presented in the Gulf War case study indicates that the U.S. Army has the greatest engineering requirements operationally and tactically out of all the services because an army expands its lines of communications on the ground significantly more than the other services. The expanded lines require a developed infrastructure at the ports and constant construction of road networks and supply bases to sustain these extended lines.

The U.S. Army requires two heavy construction organizations, as suggested in the 1985 Carlisle study presented earlier in the thesis, to address these differences. One organization is tactically focused to support the heavy horizontal construction requirements at the division level and below and would be an Engineer Battalion (Combat) (Heavy). This would retain the old name but have a new organizational structure. The second battalion would be a construction battalion and would have an operational focus on infrastructure development. This organization would support operations at the corps level and above and would generally be found in the rear areas. The organizational configuration would be similar to the current combat heavy engineer battalion.

The author recommends assembling the new combat heavy battalion by increasing the Combat Support Equipment Company's[139] three horizontal platoon structure by one vertical line platoon and placing three of these companies under a battalion headquarters. This would facilitate task organization of one of these general engineering capable companies per brigade. The battalion headquarters would have the same staff organization as that found in the present combat heavy. The difference is there would be no support section consisting of maintenance, mess, and additional equipment platoons in this battalion headquarters company and the CSE company would be the building block of this new battalion.

The present CSE TOE would provide the starting framework for this new company's equipment authorization. The TOE of the CSE should be changed to ensure that there are appropriate tractor-trailers to move all the company assets in one lift. Bituminous distributors in the company would be increased by three. Each vehicle should have a radio and night vision device capability to ensure the ability to operate in a fast paced combat environment, day or night along extended LOCs. Also, each CSE company would retain its organic DS, mess, communications, supply and organizational maintenance capability. Additionally, each company should receive soil and surveying capability and a small construction management section in order to independently run construction operations. Each horizontal platoon should have four graders instead of three to provide for an overall increase in graders across the divisional battlefield. Finally the vertical line platoon allocated to the company would have the same structure, personnel and equipment as a line platoon in the construction battalion.

This recommendation minimizes organizational changes and affords maneuver units at the division level and below the critical increased horizontal capability that was identified as lacking during Desert Storm and is consistent with the task organization rule of thumb developed during SASO operations in Bosnia for BCTs. This new organization increases the overall compaction equipment and graders across the division level. The author assumed that the increased pace and expanded battlefield of Force XXI will only make these capabilities even more critical in the future.

The second organization proposed in this study would be the heavy construction battalion. This organization would retain a structure similar to the current combat heavy. This structure works best for the U.S. Army because it facilitates project management at the company level and allows for execution of missions without coordination with the battalion headquarters for a mix of vertical or horizontal construction assets. This organization will retain the functionality at the platoon level because it is naturally in line with the versatility and modularity the U.S. Army is now focused on. The combat heavy structure demonstrated flexibility and meets the intent of modularity in both case studies. The line company of the battalion is versatile and with augmentation of assets from the headquarters and support company is designed to operate independently if needed. The company-sized structure worked well and facilitated force deployment packages in Desert Storm and operations in Bosnia. Some adjustments need to be made to account for shortfalls identified in the case studies.

The criteria established for this thesis emphasizes fielding to support contingency operations as an absolute necessity. The construction battalion's vertical capability requires more specialized skills. Modern lightweight construction techniques use a great deal of metal instead of concrete masonry units and wood. The ability to work with sheet metal, welding and steel structures is limited in the battalion and should be increased. Additionally, exterior electrical capability is lacking and often required for base camp construction. Finally, the battalions need to fill back up to TOE capacity with three line companies. The placement of one of the two line companies in the reserves is risky.

The U.S. Army should review the concept of what units are in the reserves. Active duty forces should have the most critical assets in them. Waiting for a reserve call up of critical construction assets needed for force development defeats the purpose of even having the assets in the first place. Therefore, the organization should have enhanced capabilities, including a rock crusher, a quarry detachment and a mobile asphalt batch plant. These capabilities would have to be moved from the reserve force structure into the active engineer force structure.

In both case studies presented in this thesis, asphalt production was useful. The placement on surfaces of asphalt may have been cheaper in the long run than the massive amounts of gravel and the expensive geotextiles[140] used in the Bosnia.[141] These capabilities need to be placed back in the active force structure and pre-positioned in theaters like Germany and Korea. The operationally focused construction battalion is the best organization to carry these enhanced capabilities.

Based on the Gulf War, where there were long, extended lines of communications, equipment shortfalls were noted in the battalion. Equipment changes that would be useful and improve the overall operations of the construction battalion include: an increase to four graders per line company, three vibratory rollers per line company, three high speed compactors per line company, one night vision device per equipment operator to facilitate night hauling operations, modification of scoop loaders for MHE capability, and four fifteen ton dump trucks per earthmoving platoon. These changes would improve the MHE, hauling and earthmoving capabilities identified as lacking during the Gulf War and in Bosnia.

From an operational level, both case studies validate that the Army needs an initial entry construction capability to offset LOGCAP deployment limitations. "In order to capitalize on the military's quick responsiveness, initial entry assets must take engineer equipment, tools and (when possible) materials such as lumber and nails."[142] The tailored packages found in the air detachments from the U.S. Navy provide an outstanding model to start from in configuring a package for the U.S. Army construction battalions. As a minimum, each active duty construction battalion requires this capability.

Operation Desert Storm clearly showed that the U.S. Army will have the most extensive engineer construction requirements because it is a ground force operating on a continually expanding battlefield. The offensive movement of maneuver forces creates this expanding battlefield. Since the “digitized division” is designed to cover greater frontages with less combat power than divisions operating during Desert Storm, the requirement for the quick repositioning of forces based on information superiority will only expand the lines of communication further than those found in Operation Desert Storm and demand a mature road network and increased bases of supply across the battlefield.   The U.S. Army should, therefore have the most capable construction force, to meet these requirements.

Both case studies presented in this thesis indicate that a force projection army, which deploys to a foreign theater of operation, must be able to construct an infrastructure capable of supporting that force. Saudi Arabia was a mature theater with extensive funding placed into the enhancement of the country’s infrastructure prior to the deployment of forces to the theater. Bosnia lacked a sufficient infrastructure. Both theaters mature and immature required extensive engineer efforts. A reduced logistical footprint will decrease storage requirements, not eliminate them. The facilities required to receive and stage equipment and troops prior to on-ward movement in a theater still remain. Base camps, of a limited scale are still necessary, especially in support of SASO operations, which can continue for a number of years.

The U.S. Army engineers have created a piecemeal force that does not allow for the massing of construction efforts needed to accomplish minimum essential requirements. Used correctly, construction can be an effective combat multiplier by facilitating movement and logistical support. During Operation Desert Shield, prior to the arrival of combat heavy battalions, some maneuver units on the ground could not move to their assigned sectors because there were no road networks to support this movement. Having a potent fighting force is important, but as *Army Vision 2010* outlines, this force must be able to quickly move.

Infrastructure support is critical to the success of both regional major theater war and SASO contingencies. Many argue about “tooth to tail ratios” today and tend to think that reducing the military footprint demands reduction of essential support capabilities. The Gulf War only involved the deployment of two U.S. Army Corps. This is only half the overall ground force capability of the United States Army. Operations in Bosnia only involve a small number of forces. History is replete with examples of forces culminating as a result of poor logistical support and ultimately losing. "In a 1991 interim report to Congress, …the Department of Defense noted that logistical support during the Gulf War was 'successful, but the system was taxed.' And yet the ground war only lasted 100 hours."[143]

The Army needs to make an investment in enhancing its engineering construction capability. The reduced logistical footprint desired for the digitized division must be realistic. The requirements for engineer construction capability must be based on the mission, not an unproven theory that the U.S. Army should be all combat capability with a streamlined combat support capability.

APPENDIX A DEFINITIONS OF TERMS

COMMZ: (Communications Zone) (JP1-10, NATO)-The rear part of the theater of operations which is behind but contiguous to the combat zone (CZ) that contains the lines of communications (LOCs), establishments for supply and evacuation, and other agencies required to immediately support and maintain the field forces. (see also rear area and lines of communications) FM 100-7.

Countermobility: The construction of obstacles and emplacement of minefields to delay, disrupt, and destroy the enemy by reinforcement of the terrain. The primary purpose of the countermobility operations is to slow or divert the enemy, to increase time for target acquisition, and to increase weapon effectiveness. See FM 5-102, 101-1-1, 20-32, 90-7.

General Engineering: General engineering helps establish and maintain the infrastructure necessary for sustaining military operations in theater. General engineering tasks may include construction or repair of existing logistics-support faculties, supply routes, airfields, ports, water wells, power plants, and pipelines. It may be performed by a combination of joint engineering units, civilian contractors, and host-nation (HN) forces and usually requires large amounts of construction materials, which must be planned and provided for in a timely manner. See FM 5-104 and 5-100 for more information on techniques and procedures for general engineering.

Horizontal Construction: Term used when referring to construction tasks relating to earthmoving operations. Generally heavy earthmoving equipment such as scrapers, graders, dozers, dump trucks, asphalt distributors, cranes for heavy lift and paving machines are used to accomplish horizontal construction. Cranes are generally kept in horizontal platoons but can be used to support vertical construction tasks. Many vertical construction projects require massive amounts of site preparation using horizontal construction assets before a structure can be built. For example, in Bosnia, a level, weight-bearing surface was needed before construction could begin on form work for the placement of a concrete apron and a clamshell lightweight structure. Often in road building operations, vertical platoon members work side by side with the horizontal platoon members to emplace culverts under roads to facilitate drainage of water away from the road.

Lines of Communications: All the land, water, and air routes that connect an operating military force with a base of operations and along which supplies and military forces move. (See also COMMZ) See FMs 10-1, 100-5, 100-7, 100-10, and 100-15.

Mobility: Those activities that enable a force to move personnel and equipment on the battlefield without delays due to terrain or obstacles. See FM 5-101, 101-1-1, 90-13, and 90-13-1.

Survivability: Includes all aspects of protecting personnel, weapons, and supplies while simultaneously deceiving the enemy. It encompasses planning and locating position sites, designing adequate overhead cover, analyzing terrain conditions and construction materials, selecting excavation methods, and countering the effects of direct and indirect fire weapons. See FM 5-103, and 101-5-1.

Sustainment Engineering: Sustainment engineering commonly is used in place of the term general engineering. The term means the same as general engineering.

Topographic Engineering: This type of engineering addresses terrain analysis, geodetic survey, production and reproduction, database management and exploitation. The focus is on terrain analysis and the presentation of its results to the commander. Topographic units are capable of the reproduction of maps and production and distribution of other terrain products.[144]

Vertical Construction: Term used when referring to construction tasks relating to the construction of structures. Generally vertical trades include plumbers, electricians, carpenters, concrete and masonry specialists, steel workers, welders, and external electrical specialists. Construction of structures can include placement of foundations, placement of concrete structures, installation of culverts and headwalls for road construction, water pumping operations for flooding control and installment of the mechanical systems and utility lines required to support the structure.

APPENDIX B-TOE
SPECIFIED CAPABILITIES OF ENGINEER BATTALION (COMBAT) (HEAVY)

1. MISSION. A. TO INCREASE THE COMBAT EFFECTIVENESS OF DIVISION, CORPS AND THEATER ARMY FORCES BY ACCOMPLISHING GENERAL ENGINEERING TASKS AND LIMITED MOBILITY, COUNTERMOBILITY, AND SURVIVABILITY TASKS.

B. TO CONSTRUCT, REPAIR, AND MAINTAIN MAIN SUPPLY ROUTES LANDING STRIPS, BUILDINGS, STRUCTURES AND UTILITIES.

C. TO PERFORM REAR AREA SECURITY OPERATIONS WHEN REQUIRED.

2. ASSIGNMENT. TO THE ENGINEER BRIGADE, CORPS, AIRBORNE CORPS, JOINT OR COMBINED TASK FORCE AND ECHELONS ABOVE CORPS.

3. CAPABILITIES. A. AT LEVEL 1, THIS UNIT:

(1) PERFORMS ENGINEERING TASKS SUCH AS CONSTRUCTION, REHABILITATION, REPAIR, MAINTENANCE, AND MODIFICATION OF LANDING STRIPS, AIRFIELDS, COMMAND POSTS, MAIN SUPPLY ROUTES, SUPPLY INSTALLATIONS, BUILDING STRUCTURES, BRIDGES AND OTHER RELATED TASKS AS REQUIRED, GENERALLY TO THE REAR OF THE DIVISION.

(2) PROVIDES REPAIRS AND LIMITED RECONSTRUCTION OF RAILROADS, SEWAGE AND WATER FACILITIES.

(3) PROVIDES BITUMINOUS PAVING OPERATIONS AND QUARRYING AND CRUSHING OPERATIONS, REHABILITATES PORTS, AND CONSTRUCTS PIPELINES WHEN AUGMENTED WITH SPECIALIZED ENGINEER PERSONNEL AND EQUIPMENT.

(4) PROVIDES FIELD ENGINEERING ASSISTANCE AND SUPPORT TO DIVISION ENGINEER IN PREPARATION OF PROTECTIVE POSITIONS

(5) CONDUCTS ENGINEER RECONNAISSANCE.

(6) CREATES OBSTACLES TO DEGRADE ENEMY MOBILITY IN REAR AREAS.

(7) CLEARS OBSTACLES AS PART OF AREA CLEARANCE OPERATION, NOT AS PART OF ASSAULT BREACHING OPERATIONS.

(8) PERFORMS REAR AREA OPERATIONS TO INCLUDE INFANTRY COMBAT MISSIONS WITHIN LIMITATIONS OF ORGANIC WEAPONS AND EQUIPMENT.

(9) SUPERVISES CONTRACT CONSTRUCTION, SKILLED CONSTRUCTION LABOR AND UNSKILLED INDIGENOUS PERSONNEL.

(10) CONDUCTS AREA DAMAGE CLEARANCE/RESTORATION OPERATIONS.

(11) PROVIDES RELIGIOUS SUPPORT MISSION TO ASSIGNED AND ATTACHED UNITS.

B. WITH ATTACHMENT: WHEN SUPPORTED BY ATTACHMENTS OF SPECIALIZED PERSONNEL AND EQUIPMENT THE BATTALION PROVIDES:

(1) QUARRYING AND CRUSHING OPERATIONS (QUARRY TEAM - TOE 05520LC)

(2) REHABILITATION OF PORTS (ENGINEER COMPANY, PORT OPENING, TOE 05603LO).

(3) CONSTRUCTION OF PETROLEUM PIPELINES AND STORAGE FACILITIES (PIPELINE CONSTRUCTION SUPPORT COMPANY, TOE O5434LO).

(4) POWER DISTRIBUTION (ENGINEER PRIME POWER BN, 05615L).

(5) WELL DRILLING (05520LE00).

(6) CONSTRUCTION SUPPORT EQUIPMENT AND PERSONNEL FOR ROCK CRUSHING, BITUMINOUS MIXING AND PAVING. (ENGINEER CONSTRUCTION SUPPORT COMPANY, TOE 05413L0).

C. INDIVIDUALS OF THIS ORGANIZATION, EXCEPT MEDICAL PERSONNEL AND THE CHAPLAIN, CAN ASSIST IN THE COORDINATED DEFENSE OF THE UNIT'S AREA OR INSTALLATION.

D. THIS UNIT PERFORMS DIRECT SUPPORT MAINTENANCE ON ENGINEER AND POWER GENERATION EQUIPMENT FOR THE BATTALION AND UNIT MAINTENANCE ON ORGANIC EQUIPMENT EXCEPT MEDICAL EQUIPMENT.

E. THIS UNIT IS DEPENDENT UPON APPROPRIATE ELEMENTS OF CORPS FOR HEALTH SERVICE SUPPORT, LEGAL, UNIT MAINTENANCE OF MEDICAL EQUIPMENT, NON-DIVISIONAL, DS FOR ASL SUPPORT FOR ENGINEER AND POWER GENERATION EQUIPMENT, FINANCE, AND PERSONNEL AND ADMINISTRATIVE SERVICES.

4. BASIS OF ALLOCATION. ONE PER DIVISION AND .246 PER WORKLOAD PER 1000 MANHOURS ENGINEER CONSTRUCTION PER DAY.

5. CATEGORY. THIS UNIT IS DESIGNATED A CATEGORY II UNIT. (FOR UNIT CATEGORIES, SEE AR 310-25.)

6. MOBILITY.

A. THIS UNIT IS CAPABLE OF TRANSPORTING 1,224,965 POUNDS (60,994 CUBE) OF TOE EQUIPMENT WITH ORGANIC VEHICLES.

B. THIS UNIT HAS 1,486,611 (45,206 CUBE) POUNDS OF TOE EQUIPMENT REQUIRING TRANSPORTATION.

C. THIS UNIT REQUIRES 100 PERCENT OF ITS TOE EQUIPMENT AND SUPPLIES BE TRANSPORTED IN A SINGLE LIFT USING ITS AUTHORIZED ORGANIC VEHICLES. (SOURCE: ENGINEER SCHOOL MEMORANDUM, DTD 8 FEB 94).

7. DOCTRINE. THE FOLLOWING DOCTRINAL PUBLICATIONS ARE APPLICABLE TO THE OPERATION OF THIS UNIT:

FM 5-100, ENGINEER COMBAT OPERATIONS.
FM 5-100-15-1, CORPS ENGINEER OPERATIONS
FM 5-101, MOBILITY.
FM 5-102, COUNTERMOBILITY.
FM 5-104, GENERAL ENGINEERING
FM 5-105, SURVIVABILITY.
FM 5-114, ENGINEER OPERATIONS, SHORT OF WAR
FM 5-116, ENGINEER OPERATIONS, EAC
FM 5-430-00-1/2, PLANNING AND DESIGN OF ROADS, AIRFIELDS, AND HELIPORTS IN THE THEATER OF OPERATIONS
FM 5-480, PORT CONSTRUCTION AND REPAIR
FM 5-482, MILITARY PETROLEUM PIPELINE SYSTEMS
FM 100-5, OPERATIONS
FM 100-7, DECISIVE FORCE: THE ARMY IN THEATER OPERATIONS
FM 100-16, ARMY OPERATIONAL SUPPORT[145]

APPENDIX C--JOINT CONSTRUCTION CAPABILITY TABLE [146]

Table1

	Army					Air Force	Navy	USMC
Equipment	**Cbt Hvy**	**Cbt (W)**	**Abn**	**CSC**	**CSE**	**RED HORSE**	**Seabee**	**CEB**
Road grader, > size 5	9	9	9		6			
Road grader, < size 5						5	6	7
Dozer, > D7	21	12		3	6	2	6	20
Dozer, < D7			15			4	2	3
Front-end loader, > 2.5 cu yd	2			5	3			
Front-end loader, < 2.5 cu yd	6		9	4		6	10	8
Backhoe or SEE*	6	18	18		6	3	2	*
Trencher						1	2	*
Scraper	12		9		6	2	8	6
Dump truck, > 10 ton	9			8	20	12	16	
Dump truck, < 10 ton	30	54	32		9			34
Line maintenance truck						1	1	1
HEMMT/TPU fuel truck	9	3	3	1	3	3	4	
Tractor Truck	28	12	15	7	6	4	1	8
Low-bed semi trailer	22	12	15	6	6	8	13	8
Rock drill				2			1	
Well driller						1	1	
10-K AT forklift	3		2	1		3	3	8
Concrete mixer truck						1	2	
8-cu-yd mobile concrete mixer	3					1	1	3
Asphalt paver				2		2	1	
Bituminous distribution truck	2			1				
Asphalt mix plant				1				
Water distributor truck	6	3	3	1	3	2	6	7
Crane	5	2	3	3	3	1	4	10
Vibratory roller	3	3	3		3	3	3	4
Pneumatic roller	5		3	2				

Steel-wheeled roller	1			4				
Sheep foot roller	3	3	3		3			
Towed sweeper	1			2				
Rock crusher/screen				1				

*Small emplacement excavator (SEE) tractor attachments.

NOTES:

1. Air Force Prime BEEF units are individually tailored to meet the needs of the assigned bases. Their equipment is not structured.

APPENDIX D ENGINEER BATTALION (COMBAT) (HEAVY)

ORGANIZATIONAL STRUCTURE

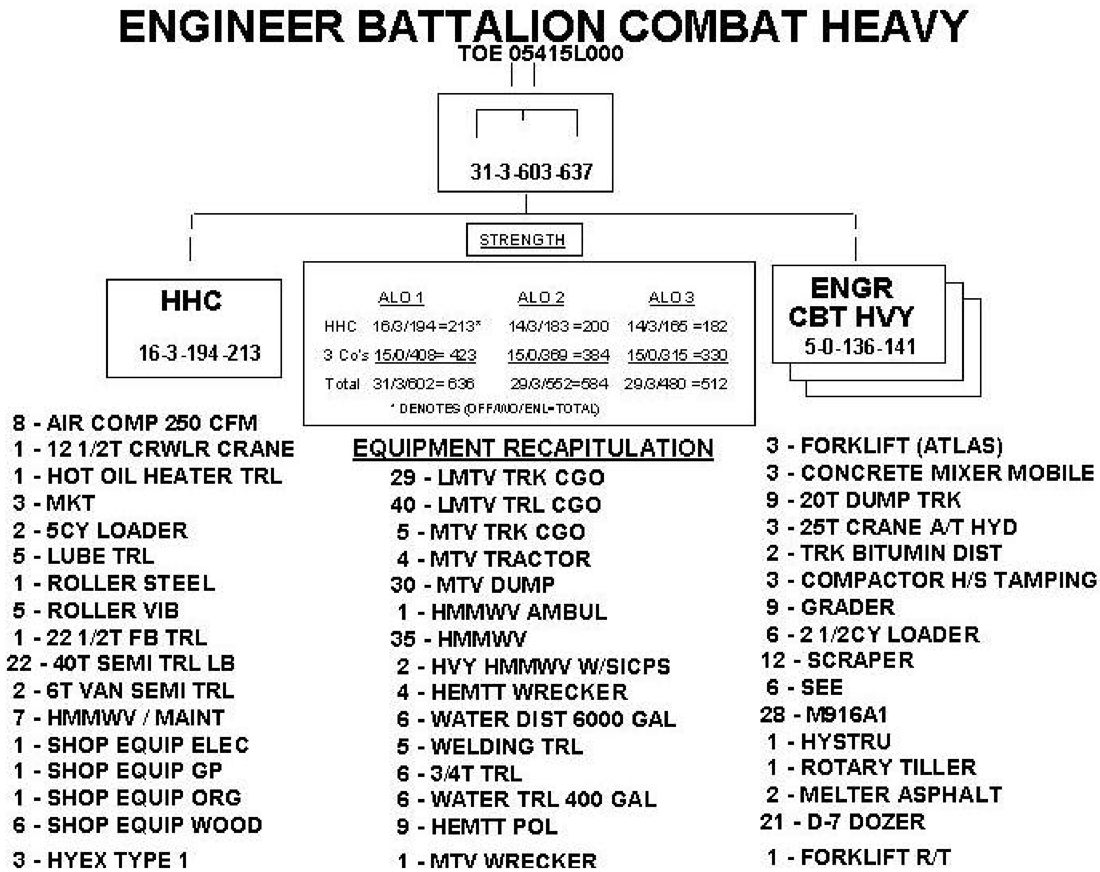
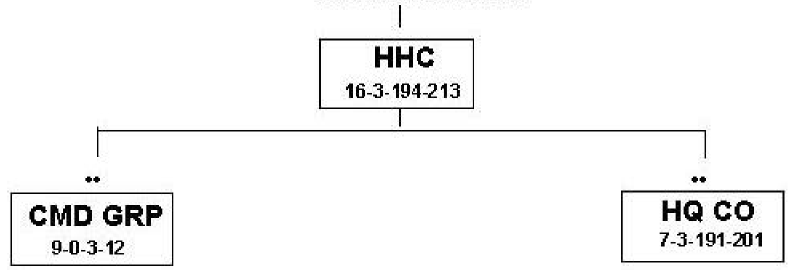

ENGINEER BATTALION COMBAT HEAVY
TOE 05415L000
31-3-603-637
STRENGTH
HHC
16-3-194-213
ALO 1
ALO 2
ALO 3
HHC 16/3/194=213* 14/3/183 =200 14/3/165 =182
3 Co's 15/0/408= 423 15/0/369 =384 15/0/315 =330
Total 31/3/602= 636 29/3/552=584 29/3/480 =512
* DENOTES (OFF/WO/ENL=TOTAL)
ENGR
CBT HVY
5-0-136-141
8 - AIR COMP 250 CFM
1 - 12 1/2T CRWLR CRANE
1 - HOT OIL HEATER TRL
3 - MKT
2 - 5CY LOADER
5 - LUBE TRL
1 - ROLLER STEEL
5 - ROLLER VIB
1 - 22 1/2T FB TRL
22 - 40T SEMI TRL LB
2 - 6T VAN SEMI TRL
7 - HMMWV / MAINT
1 - SHOP EQUIP ELEC
1 - SHOP EQUIP GP
1 - SHOP EQUIP ORG
6 - SHOP EQUIP WOOD
3 - HYEX TYPE 1
EQUIPMENT RECAPITULATION
29 - LMTV TRK CGO
40 - LMTV TRL CGO
5 - MTV TRK CGO
4 - MTV TRACTOR
30 - MTV DUMP
1 - HMMWV AMBUL
35 - HMMWV
2 - HVY HMMWV W/SICPS
4 - HEMTT WRECKER
6 - WATER DIST 6000 GAL
5 - WELDING TRL
6 - 3/4T TRL
6 - WATER TRL 400 GAL
9 - HEMTT POL
1 - MTV WRECKER
3 - FORKLIFT (ATLAS)
3 - CONCRETE MIXER MOBILE
9 - 20T DUMP TRK
3 - 25T CRANE A/T HYD
2 - TRK BITUMIN DIST
3 - COMPACTOR H/S TAMPING
9 - GRADER
6 - 2 1/2CY LOADER
12 - SCRAPER
6 - SEE
28 - M916A1
1 - HYSTRU
1 - ROTARY TILLER
2 - MELTER ASPHALT
21 - D-7 DOZER
1 - FORKLIFT R/T

Figure 1

HEADQUARTERS & SUPPORT COMPANY

HHC, EN BN (CBT HVY)

TOE 05416L000



3 HMMWV

EQUIPMENT RECAPITULATION

1 - AIR COMP 250 CFM
1 - 12 1/2T CRWLR CRANE
1 - HOT OIL HEATER TRL
3 - MKT
2 - 5CY LOADERS
2 - LUBE TRL
1 - ROLLER STEEL
2 - ROLLER VIB
1 - 22 1/2T FLATBED TRL
1 - HYSTRU

7 - 40T SEMI TRL LB
2 - 6 TON SEMI TRL VAN
1 - ROTARY TILLER
3 - HMMWV / MAINT
1 - SHOP EQUIP ELEC
1 - SHOP EQUIP GP
1 - SHOP EQUIP ORG
3 - FORKLIFT (ATLAS)
1 - HMMWV AMBUL
3 - CONCRETE MIXER MOBILE

2 - MELTER ASPHALT
11 - LMTV TRK CGO
7 - LMTV TRL CGO
2 - MTV TRK CGO
4 - MTV TRACTOR
7 - M916A1
1 - HEMTT WRECKER
2 - WELDING TRL
1 - FORKLIFT R/T

6 - D-7 DOZERS
3 - 3/4T TRL
17 - HMMWV
3 - HEMTT POL
2 - HVY HMMWV W/SICPS
3 - WATER TRL 400 GAL
9 - 20T DUMP
2 - 25T CRANE
2 - TRK BITUMIN DIST
1 - MTV WRECKER
3 - HYEX TYPE 1

Figure 2

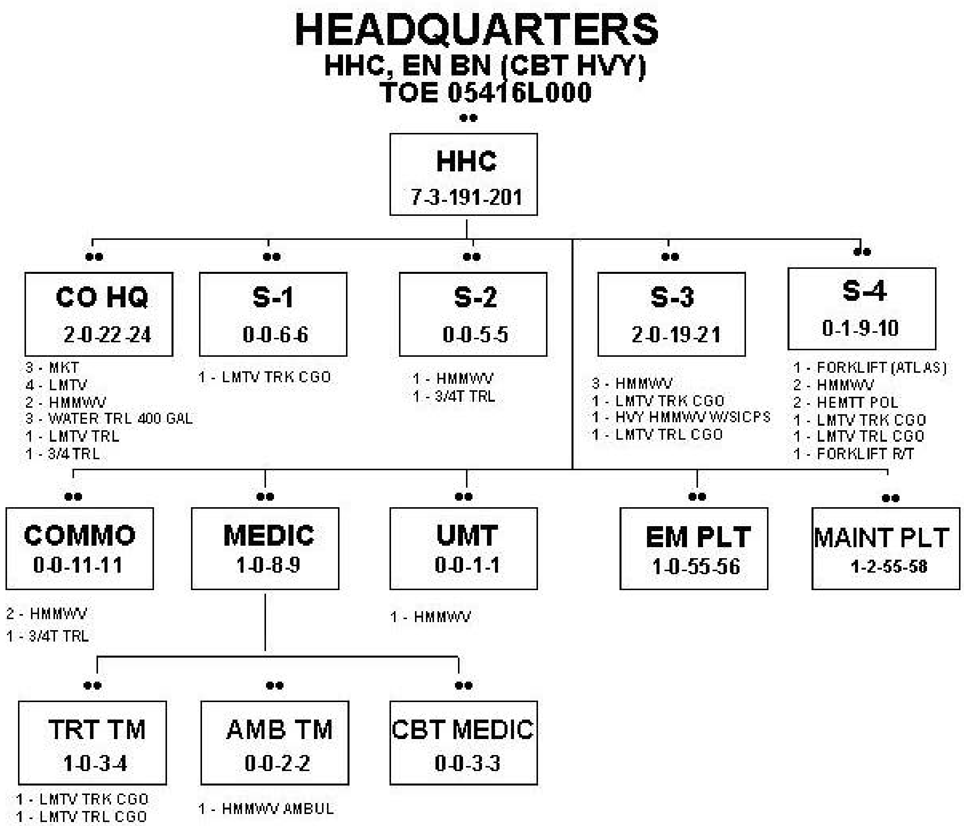


Figure 3

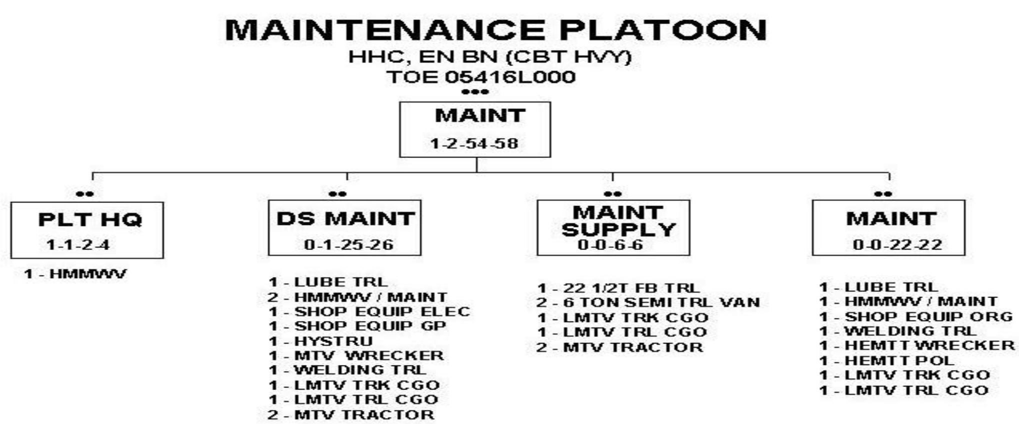


Figure 4

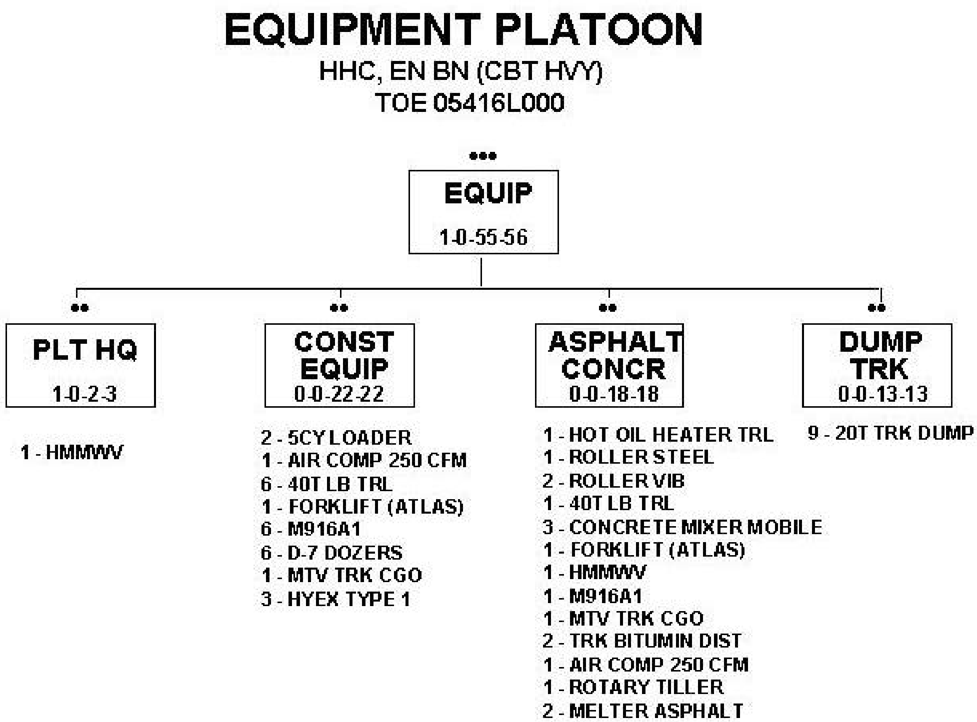


Figure 5

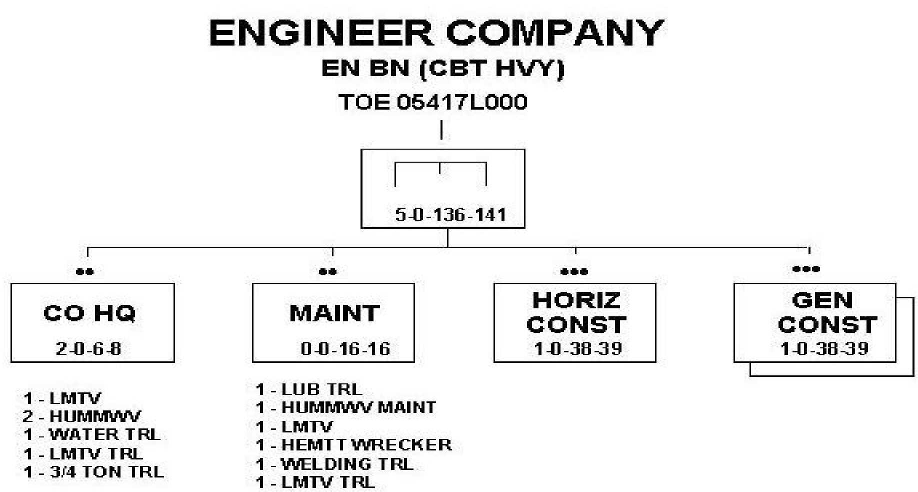


Figure 6

HORIZONTAL CONSTRUCTION PLATOON

EN CO, EN BN (CBT HVY)

TOE 05417L000

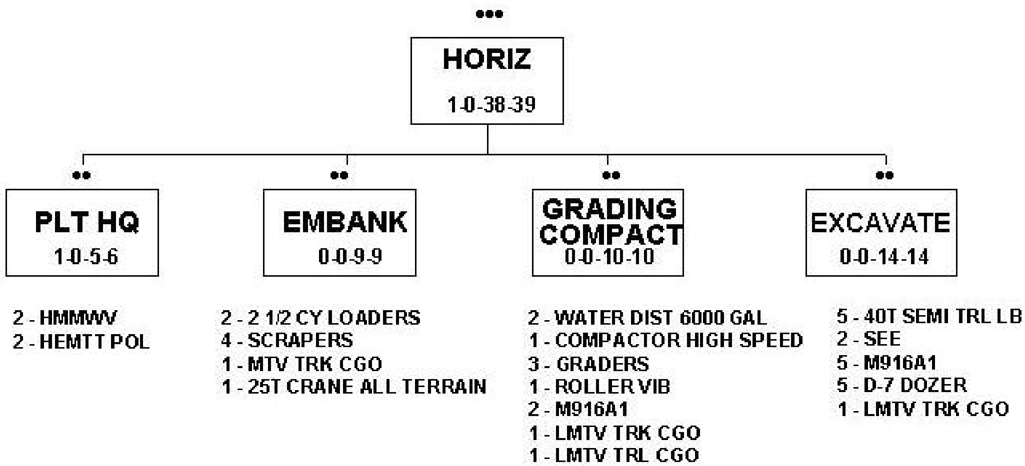


Figure 7

GENERAL CONSTRUCTION PLATOON

EN CO, EN BN (CBT HVY)

TOE 05417L000

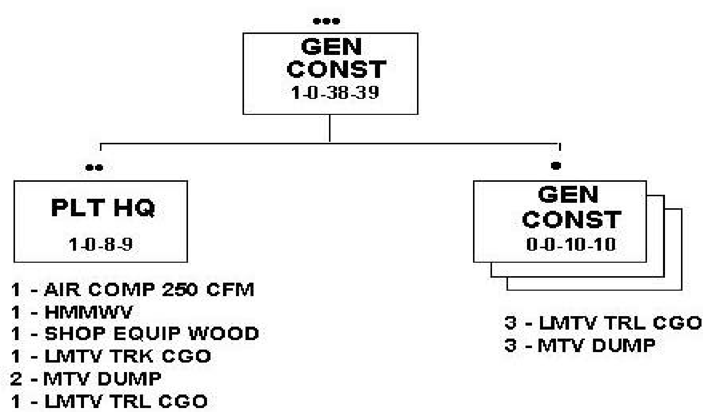


Figure 8

APPENDIX E EQUIPMENT LISTINGS FOR THE NMCB AND RED HORSE SQUADRON

The Naval Air Detachment Equipment Listing[147]

1 Truck, Utility ¾ T	1 Water Distributor	2 Skid Mounted Generators 30 KW
1 Truck, Cargo 1 ¼ T`	1 Compressor, 250 CFM	1 Lube Unit, Skid
2 Truck, Stake 15 T	1 Grader, Motorized	2 Welder, ARC/MIG
2 Truck, Dump 15 T	1 Loader, Scoop	1 Pump, Reciprocating 100 GPM
2 Truck, Tractor 15 T	1 Roller Vibratory	2 Pump, Centrifugal, 400 GPM
2 Semi trailer, 35 T	1 Tractor, FT	1 Pump, SIXCON, POL
2 Trailer, Tank 400G	1 Tractor, Wheeled	5 Tank, SIXCON, POL
2 Trailer, Forklift	4 Floodlight	1 Pump, SIXCON, water
1 Mixer, Concrete	2 Generators, Skid, 15 KW	2 Tank, SIXCON, water

Table 2

Red Horse Squadron Equipment Listing[148]

1 Crane, 15T	1 Trailer, 6 T	3 Truck, Tractor
2 Scoop Loader	2 Sweeper	6 Truck Dump 14 CY
2 Scraper 18 CY	2 Mixer Rotary	3 Trailer, 50T
5 Loader, 2 ½ CY	1 Concrete Mixer	2 Tractor, T-7
2 Grader, Size 5	2 Roller Vibratory	2 Tractor, T-9
1 Excavator	2 Forklift, 10K	11 Truck, 2 ½ T
2 Rock Drill Crawler	2 Truck, 20 T	1 Crush Trailer
1 Well Drilling Machine	2 Tractors. IW-70	2 Cleaner, Vac.

Table 3

APPENDIX F ENGINEER SCHOO[illegible]MENTS FOR OPERATIONS IN SUPPORT OF THE GULF WAR - COMBAT HEAVY ENGINEER BATTALIONS[149]

Equipment Recommendations:

- **Heavy Haul Tractors and Trailers:** Battalions recommended having one M920/916 tractor per piece of heavy engineer equipment to operate effectively in a desert environment.
- **Asphalt Distributors:** There was an overall shortage in theater. They were needed to spread diesel fuel and crude oil for dust control and compaction. Each combat heavy engineer battalion is authorized two asphalt distributors. This was not sufficient to support operations for the Gulf War.

- **Bulldozers:** The D7 with ripper was the most effective bulldozer in support of operations in the Gulf War. The bulldozers with rippers are of greater demand than those with winches. There should be a greater authorization of dozers with rippers than with winches. There also were shortages of cutting edges and filters. Units should be able to stock items, which were in high demand but short, or local purchase them prior to deploying. Limited haul assets for dozers resulted in idle stick time. The AAR recommended replacing the current tractor-trailers with heavy duty-heavy equipment transporters (HD-HET) or HEMMT with trailers. They also recommended one tractor-trailer per bulldozer in the force structure.

- **Night Vision Devices (NVD):** The Battalion had limited NVD capability. This limited operations to daylight only. Since running twenty-four hour hauling operations, one per driver is reasonable. Material Handling Equipment (MHE): The Battalions lacked MHE. Units made up for this shortfall by using cranes and scoop loaders over long distances to move heavy materials. Units recommended modifying scoop loaders so they have the versatility of MHE and well as hauling.[150] Overall asphalt production proved crucial. Asphalt was critical for asphalt pavement construction around helipads, airfields, hardstands, wash racks, warehouses, large festival tents and other moveable structures. Many engineer construction support companies left their asphalt production capability at home station. The combat heavy engineer battalions only had two asphalt distributors and this proved insufficient to meet project requirements.[151]

Organizational redesign recommendations included were:

- **The HQ and HQ support company:** The HQ and HQ support companies span of control was too big and challenged most battalions. In addition, the requirement to attach specialty engineer companies and detachments to the combat heavy engineer battalions complicated the span of control problems because this company provides Direct Support (DS) maintenance and administrative support to these organizations. Units recommended breaking the HSC into a HQ company and a separate maintenance company.
- **Line Company:** Overall the battalions assessed the one horizontal platoon and two vertical platoon structure for the line companies as effective. This structure allowed company commanders to effectively plan, control and execute company-sized missions.
- **Operations Section:** Battalions evaluated the operations sections as lacking design management and contracting expertise. The battalions required augmentation of civil engineering officers to address these shortfalls.
- **Liaison Officers (LNOs):** Units are not authorized liaison officer but needed them to enhance communications over extended areas of operations characteristic of combat heavy engineer battalions. Units had to assign other officers in the battalion Liaison responsibilities and lacked vehicles and communications equipment to support them. These officers coordinated with higher headquarters.[152]
- **Troop Construction:** Troop construction worked well, but there were some equipment challenges. First and foremost, the heavy battalions did not have rock crushing

capabilities and enough distributors to go around. This made supply of aggregate materials challenging.

- **The battalion:** The battalion does not have the ability to produce asphalt. Asphalt production limitations hindered construction of quality roads and resulted in duplicative effort to keep roads operational. [153]

APPENDIX G ENGINEER COMPANY (COMBAT SUPPORT EQUIPMENT)

The company is normally assigned to a corps and attached to an engineer brigade or group. When assigned to the ENCOM, the company augments the horizontal-equipment capabilities of the combat heavy battalions that are engaged in theater projects such as airfields, logistics bases, or MSR maintenance. It—

- Supports engineer combat operations within corps and division areas by conducting M/CM/S and general-engineering tasks.

- Provides manned engineer construction equipment to construct, rehabilitate, repair, maintain, and modify landing strips, airfields, CPs (Command Posts), MSRs, and LOC.

- Provides construction equipment support for divisional engineer battalions, when required.
- Provides dump-truck support, when required.[154]

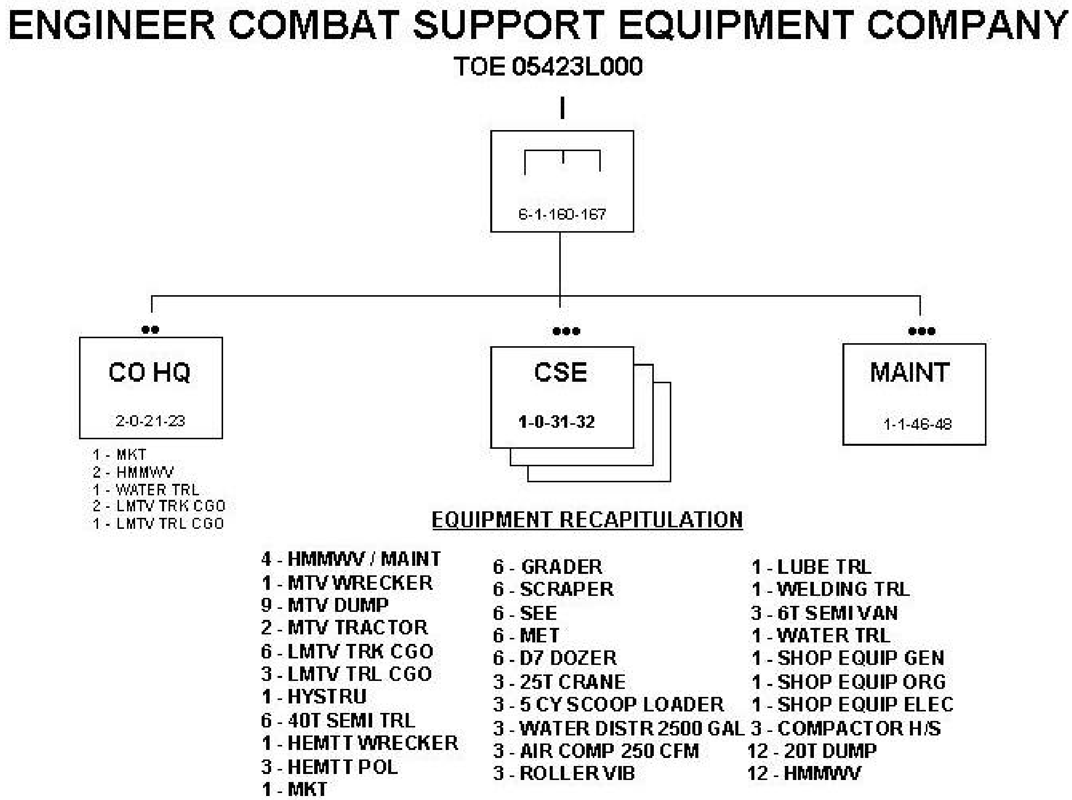


Figure 9

APPENDIX H RECORD OF U.S. MILITARY CONSTRUCTION UNITS DEPLOYING IN SUPPORT OF OPERATIONS IN BOSNIA

Table 4

IFOR (Implementation Force): First eleven months, the 94th Engineer Battalion (Combat Heavy) was deployed as an entire battalion and was augmented by the 362nd Combat Support Equipment Company from Fort Bragg. (1995-1996). Companies from the battalion were placed

in each brigade area in the American Sector.[155] This operation supported a force of over 20,000 in theater. Additional construction assets in theater included two U.S. Navy construction battalions and two U.S. Air Force Squadrons. The normally 800 personnel strong 1st Engineer Brigade of the 1st Armored Division deployed 2,400 personnel.[156]
IFOR/SFOR (Stabilization Force): The next six months the 62nd Engineer Battalion (Combat Heavy) deployed. Task organization included HSC, A Co and B Co. (October 1996-April 1997).
SFOR: Next six months the 642nd Combat Support Equipment Company (CSE) deployed with a vertical platoon attached from a National Guard combat heavy engineer battalion (April 1997-October 1997)[157]
SFOR: Deployed Naval Mobile Construction Battalion 133 from Gulfport, Mississippi. (March 1998-October 1998)[158]
SFOR: Deployed Alpha Company, 52nd Engineer Battalion, a MCB 40 (Mobile Construction Battalion) (October 1998-April 1999)[159], Bravo Company, 94th Engineer Battalion and a section of the 130th Brigade construction management section. A surgeon general's office facilities planner oversaw hospital design and construction. The U.S. Navy deployed design and project management capability and the Air Force deployed an Airfield construction expert. Mechanized combat engineers worked with joint heavy construction forces in theater. Tele engineering was used constantly for sewage and electrical expertise. Focus was on transferring soldiers from tents to SEA huts. This decreased fire hazards and greatly improved the quality of life.[160]
SFOR: Deployed Alpha Company, 62nd Engineer Battalion minus one vertical platoon.[161]
SFOR: Deployed 642nd CSE (September 1999-March 2000).[162]

ENDNOTES

[1] Janice Holt Guiles, *The Damned Engineers*, (Washington D.C., 1985), Introduction. In this book, Guiles recounts the story of one engineer battalion's experience during World War II. The engineer battalion in this historical book fights as infantry for ten days and defends sufficiently to stop the spearhead of a German attack commanded by Colonol Jochen Peiper. Stopping Peiper significantly contributed to the victory of allied forces in the Battle of the Bulge. This book inspires young officers today and teaches them about the proud tradition of being an engineer officer.

[2] Janice Holt Guiles, *The Damned Engineers*, (Washington D.C., 1985), ix to xv.

[3] Mobility, countermobility, survivability topographic engineering and general engineering are defined in appendix A.

[4] Refer to appendix B for a detailed listing of this unit's capabilities.

[5] USA Command and General Staff College, *ST 3-0 Operations*, (Ft. Leavenworth, KS, 1 October 2000), 1-14.

[6] USA Command and General Staff College, *ST 3-0 Operations*, (Ft. Leavenworth, KS, 1 October 2000), 1-14 through 1-15.

[7] USA Command and General Staff College, *ST 3-0 Operations*, (Ft. Leavenworth, KS, 1 October 2000), 1-15.

[8] Department of the Army, *Army Vision 2010* (Washington, D.C., 1996) [database on-line]; available from http://www.army.mil/2010/; Internet; accessed 08/25/00.

[9] Ibid.

[8] Department of Combat Developments, *February 1998 Operational Concept for Military Engineering Operations* (Ft. Leonardwood, MO, 1998) [database on-line]; available from http://www.wood.army.mil/DCD/nolimits/ENDIV/ict_pw/oper.htm; Internet; accessed 08/25/00. 2-22.

[11] Ibid.

[12] Department of Combat Developments, *Prioritization Paper For Engineer Future Capabilities* (Ft. Leonardwood, MO, 1999) [database on-line]; available from http://www.wood.army.mil/DCD/nolimits/ENDIV/prioritization_paper.htm; Internet; accessed 08/25/00.

[13] Department of Combat Developments, *February 1998 Operational Concept for Military Engineering Operations*, 1-22

[14] Department of Combat Developments, *Theater Support Engineer Operations Integrated Concept Team Charter* (Ft. Leonardwood, MO, 1998) [database on-line]; available from http: //www.wood.army.mil/DCD/nolimits/ENDIV/ict_pw/tseoict.htm; Internet; accessed Internet; 08/25/00.

[15] Ibid.

[16] The author received this information from Mr. Peter O'Malley, a GS-13 who works in the Force Structure department of the Engineer School. Mr O'Malley is involved in preparing the support information for the section of the Total Army Analysis (TAA) addressing the Echelon Above Corps assets.

[17] Refer to appendix C, table one for a listing of all the heavy engineer assets in the U.S. Army, U.S. Navy, U.S. Air Force and U.S. Marines.

[18] Headquarters, Department of the Army, *FM 5-100 Engineer Operations*, (Washington, D.C., 27 February 1996), 1-10.

[19] This basic concept was discussed during the "Operational Logistics" elective taught as part of the electives program for the School of Advanced Military Studies Program in the December of 2000.

[20] The patterns of operations for the Army are identified in Joint Vision 2010. These are project the force, protect the force, information dominance, shape the battle space, decisive operations, and sustain the force. The engineer school did this crosswalk referenced in the thesis and showed how the engineer functions integrate with the Army's patterns of operations. The *Operational Concept for Military Engineering Operations* broke engineering functions down into three categories, Terrain Visualization, Maneuver Engineering and Force Support Engineering. The tasks listed in this paper were pulled out of the chart, which showed that crosswalk. The crosswalk can be found on the Internet. Department of Combat Developments, February 1998 *Operational Concept for Military Engineering Operations* (Ft. Leonardwood, MO, 1998) [database on-line]; available from http://www.wood.army.mil/DCD/nolimits/ENDIV/ict_pw/oper.htm; Internet; accessed 08/25/00.

[21] Reference the specified capabilities as shown in the current Engineer Battalion (Combat) (Heavy) Modified Table of Organization and Equipment in appendix B.

[22] Martin Keiner and Paula Loomis, "Total Force in the Air Force," *Illus Military Engineer*, February-March 1999, 38-40. This article highlights a number of specific examples where the use of troop construction capability resulted in a significant reduction of costs compared to if the same missions were executed by contracted construction capability. The author found a number of articles similar to this, which highlighted extensive savings by use of military construction assets over the use of contracted construction. Also, based on experience commanding two combat heavy companies in the United States and overseas, this author holds the opinion that use of military troop construction can save the Army extensive money based on viewing civilian estimates and comparing them with the actual cost incurred by executing the project with the military construction company.

[23] Kevin Lindsay, LTC, U.S. Army, "Engineers, Where Do We Go From Here?" *Engineer*, Fort Leonardwood, MO, October 2000, 2-14.

[24] Mobility, Countermobility, Survivability and General Engineering are defined in appendix A of this thesis, as is Lines of Communications. They are the basic missions for the mobility and survivability battle operating system (BOS) and define the basic engineer functions on the battlefield. These concepts encapsulate what the engineer does on the battlefield, both in the rear and forward toward the front lines.

[25] This concept is found in multiple recommendations about what to do with combat heavy engineer battalions. Kevin Lindsay, LTC, U.S. Army, "Engineers, Where Do We Go From Here?" *Engineer*, Fort Leonardwood, MO, October 2000, 2-14. U.S. Army War College, "A Combat Engineer Force Design for 1995", (Carlisle Barracks, Pennsylvania, 07 June 1985), 10-

1. Army Combat Developments Command, *The Engineer Construction Battalion (U)*, (Ft. Belvoir, VA, 1970), H-II-5.

[26] Department of Combat Developments, *February 1998 Operational Concept for Military Engineering Operations*, 20-21.

[27] TRADOC, *TRADOC Pamphlet 525-68 Military Operations Concept for Modularity*, (Fort Monroe, VA, 1995), 10.

[27] TRADOC was formed in 1973. The intent of this organization was to bring the doctrine and material development functions together. The missions for the organization include accessing the force, training the Army, and setting the Army's standards and requirements.

[28] Eric Elsmo, "Modular Design for Future Logistics," *Army Logistician* (Fort Lee, VA, May-Jun 99) [database on-line]; available from: http://www.almc.army.mil/alog/MayJun99/MS327.htm; Internet; accessed 12/21/00.

[30] Ibid., 3.

[31] Headquarters, Department of the Army, *FM 5-104 General Engineering*, (Washington, D.C., November, 1986), 2.

[32] Headquarters, Department of the Army, *FM 5-104 General Engineering*, 3.

[33] Ibid.

[34] Army Combat Developments Command, *The Engineer Construction Battalion (U)*, 2-21-2 to 2-2.

[35] Headquarters, Department of the Army, *FM 5-104 General Engineering*, 5.

[36] Ibid.

[37] Army Combat Developments Command, *The Engineer Construction Battalion (U)*,G-III-1 to G-III-3.

.
[38] The 416th Engineer Command, *United States Army Reserve in Operation Desert Storm, Engineer Support at Echelons above Corps, the 416th Engineer Command*, (Washington, D.C., 18 May 1992), 14-19.

[39] Ibid., 2-13 to 2-14.

[40] Janice Holt Giles, 4.

[41] Army Combat Developments Command, *The Engineer Construction Battalion (U)*, 2-15.

[42] Ibid., 2-12

[43] Peter J. Novembre, Major, U.S. Army, *Universally Capable Engineer Battalion*, (Ft. Leavenworth, KS, 1972), 1-3

[44] Army Combat Developments Command, *The Engineer Construction Battalion (U)*, H-II-5 to H-II-8.

[45] Construction Battalion Evaluation Directorate, *Field Evaluation Engineer Construction Battalion Volume I Executive Summary*, (Ft. Carson, Colorado, 28 March 1974), 6-7.

[46] Ibid., 7-11.

[47] Ibid., 10-11.

[48] Ibid.

[49] The Nun Amendment required "the Defense Department to improve the Tooth to Tail ratio in Europe during FY 75 and FY 76. This amendment reflected the often repeated argument that the US Forces worldwide, and more specifically those in Europe, have too little of the force devoted to "tooth" (or combat) and too much devoted to "tail" or combat service support." John M. Frank, "Engineer Combat Battalion (Heavy),", *Engineer*, Ft. Belvoir, VA, Winter-Spring 1975, 38.

[50] Ibid.

[51] Ibid., 38-41.

[52] The author drew this conclusion after exchanging electronic mails (e-mails) with the Engineer School historian Dr. Larry Roberts. Dr. Roberts relayed that documentation on the decision to retain functionalized platoons instead of converting to companies was not available. Based on his memory of the period, the tooth-to-tail ratio issue overshadowed all the decisions. The engineers decided to create a "multi-functional" battalion capable of both construction and combat. This was embodied in the Combat Engineer Battalion (Heavy). The decision to leave the functional platoons in place was a byproduct of this reasoning. A more civilian type organization, verses one designed for combat is less likely to survive the tooth-to-tail debate.

[53] U.S. Army War College, *A Combat Engineer Force Design for 1995*, (Carlisle Barracks. Pennsylvania, 07 June 1985), 10-1.

[54] Ibid., 10-1 to 10-4.

[55] Ibid.

[56] Ibid., 10-15

[57] Ibid. Refer to appendix A for the definition of COMMZ.

[58] This concept is found addressed in both U.S. Army Engineer and Joint Civil Engineering doctrinal manuals. It is also frequently addressed in much of the current writing of engineer and logistical officers across the force.

[59] Comment based on author's experience in two deployments.

[60] Refer to appendix D for figures one through five.

[61] Refer to appendix D for figures six through eight.

[62] John Lehman, CPT, U.S. Navy, "Joint Civil/Construction Engineer Training. A Navy Perspective?" *Engineer*, Fort Leonardwood, MO, December 1994, 10.

[63] Naval Mobile Construction Battalion, *Naval Mobile Construction Battalion Web Page*, (Gulfport, Mississippi, 2000), [database on-line]; available from: http://www.seabee.navy.mil/nmcb1/hqco.htm; Internet; accessed 10/12/00.

[64] The information above comes from two sources. The first source is Michael McGill, MAJ, USMCR, and Al Robertson, CDR, USNR, "Seabees-A Force Multiplier," *Marine Corps Gazette*, Quantico VA, March 1996, 28-31. The second source is the Naval Mobile Construction Battalion Web Page.

[65] Refer to appendix E, table two for a listing of equipment found in the Air Detachment.

[66] Ibid., E-12.

[67] IDMT Association, *IDMT Association, Red Horse: Background* (Fort Indiantown Gap, PA, October 2000) [database on-line]; available from: http://www.idmtassociation.com/823red.htm; Internet; accessed 10/12/00.

[68] Refer to appendix E, table three for a listing of equipment found in the Air Force Red Horse Squadron.

[69] Naval Mobile Construction Battalion Web Page.

[70] Janet A. McDonnel, 191.

[71] Barbara Bryant, "City in the Sand Building Support for Desert Shield/Storm," *Military Engineer*, November-December, 1991, 10.

[72] Author knows this based on the personal experience of living in "Kobar" Towers and another location of abandoned buildings on the beach called fondly "tiger beach." Kobar towers was a brand new apartment complex. The Saudi Arabian government built it for the Bedouins, but they refused to use it. The towers were a major center for troop bed-down for reception of units in theater and redeployment from theater. "Tiger beach" was the 515th Engineer Company home upon arrival into theater. It was a deserted small village of a few run down buildings, which were in a serious state of disrepair and filthy. Other U.S. Army units lived there upon their arrival in country also.

[73] Janet A. McDonnel, 118-119.

[74] Ibid., 118.

[75] Ibid., 93

[76] Refer to appendix G for organizational structure of the CSE. The CSE is functionalized at the company level with only horizontal assets.

[77] Headquarters, Department of the Army, *AAR, Volume II, Main Report Chief of Engineers*, (Fort Leavenworth, KS), 7.

[78] United States Army Engineer School, 14-15.

[79] McDonnel, 103.

[80] McDonnel, 191-192.

[81] ARCENT, *ARCENT After Action Reports and Lessons Learned, Engineer Lessons Learned From ARCENT Records of BG Scales Papers*, (Ft. Leavenworth, KS, 1991), 8-9.

[82] United States Army Engineer School, 9.

[83] 20th Engineer Brigade, *Center for Army Lessons Learned Gulf War Collection, 20th Engineer Brigade AAR, July 1991* (Fort Leavenworth KS, July 1991) [database on-line]; available from http://www…/@de_call_8773.env?CO_Session_Key=YCAURAAMNUKMV&CQDC=271&CO_Multi]10/29/00; Internet; accessed 08/19/00.

[84] 20th Engineer Brigade, *Center for Army Lessons Learned Gulf War Collection, 20th Engineer Brigade AAR, July 1991.*

[85] United States Army Engineer School, 9-10. These missions are listed in a number of other sources including the 411th After Action Review.

[86] An automatic building machine cuts, bends, and seams the metal of the exterior of the K-Span structure. Pictures of this equipment are available on the Internet. Type in ABM and it will lead to some commercial websites that show the equipment. ABMs are used frequently in commercial and military construction. During a project at Fort Carson, Colorado, the author's combat heavy engineer company built a K-Span. The company required external training from civilian contractors on how to work the equipment and work with the metal. Metal specialists would have been invaluable for this mission. The structure has massive rebar in the concrete foundation, which must be placed and has substantial welding requirements. The present combat heavy engineer company does not have adequate welding capability to support this mission.

[87] McDonnel.,191-192.

[88] The 416th Engineer Command , *United States Army Reserve in Operation Desert Storm, Engineer Support at Echelons above Corps, the 416th Engineer Command*," (Washington, D.C.,18 May 1992), 46.

[89] United States Army Engineer School, 6.

[90] Ibid., 124

[91] Refer to appendix F for the Engineer School AAR recommendations.

[92] 416th Engineer Command, 32-34.

[93] Ibid.

[94] McDonnel, 193.

[95] Ibid.

[96] 416th Engineer Command, 7.

[97] 416th Engineer Command, 7.

[98] Ibid.

[99] McDonnel,13.

[100] 416th Engineer Command, 7.

[101] McDonnel., 8

[102] Ibid.

[103] Dave Treleaven, Major, U.S. Army, Engineers in Bosnia An Overview, *Engineer* (Ft. Leavenworth, Kansas, 2000) [database on-line]; available from http://www.wood.army.mil/engrmag/pb5961/treleav.htm; Internet; accessed 06/01/00.

[104] Ibid.

[105] Ibid.

[106] Center for Army Lessons Learned, *BHCAAT XIII Initial Impressions Report (IIR)*, (Ft. Leavenworth, Kansas, 1998), 168.

[107] Refer to appendix G for organizational structure of the CSE.

[108] DCSENGR, *Strategic and Operational Level Compilation of Observations for Operation Joint Endeavor After Action Review* (Ft. Leonardwood, MO, December 96), 11.

[109] U.S. Army Europe, *Operation Joint Endeavor, USAREUR Headquarters, After Action Report, Volume I May 1997* (Ft. Leavenworth, KS, 2000) [database on-line]; available from http:// https://160.149.150.44/cgi-bin/cqcgi/@de_call_8773.env?cq_SESSION_KEY=DGZSRXHMRHMW&CQDC=11&CQ_CUR_DOCUMENT=92&CQ_SAVE[Show_Docl]=TRUE&CQ_RESULTS_DOC_TEXT=YES; Internet; accessed 09/25/00.

[110] "LOGCAP was established by the Army in 1985 as a means to (1) preplan for the use of contractor support in contingencies or crisis, (2) take advantage of existing civilian resources in the United States and overseas to augment active and reserve forces. Initially the program concept was that each U.S. Army component of a unified command would individually plan and contract for its own logistics and engineering services. In 1992, the concept was changed to

provide a single, centrally managed worldwide planning and services contract. Although it originated as an Army program, LOGCAP is available to the other services….The United States Army Corps of Engineers was responsible for LOGCAP contract administration in Bosnia….On October 1, 1996, the Army transferred LOGCAP management responsibilities from the Corps to AMC (Army Material Command)." United States General Accounting Office, *Report to Congressional Requesters, Contingency Operations, Opportunities to Improve the Logistics Civil Augmentation Program*, (Washington, D.C., February 1997), 2-22.

[111] United States General Accounting Office, 1.

[112] David Brinkley, Major, U.S. Army, "The Engineer School: Providing Lessons Learned to the Force", *Engineer* (Ft. Leonardwood, MO, 1996) [database on-line]; available from http://www.wood.army.mil/engrmag/pb5963/brinkley.htm. Internet accessed 08/27/00.

[113] United States General Accounting Office, 4.

[114] Ibid.

[115] Treleaven.

[116] Center for Army Lessons Learned, *BHCAAT XIII Initial Impressions Report (IIR)*, 169.

[117] Center for Army Lessons Learned, *BHCAAT XIII Initial Impressions Report (IIR)*, 168.

[118] DCSENG, 12.

[119] U.S. Army Europe, *Operation Joint Endeavor, USAREUR Headquarters, After Action Report, Volume II May 1997* (Ft. Leavenworth, KS, 1997) [database on-line]; available from http:// https://160.149.150.44/cgi-bin/cqcgi/@de_call_8773.env?cq_SESSION_KEY=DGZSRXHMRHMW&CQDC=11&CQ_CUR_DOCUMENT=95&CQ_SAVE[Show_Docl]=TRUE&CQ_RESULTS_DOC_TEXT=YES; Internet; accessed 09/25/00.

[120] DCSENGR, 2.

[121] DCSENGR, 11-12

[122] Ibid., 12.

[123] Ibid.

[124] "Force provider is a complete, containerized, highly deployable bare-base system that is engineered to provide climate-controlled billeting, dining, shower, latrine, laundry, and morale, welfare and recreation (MWR) facilities in battalion sized modules designed for 550 soldiers each. It is packaged with utility systems, including water storage and distribution (80,000 gallons), fuel storage and distribution (40,000 gallons), wastewater storage, and power generation and distribution capabilities. Force providers basic building block is the tent, extendable, modular, personnel (TEMPER), which comes with external forced-air heating and cooling similar to the systems in the average home." Tim Lindsay, LTC, U.S. Army, James McLaughlin, and

Norm Breneau, *Force Provider Deploys to Bosnia* (Ft. Lee, VA, May 1997) [database on-line]; available from http://www.almc.army.mil/alog/May97/ms154.htm; Internet; accessed 04/11/00.

125 Center for Army Lessons Learned, *BHCAAT XIII Initial Impressions Report (IIR)*, 168.

126 Ibid, 85.

127 First Cavalry Division, *Multinational Division (North) Mission Execution for CS and CSS, October 1999* (Ft. Leavenworth, October 1999) [database on-line]; available from https://160.149.150.44/cgi-bin/cqcgi/@de_call_8773.env?CQ_SESSION. KEY=DGZSRXHMRHMW&CQ_LIBRARY_LINK=YES&CQOBID=RWP-05-948399&CQNODENUM=3&CQ_SAVE[NODE3]=RPW-05-948399&CQLIBID=16&CQSRCHLIB=bosnia&CQ_SAVE[Current_Group]=1&CQ_SAVE[LINK_NODE_ID]=rpw-05-948399; Internet accessed 09/25/00.

128 Center for Army Lessons Learned, *BHCAAT XIII Initial Impressions Report (IIR)*, 93.

129 Thomas Bostick, Colonel, U.S. Army, "Bosnia: The Second Time Around", *Engineer* (Ft. Leonardwood, MO, 1999) [database on-line]; available from http://www.wood.army.mil/engrmag/pb5992/bostick.htm; Internet; accessed 06/01/00.

130 U.S. Army Europe, *Operation Joint Endeavor, USAREUR Headquarters, After Action Report, Volume I May 1999* (Ft. Leavenworth, KS, 1997) [database on-line]; available from http:// https://160.149.150.44/cgi-bin/cqcgi/@de_call_8773.env?cq_SESSION_KEY=DGZSRXHMRHMW&CQDC=11&CQ_CUR_DOCUMENT=97&CQ_SAVE[Show_Docl]=TRUE&CQ_RESULTS_DOC_TEXT=YES; Internet accessed 09/25/00.

131 Center for Army Lessons Learned, *B/H CAAT 5 Initial Impressions Report May 1997*, (Ft. Leavenworth, KS, 1997), viii.

132 Table four is in appendix H and has a breakdown of some of the construction force packages deployed in support of operations in Bosnia.

133 Refer to appendix G for the organizational structure of the CSE.

134 Refer to appendix H for a breakdown of some of the construction assets for operations in Bosnia. Analysis of this record of unit deployments provides a means to assess the ability of the battalion to meet the criteria of modularity in support of SASO operations.

135 Center for Army Lessons Learned, *BHCAAT XIII Initial Impressions Report (IIR)*, 84.

136 Center for Army Lesssons Learned, *Unit Requirements Statement* (Ft. Leavenworth, KS, 2000) [database on-line]; available from https://160.149.150.44/cgi-bin/cqcgi/@de_call_8773.env?cq_SESSION_KEY=DGZSRXHMRHMW&CQDC=8&CQ_CUR_DOCUMENT=2&CQ_SAVE[Show_Docl]=TRUE&CQ_RESULTS_DOC_TEXT=YES.; Internet; accessed 09/25/00.

137 Note that the unit listings in table four show two NMCBs are present when forces initially deploy to Bosnia. Also, from March 1998 to April 1999 the NMCB assets are used. This was an

intensive construction period. The leadership in Bosnia decided that forces would be there longer than the original 18-month estimate. The initial facilities built were constructed to last for two years or less. They needed upgrading to a more semi permanent type construction standard capable of supporting troops over a period of years instead of months.

[138] U.S. Army Engineer School, *Operation Joint Endeavor Lessons Learned Bullets*, (Ft. Leonardwood, MO, 1996), 2.

[139] Refer to appendix G for a description of CSE company and organizational chart.

[140] Geotextiles were used extensively in Bosnia during the Author's deployment with the 62nd Engineer Battalion (Combat) (Heavy). The geotextiles are a strengthening material, which is rolled on the ground to increase its strength and enhance soil-bearing capacity. The geotextiles are labor intensive and expensive. Perhaps use of other horizontal construction techniques could have reduced this cost in the long run. Funding limitations caused by the requirement for excessive aggregate layers and multiple geotextile layers in the mud resulted in construction of surfaces, which did not meet design specification for the military load classes operating on the surface. The surfaces did not last long and constantly required repair.

[141] Comment based on observations made by author as a company commander of a combat heavy engineer company in Bosnia.

[142] Stephanie Arnold, Captain U.S. Army, "Building Kosovo of Tomorrow," *Engineer*, Ft. Leonardwood, MO November 1999, 5-6.

[143] McGill, 28-31.

[144] Headquarters, Department of the Army, *FM 3-34.230 (Formerly FM 5-105) Topographic Operations*, (Washington,D.C, 2000), 3-2.

[145] Requirements Document Directorate, *Consolidated TOE Update (CTU , April 2000)* (Ft. Leavenworth, Kansas, 2000) [database on-line]; available from http://www.usafmsardd.army.mil/toe.cfm?toenumber=5415L000; Internet; accessed 08/21/00

[146] Headquarters, Department of the Army, *FM 5-116 Engineer Operations: Echelons Above Corps* (Washington, D.C., 2000) [database on-line]; available from http://www.adtdl.army.mil/cgi-bin/atdl.dll/fm/5-116/ch4.htm; Internet; accessed 06/26/00.

[147] Corps Engineer Section XVIII Airborne Corps, *Planning Guide*, Fort Bragg, NC, April 1997, E-16 to E-17.

[148] Corps Engineer Section XVIII Airborne Corps, E-15.

[149] United States Army Engineer School, 9-15.

[150] United States Army Engineer School, 9-15.

[151] McDonnel, 8.

[152] United States Army Engineer School, 9-15.

[153] Ibid.

[154] Ibid.

[155] Arnold, 4.

[156] Treleaven.

[157] 642nd CSE, *642nd CSE Company History (Ft. Drum, NY, 2000)* [database on-line]; available from http://www.drum.army.mil/divstaff/41stEngr/642history.html; Internet; accessed 09/23/00.

[158] Derrick Witherspoon, Sergeant, U.S. Army, *TALON: Seabees Work For Better Future—19980918* (Ft. Leavenworth, Kansas, September 1998) [database on-line]; available from https://tfeagle.army.mil/talon/18Sept 98/story6.html; Internet accessed 08/01/00.

[159] Ibid.

[160] Bostick, "Bosnia: The Second Time Around," *Engineer.*

[161] Center for Army Lessons Learned, *Unit Requirements Statement* (Ft. Leavenworth, KS, 2000) [database on-line]; available from https://160.149.150.44/cgi-bin/cqcgi/@de_call_8773.env?cq_SESSION_KEY=DGZSRXHMRHMW&CQDC=8&CQ_CUR_DOCUMENT=17&CQ_SAVE[Show_Docl]=TRUE&CQ_RESULTS_DOC_TEXT=YES; Internet; accessed 09/25/00.

[162] 642nd CSE.

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