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IMPROVING ENGINEER RECONNAISSANCE IN FIRST MARINE DIVISION

by

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IMPROVING ENGINEER RECONNAISSANCE IN FIRST MARINE DIVISION

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ABSTRACT

This thesis explores alternative organizational designs to improve 1st Marine Division's engineer reconnaissance capability. It defines engineer reconnaissance as a complementary component of the divisions decentralized reconnaissance function, and addresses the evolution of engineer reconnaissance and its relevence to current and future maneuver commanders. This thesis expands on current deficiencies in training, organization, and coordination to define the engineer reconnaissance deficiency in terms of an organizational design problem. Four alternative solutions are proposed to develop and maintain an improved engineer reconnaissance core competency involving both structural and training changes. This thesis evaluates each alternative by three cost criteria (personnel, training, and lateral coordination requirements), and four benefit criteria (quality, acceptability, applicability, and maintainability) using an additive weighting and ranking method of analysis to determine an optimal course of action. Results of this analysis suggest that creating an engineer reconnaissance section at 1st Combat Engineer Battalion will provide the greatest engineer reconnaissance benefit to the division at the lowest cost.

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I. INTRODUCTION

A. BACKGROUND

Desert Shield and Desert Storm identified a deficiency in the U.S. Marine Corps ability to conduct close and deep engineer reconnaissance missions. Neither combat engineers nor reconnaissance Marines had the proper training or experience to conduct engineer reconnaissance missions to gather information on Iraqi obstacle belts and defensive measures. First Marine Division solved this particular problem by attaching specially trained Marines from 1st Combat Engineer Battalion (1st CEB) to established teams in 1st Reconnaissance Battalion. These composite reconnaissance teams trained for approximately six weeks prior to insertion into Kuwait to gather vital information for 1st Marine Division Commanders. This solution required an inordinate amount of preparation to develop the desired levels of proficiency in the engineer reconnaissance skills necessary to conduct these missions. Future adversaries and environments may not provide Marines with this preparation time, suggesting that the Marine combat engineer and reconnaissance communities develop and maintain a readily employable engineer reconnaissance capability.

B. OBJECTIVES

This thesis will address how to develop and maintain an engineer reconnaissance capability in 1st Marine Division capable of operating across the geographic depth of the battlefield. It will investigate potential alternative solutions to the current deficiency and evaluate the relative costs and benefits of each alternative to yield a recommended course of action. The primary research question addressed by this thesis is what alternative organizational designs and training solutions provide 1st Marine Division with the best

engineer reconnaissance capability? In answering this primary research question, this thesis also addresses the following subsidiary questions:

1. What is engineer reconnaissance and how does it fit into the division's reconnaissance function?
2. Why does 1st Marine Division require this capability?
3. What are the current engineer reconnaissance capabilities and limitations?
4. Which alternative provides the greatest benefit at the lowest cost?

C. ASSUMPTIONS

This thesis assumes that engineer reconnaissance is part of the division's reconnaissance function. While engineer reconnaissance differs significantly from amphibious and armored reconnaissance in some of the information collected, it shares many of the methods of collection and means of employment across the geographic depth of the battlefield.

This thesis assumes that increases in personnel strength in any one organization in the Marine Corps will require a corresponding decrease in personnel strength from another organization within the Marine Corps. Like all organizations, the Marine Corps and 1st Marine Division must allocate a finite pool of resources among its operating and supporting structures. This becomes important when discussing any organizational design changes involving personnel. The recent drawdown in personnel and operating forces suggests that any organizational changes will be at best a "zero-sum" game. Specifically, any personnel increases within the division or a subordinate reconnaissance organization will be at the expense of another organization within or outside of 1st Marine Division.

This thesis also assumes that 1st Marine Division will absorb the current distribution of reconnaissance assets at the regimental level into a new division level reconnaissance organization. This may entail a re-emergence of the 1st Reconnaissance Battalion, or a new organization incorporating both division and MEF level reconnaissance assets (Anderson, 1997). Lacking a final decision on reconnaissance force structure and organization, this thesis uses the organization, mission and training plans of the current Division Reconnaissance Company and Light Armored Reconnaissance (LAR) Battalions as the organizations responsible for ground reconnaissance in 1st Marine Division.

D. METHODOLOGY

The following methodology was used in preparation of this thesis:

1. Data collection involved a comprehensive review of military journals, magazine articles, field manuals, mission statements and training plans for selected 1st Marine Division organizations, and reference materials from engineer reconnaissance files maintained at 1st CEB. Six interviews were conducted with Marines experienced in combat engineer and reconnaissance operations, of which two were used as direct references.
2. Alternative solutions were developed from both existing and new proposals addressing engineer reconnaissance.
3. Alternative solutions were evaluated using an additive weighting and ranking form of cost/benefit analysis. Evaluation criteria were established and measured by their relative importance to the alternative solutions presented.

An optimal solution was selected from the alternatives by determining the lowest of the alternatives cost-to-benefit ratios.

E. ORGANIZATION OF STUDY

Chapter II provides necessary background information on engineer reconnaissance. The chapter addresses engineer reconnaissance as part of 1st Marine Divisions reconnaissance function, and defines engineer reconnaissance in terms of the tasks entailed and the knowledge and skill sets it requires. Chapter II reviews the requirement for engineer reconnaissance, discusses current capabilities and limitations of various reconnaissance organizations, and reviews the development of engineer reconnaissance doctrine.

Chapter III defines the engineer reconnaissance problem in organizational design terms. This includes the concepts of organizational core competencies, centers of gravity and related diversification, task uncertainty and information requirements, and inter-organizational coordination requirements.

Chapter IV develops four potential alternative solutions involving structural changes to existing organizations, creation of new organizations, and improved cross training between existing organizations.

Chapter V establishes cost and benefit evaluation criteria and analyzes the alternatives developed in chapter IV. It identifies relative strengths and weaknesses associated with each alternative and ranks the alternatives in terms of their cost-to-benefit ratios.

Chapter VI discusses some conclusions and limitations of the thesis, and provides recommendations and suggestions for further study.

II. OVERVIEW OF ENGINEER RECONNAISSANCE

A. INTRODUCTION

This chapter frames engineer reconnaissance as a complementary component of the 1st Marine Division's decentralized reconnaissance function. The chapter defines engineer reconnaissance as part of this function, and addresses the historical, current and projected future requirements for maintaining a readily employable engineer reconnaissance capability. This definition differentiates engineer reconnaissance from traditional reconnaissance functions conducted by divisional reconnaissance organizations, specifically Division Reconnaissance Company, and 1st and 3rd LAR Battalions. A review of current engineer reconnaissance capabilities within the division highlights this functional difference and suggests some basic shortcomings in organizational structure and training with respect to engineer reconnaissance. This chapter concludes with a brief discussion of current engineer reconnaissance doctrine and its reliance on inter-organization coordination for close and deep engineer reconnaissance missions.

B. RECONNAISSANCE FUNCTIONS IN 1ST MARINE DIVISION

Reconnaissance is a decentralized function in 1st Marine Division. Figure 2.1 is an organizational chart illustrating the four distinct divisional organizations that are formally tasked with portions of the reconnaissance function. The division commander tasks each of these organizations with providing certain reconnaissance capabilities in support of the division, a task-organized Marine Air Ground Task Force (MAGTF) such as a Marine Expeditionary Unit (MEU), or a specific supported commander. First Marine Division thus creates a division of labor for reconnaissance, tasking subordinate

units with particular types of reconnaissance that combine as the division's reconnaissance function. The Division Reconnaissance Company and LAR Battalions conduct primarily tactical reconnaissance while 1st CEB conducts engineer reconnaissance. While following sections address each organization's mission and capabilities with respect to engineer reconnaissance, it is important to initially frame

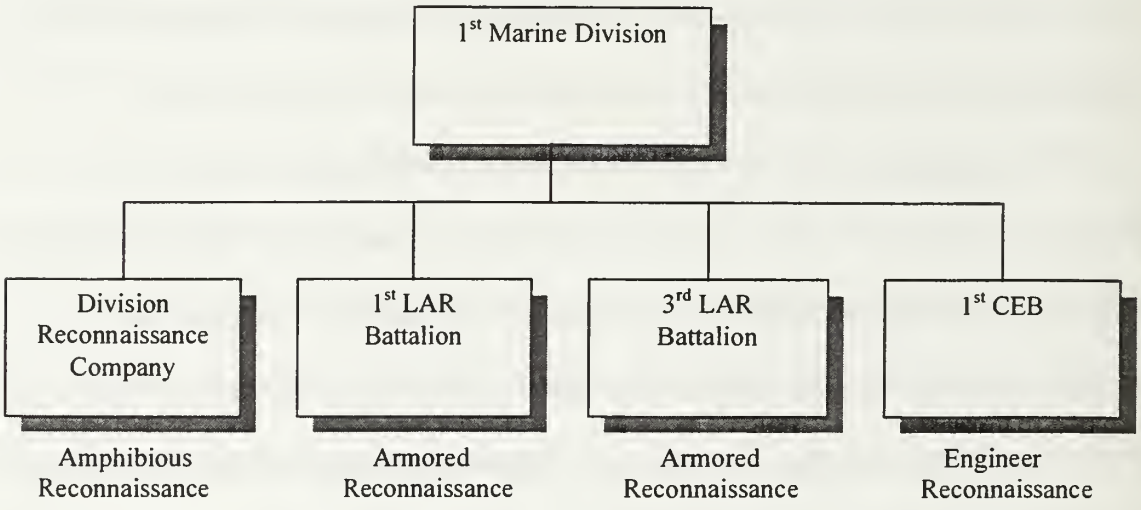

Figure 2.1. 1st Marine Division Reconnaissance Organizations and Functions.

engineer reconnaissance as a complementary component of the division's reconnaissance function as a whole. This understanding facilitates subsequent discussions of the engineer reconnaissance function in 1st Marine Division.

C. ENGINEER RECONNAISSANCE DEFINED

Engineer reconnaissance is a function assigned to military engineer organizations to collect information pursuant to planning or conducting operations. Military engineer organizations further define this function as tasks which the organization must perform in

order to complete its mission. All MAGTF combat engineer units include engineer reconnaissance in their mission essential task list (METL). Types of engineer reconnaissance differ between combat engineers in the ground combat element (GCE), aviation combat element (ACE) and combat service support element (CSSE) based on different engineer missions in support of each element. Engineer reconnaissance for the GCE focuses on collecting data to support ground combat operations, while engineer reconnaissance for the CSSE involves collecting data in support of combat service support operations such as base camp construction, water point development, or augmentation of GCE combat engineers. Combat engineers assigned to the ACE focus on collecting data in support of expeditionary airfield operations, forward arming and refueling point (FARP) operations, and other aviation support missions. This research focuses on the engineer reconnaissance mission of 1st CEB in 1st Marine Division, and will define engineer reconnaissance within this context.

Given the variety of engineer reconnaissance functions in support of the MAGTF, it is not surprising that current doctrinal publications do not adequately define or address engineer reconnaissance. This is particularly true for engineer reconnaissance functions in support of the GCE that focus on collecting information critical to ground maneuver forces. Although doctrinal publications such as Field Manual (FM) 5-100 Engineer Combat Operations address the importance of conducting engineer reconnaissance, they fail to adequately define the term or its associated functions. Recognizing this shortcoming, the U.S. Army Engineer School is currently drafting FM 5-170 Engineer Reconnaissance to provide a common doctrinal basis for both U.S. Army and U.S. Marine Corps combat engineer units tasked with conducting engineer reconnaissance.

Excerpts from an untitled study by the BDM Corporation, a defense consulting firm in Washington D.C., provided the best definition of engineer reconnaissance encountered during the course of this research. The study addresses engineer functions in support of the MAGTF and defines engineer reconnaissance as follows:

> Thorough engineer reconnaissance is the primary tool used by engineer elements at all echelons to maintain a current picture of the battle field and may be performed in different degrees during all types of military operations. Engineer reconnaissance within the zone of action is a pre-planned and continuous operation performed by air or ground mobile teams of engineers tasked to provide general or specific reconnaissance based intelligence. Specific engineer reconnaissance tasks within a given situation are determined by the current availability of accurate terrain information and the developing tactical situation. Engineer reconnaissance enables the commander to "see" the battlefield by providing information or intelligence on obstacles, field fortifications, camouflage, expected maneuver routes, area trafficability, and hydrography, including locations and suitability of river crossing sites as well as water point locations and stocks of engineer materials. (BDM Corporation, p.II-7)

Given the lack of doctrinal guidance, 1st CEB developed extensive SOPs addressing its perceived role in conducting engineer reconnaissance. It defines its engineer reconnaissance mission in terms of types of reconnaissance the battalion must be able to conduct. A brief description of each type of reconnaissance follows:

1. Road reconnaissance - determining a road's trafficability by conducting soil analysis (if not paved), determining surface composition, roadway width, gradient, number of turn-around points, and degrees of curvature.

2. Route Reconnaissance - collecting information on routes along the axes of advance or withdrawal that may influence the commander's plan.
3. Bridge Reconnaissance - determining a bridge's classification to include type and length, load bearing capacity, estimation of required repairs, and demolition requirements for its destruction.
4. Obstacle Reconnaissance - locating, recording, and possibly marking all natural and man made obstacles and providing estimates of breaching, spanning, or bypassing locations and requirements.
5. Tunnel Reconnaissance - determining critical dimensions, trafficability, hasty repair requirements, and demolition requirements for all types of tunnels.
6. Ford and Ferry Reconnaissance - locating possible ford and ferry sites, determining depth of crossing, streambed materials, access and egress routes, bank configuration, and water flow velocity.
7. Threat Engineer Reconnaissance - identifying and evaluating threat engineer forces, equipment, capabilities, and activity. (Virden, 1997) (Sapp, 1995)

These tasks form the basis for engineer reconnaissance in 1st CEB and 1st Marine Division. They are applicable in varying degrees to both offensive and defensive operations, which existing 1st CEB reconnaissance proposals and SOPs by Chief Warrant Officer Virden (1997) and Major Sapp (1995) address at length.

D. REQUIREMENT FOR ENGINEER RECONNAISSANCE

Success in combat is heavily reliant on warfighters having required information available in sufficient time to plan and execute combat operations. Engineer reconnaissance has played a vital role in past conflicts, and is essential to current and future conflicts and war plans, as well.

1. Historical Requirement

The requirement for engineer reconnaissance in support of ground combat forces has significant historical precedent. Combat engineers have identified and breached obstacles for advancing American forces since the Revolutionary War. Sapp's 1996 paper outlining the importance of engineer functions in operational maneuver from the sea makes reference to General George Washington's general orders from 1779: "On a march, in the vicinity of an enemy, a detachment of miners and sappers (combat engineers) shall be stationed at the head of the column, directly after the vanguard for the purpose of opening and mending roads and removing obstacles"(Sapp, p.1, 1996). This statement alludes to the importance of conducting obstacle reconnaissance in offensive operations and forms the basis for current obstacle breaching doctrine.

Engineer reconnaissance played a vital role during World War II and the Korean War, as well. In 1944 United States Army combat engineers reconnoitered and breached German minefields on D-Day in support of advancing allied forces (Turque and Wilkinson, 1991). During the Korean War, bridge reconnaissance missions conducted by 1st Marine Division allowed Marine forces to span a critical bridge at Koto-ri destroyed by enemy sappers. This action was instrumental in the Marines tactical withdrawal from the Chosin Reservoir (Montross and Canzona, 1957).

In 1982 9th Engineer Support Battalion (ESB) recognized the need for timely and detailed engineer intelligence in support of III Marine Amphibious Force (III MAF, predecessor to III Marine Expeditionary Force). To meet this requirement 9th ESB organized and briefly maintained an Engineer Intelligence Platoon (EIP) to conduct engineer reconnaissance and augment the III MAF intelligence collection capability. For nearly four years the platoon participated in numerous III MAF exercises in the western Pacific, and was noted for its performance conducting a detailed route reconnaissance in South Korea during Team Spirit 84. Although the organization was disbanded in 1986, the EIPs brief success illustrated the engineer communities potential contribution to Marine Corps reconnaissance (Motto, 1984).

A more recent and compelling need for an engineer reconnaissance capability was illustrated by the 1st Marine Divisions experience with Iraqi minefields and obstacles during Desert Shield/Desert Storm. Combat engineers from 1st CEB conducted reconnaissance patrols with Reconnaissance Marines from 1st Reconnaissance Battalion during Desert Shield to locate and identify minefields and other obstacles employed by occupying Iraqi forces in Kuwait. These patrols provided critical intelligence for commanders of U.S. Marine maneuver elements (Task Forces ((TF)) Ripper, Papa Bear, Taro, and Grizzly) to plan and conduct combined arms breaching operations on the first day of the ground war. First Combat Engineer Battalion's command chronology from this period summarizes the importance of these actions to the Marines conducting the breaches:

> The best intelligence concerning the first obstacle belt was delivered on 20-21 Feb 91 when Sgt Bell briefed the commanders of TF Ripper and TF Papa Bear on the results of a patrol conducted by his recon

> team. His team traveled 20 kilometers into Kuwait and set up a hide position from which they observed the minefield. He brought back the details and descriptions badly needed by the assaulting forces, particularly the engineers of the OCDs (Obstacle Clearing Detachments) (Kebelman, 1991).

Further comments by the 1st CEB commander identify both the need for engineer reconnaissance and the organizational and training implications of using combat engineers in a reconnaissance role.

> The value of including a combat engineer in the recon team could never have been made more clear. This experience should serve not only to solidify the relationship between the two disciplines, but to boost the amount of reconnaissance training we conduct at 1st CEB (Kebelman, 1991).

Studies conducted by the U.S. Army also validate the historic requirement for engineer reconnaissance. Data collected in 1989 by the Army Research Institute at the National Training Center, Fort Irwin, California, showed that 75% of TFs that conducted obstacle reconnaissance missions executed successful obstacle breaches. Conversely, TFs that did not conduct obstacle reconnaissance executed far less effective breaching efforts and often were stopped by the obstacle (Kula, 1992).

2. Current Requirement

The 1st Marine Division Campaign Plan establishes a requirement for 1st CEB to maintain an engineer reconnaissance capability (Libutti, 1994). This is critical given 1st Marine Divisions regional areas of interest of Southwest Asia (SWA) and the Korean Peninsula, both of which have Major Regional Conflict (MRC) contingency plans associated with them. Iraq and Iran maintain large stocks of landmines and have demonstrated their willingness to employ them in past conflicts (Watson, 1991). Both North and South Korea have constructed and emplaced formidable obstacles in depth

along the DMZ that pose serious mobility concerns to combat engineers and maneuver commanders in 1st Marine Division (Galloway, 1994). North Korea's very limited road network, large number of bridges, and mountainous terrain pose additional mobility concerns that combat engineer reconnaissance teams will have to assess in the event of conflict. Each of these potential MRC threats would require a significant engineer reconnaissance effort to insure the tactical mobility of 1st Marine Division maneuver elements.

The lack of current map products for many countries of interest, including most of the Third World, suggests a current and future requirement for engineer reconnaissance. A 1989 study conducted by Robert Steele, the senior civilian consultant with the Marine Corps Intelligence Activity, determined that only ten of the Marine Corps 69 countries of interest had complete 1:50,000-scale map coverage. Most of that coverage was dated by at least ten years, and did not reflect current road networks, bridges, or airfields. As of 1992, most of Central America, SWA, Africa, and Asia still had minimal 1:50,000 coverage. Commanders deployed to these areas will require updated information on existing transportation infrastructure, which engineer reconnaissance teams can provide (Steele, 1992).

3. Projected Future Requirement

In addition to operations plans for SWA and the Korean Peninsula, 1st Marine Division must be prepared to "...respond to crises across the operational continuum" (Libutti, 1994, p. 2). This suggests capabilities applicable for responses ranging from operations other than war, such as humanitarian relief and peacekeeping operations, to high intensity conflict. The proliferation of inexpensive, advanced technology landmines

among developing nations suggests an increasing probability of their employment in regional conflicts (First Combat Engineer Battalion b, p.7, 1996). This also poses tactical mobility concerns to maneuver elements, which can be largely addressed through improved engineer reconnaissance and breaching capabilities. A sound, rapidly employable engineer reconnaissance capability will insure tactical mobility for 1st Marine Division in all environments.

E. CURRENT ENGINEER RECONNAISSANCE CAPABILITIES AND LIMITATIONS

This section addresses the engineer reconnaissance capabilities and limitations of organizations tasked with conducting or supporting reconnaissance in 1st Marine Division. Each organization has specific core competencies that reflect their specific mission in support of the division, and these core competencies help define their engineer reconnaissance capabilities. Organizational theory (Mintzberg, 1996) suggests that organizations concentrate on those core competencies that provide unique value to the customer (in this case, 1st Marine Division). These core competencies become instrumental in forming strategies to accomplish assigned missions.

1. First Combat Engineer Battalion

First Combat Engineer Battalion represents the primary body of engineer knowledge and skill in 1st Marine Division. This expertise focuses on mobility, countermobility, survivability, and general engineering tasks and is reflected in the battalion's METL (Battalion Mission Essential Task List, 1996). These are the core competencies in which the battalion must excel in order to conduct it's mission to

"...enhance the mobility, countermobility, and survivability of the (1st) Marine Division..."(Headquarters, U.S. Marine Corps, 1992, p. 4-20).

Both the Division Campaign Plan and Fleet Marine Force Reference Publication (FMFMRP) 1-11 Fleet Marine Force Organization task 1st CEB with the engineer reconnaissance mission. Given this mission 1st CEB includes engineer reconnaissance as one of the sub-critical tasks on the Battalion METL. Specifically, the battalion must be able to "Conduct engineer reconnaissance and supporting intelligence collection within the Division Area of Operations" (1st CEB, METL, 1996).

First Combat Engineer Battalion's core competencies do not fully support this mission, however. Combat Engineers are well-trained to conduct these missions in areas under Division control (behind the Forward Edge of the Battle Area (FEBA)) or the Line of Departure), but lack the training and formal structure to conduct independent close and deep reconnaissance missions. Although strong in engineering skills, combat engineers generally lack the advanced infantry skill training and experience associated with reconnaissance organizations. While the battalion conducts some excellent basic engineer reconnaissance training through its battalion schools program, it does not have a formal reconnaissance organization staffed with trained "reconnaissance engineers" capable of operating with other reconnaissance organizations in the division. Staffing priorities and command interest impact developing a formal engineer reconnaissance organization at 1st CEB. Fluctuating manning levels in the line companies and the relatively small number of Marines possessing the requisite skill and maturity of a reconnaissance engineer are limiting factors in creating a formal engineer reconnaissance organization. Few battalion commanders have a sufficient number of qualified Marines to provide both the leadership

required in the line companies and staff a separate engineer reconnaissance organization (Bell, 1997). Given this choice, most commanders assign a higher priority to manning the line companies and are reluctant to give up their most qualified Marines to an internal reconnaissance organization. To exacerbate this problem, battalion commanders turn over approximately every two years. This results in relatively short periods of individual command influence and a high degree of potential organizational change based on different commander's goals and strategies.

2. 1st Marine Division Reconnaissance Company

The 1st Marine Division Reconnaissance Company's mission is to "...conduct amphibious reconnaissance, ground reconnaissance, and limited scale raids in support of 1st Marine Division and it's subordinate units." (Cunniffe, 1997, p. 2). Accordingly, the company's METL lists specific reconnaissance tasks focused on enemy activity and other tasks in support of division units. It lists the ability to "...collect other information of military significance including specialized terrain reconnaissance," but makes no other references to engineer reconnaissance. Captain Cunniffe's Mission Training Plan (Cunniffe, 1997) suggests that the company's core competencies are centered on classic reconnaissance tasks, and do not include engineer specific skills necessary to conduct engineer reconnaissance. This supports the premise that Reconnaissance Marines are well-trained and equipped to operate independently and collect tactical intelligence across the geographic depth of the battlefield, but are not properly trained to collect engineer-specific intelligence.

3. Light Armored Reconnaissance Battalions

First Marine Division has two LAR Battalions; 1st LAR at Camp Pendleton and 3rd LAR at Twentynine Palms. These battalions have similar missions, specifically "to conduct reconnaissance, security, limited offensive and defensive operations, and other operations as directed by the Division or supported commander" (3rd LAR Bn, 1996). Although capable of conducting both mounted and dismounted reconnaissance operations, the LAR battalions typically focus on armored operations in mechanized environments. Their METLs reflect this focus by including the ability to "conduct reconnaissance operations to include reconnaissance in force, zone, area, and point reconnaissance" as one of their prioritized tasks (3rd LAR Bn, 1996). This suggests their core competencies include armored and limited dismounted collection of tactical intelligence from the Light Armored Vehicle (LAV)-25 platform. These organizations are highly mobile across the geographic depth of the battlefield and provide the supported commander with a range of reconnaissance capabilities that complement those of the Division Reconnaissance Company.

The LAR battalion Tables of Organization (TO) include a combat engineer officer as the assistant operations officer (S-3A), but do not have any additional combat engineer line numbers. This billet provides the LAR battalions with a resident source of engineer skills and knowledge, but does not provide an organic engineer reconnaissance capability. When viewed as a staff liaison position this billet does promote cross-training between LAR and CEB if the respective commanders provide command interest and direction, and has served as the basis for developing past habitual supporting relationships between the two organizations. While these positions promote some

coordination between 1st CEB and 1st/3rd LAR, they often are not staffed with a combat engineer officer due to low manning levels or over-riding staffing priorities within 1st CEB. To summarize, the LAR battalions have some resident combat engineer expertise but no true engineer reconnaissance capability without additional augmentation from 1st CEB.

F. ENGINEER RECONNAISSANCE DOCTRINE

Engineer reconnaissance doctrine emerged from early amphibious and military reconnaissance doctrine developed by the Marine Corps during World War II. While reconnaissance organizations have detailed internal doctrine that governs training and operations, engineer reconnaissance doctrine does not adequately address current and future requirements for conducting engineer reconnaissance across the geographic depth of the battlefield.

1. Development of Engineer Reconnaissance Doctrine

In his in-depth review of United States Marine Corps reconnaissance FMFRP 12-21 AARUGHA!, Stubbe provides an interesting discussion of early reconnaissance doctrine. This early doctrine, written by Marine Major Dion Williams in 1906, focused heavily on engineer types of reconnaissance. William's divided Marine reconnaissance into two types based on location; amphibious reconnaissance conducted up to the shore and military reconnaissance of the beach and inland areas. Williams discussion of the scope of military reconnaissance highlights the focus on engineer related information. His concern with collecting information on

> ...configuration of the ground, cities, towns, roads, trails, railroads, telegraph cables, telephone lines...rivers, canals, resources (coal, repair

> facilities, land transportation, electric plants...water supply)...fieldworks, mines and minefields...(Stubbe, 1989, p. 5)

reflects the heavy influence of typical engineer functions on reconnaissance doctrine.

Williams' description of the type of officer best-suited to oversee the military portion of reconnaissance is particularly illuminating: "...a Marine officer who has had practical experience in topographic work, the construction of semipermanent fortifications and field works and in camping in the field should be assigned to cover that part of the work" (Stubbe, 1989, p. 5). This description suggests a strong engineering background combined with infantry skills, which is an apt description of current Marine combat engineers. Williams' work clearly points to the strong engineer foundation of early reconnaissance doctrine.

As Marine reconnaissance doctrine developed it became increasingly focused on pre-assault beach reconnaissance and location of enemy forces, and lost much of Williams' initial engineer-related basis. If a commander required specific engineer reconnaissance information that exceeded the "hasty reconnaissance" capabilities of Marines assigned to reconnaissance organizations, then doctrine specified attaching "qualified" engineer specialists capable of operating as part of a reconnaissance team (Marine Corps Institute, 1984). This shift forms the basis for current engineer reconnaissance doctrine in 1st Marine Division.

2. Current Engineer Reconnaissance Doctrine

Current doctrine relies on combat engineers augmenting divisional reconnaissance organizations for conducting close and deep engineer reconnaissance missions. This is in keeping with the Marine Corps method of task organizing forces to accomplish specific

missions and assumes a large degree of interoperability (or coordination) between organizations. Interoperability, however, requires a base level of skill standardization and relies on regular interaction and cross training between organizations to develop confidence and credibility. Chapter III addresses skill standardization as a coordinating mechanism between organizations.

Cross training rarely (if ever) occurs between 1st CEB and Division Reconnaissance Company, largely due to demanding operational tempos and a lack of command direction. Division Reconnaissance Company's training focuses almost exclusively on preparing platoons for assignment to MEUs, which precludes their participation in most non-MEU events (Smith, 1997).

Cross training occurs more frequently between 1st/3rd LAR and 1st CEB, primarily during major training exercises such as Combined Arms Exercises (CAXs) and other battalion and regimental level events. These events provide exposure between organizations, but fall short of the time and frequency required for members of one organization to fully understand the others' SOPs and requirements.

G. CHAPTER SUMMARY

This chapter provided an overview of engineer reconnaissance and laid the groundwork for understanding the engineer reconnaissance deficiency in 1st Marine Division. Historical precedent and current OPLANs involving 1st Marine Division validate the requirement for the division to maintain an engineer reconnaissance capability. Various doctrinal publications and the 1st Marine Division Campaign Plan assign the engineer reconnaissance mission to 1st CEB as part of the division's reconnaissance function. A review of core competencies highlighted the difficulties

faced by both 1st CEB and division reconnaissance organizations in conducting close and deep engineer reconnaissance missions. Doctrine does not adequately address how the division can develop and maintain an engineer reconnaissance capability for employment across the geographic depth of the battlefield. Despite a common early history, engineer reconnaissance and tactical reconnaissance doctrine diverged and became proprietary to separate organizations within the division. While 1st Marine Divisions division of labor with respect to reconnaissance promotes specialization at the subordinate organizational level, adequate coordinating mechanisms do not exist to effectively integrate combat engineers with division reconnaissance organizations to conduct close and deep engineer reconnaissance missions.

In summary, 1st Marine Division's engineer reconnaissance capability suffers from insufficient integration into the division's reconnaissance function. Chapter III defines and addresses the organizational design problem posed by improving engineer reconnaissance in 1st Marine Division.

III. DEFINING THE PROBLEM

A. INTRODUCTION

This chapter addresses the organizational design problem concerning engineer reconnaissance in 1st Marine Division. Chapter II viewed engineer reconnaissance as part of the division's reconnaissance function and suggested two primary causal factors that affected engineer reconnaissance capabilities. One, the lack of an effective engineer reconnaissance core competency in any of the divisional reconnaissance organizations, and two, limited coordination between the organizations tasked with conducting reconnaissance for the division. The chapter addresses creating a core competency in terms of unit grouping and organizational diversification, and describes the organizational design problem in terms of differentiation and integration of reconnaissance tasks that comprise the division's reconnaissance function. A discussion of mechanisms that promote inter-organizational coordination identifies specific reconnaissance coordination problems in 1st Marine Division. The chapter concludes with a definitive problem statement addressing the divisions engineer reconnaissance deficiency.

B. CREATING A CORE COMPETENCY

Creating an engineer reconnaissance core competency within one of the Division's reconnaissance organizations involves a degree of organizational diversification. This section addresses creating core competencies in terms of unit grouping, organizational centers of gravity, and organizational diversification.

1. Unit Grouping

Creating a core competency may involve how individuals are grouped together within an organization. Unit grouping is an organizational design parameter that "...refers to the choice of the bases by which positions are grouped together into units..."(Mintzberg, 1996, p. 335) and ultimately affects coordination and organizational interdependencies. Specifically, unit grouping "...encourages coordination by putting different jobs under common supervision, by requiring them to share common resources and achieve common measures of performance, and by using proximity to facilitate mutual adjustment among them"(Mintzberg, 1996, p. 335). Mintzberg identifies two fundamental bases for grouping, by function and by market.

Grouping by function is usually preferable in organizations that have tightly linked workflows (or interdependencies) requiring internal coordination, sharing of common resources, and improvement of skills. Armored reconnaissance, stealth reconnaissance and combat engineering are all functions within the division that promote grouping individuals by function based on interdependencies *within* each functional organization. As suggested by Chapter II, however, engineer reconnaissance as part of the division reconnaissance function may create a process interdependence *between* organizations within the division. This interdependence may promote grouping by market at the division level, whereby units are grouped according to the entire process by which a product or service is produced. For example, individuals or small elements from two or more organizations within the division may be dependent upon one another to conduct a specific type of reconnaissance (such as engineer reconnaissance). Given this, grouping individuals by either the engineer or reconnaissance functions will promote

specialization within each function but by itself does not contain the engineer reconnaissance process interdependency. With respect to structuring units to conduct various types of reconnaissance, this suggests that grouping by function is appropriate at the battalion level while grouping by market is appropriate at the division level. The division is currently organized in essentially this fashion.

2. Centers of Gravity and Related Diversification

First Combat Engineer Battalion, Division Reconnaissance Company, and 1st/3rd LAR Battalions all have strengths based on their specific core competencies and mission requirements that create an organizational "center of gravity." Mintzberg (1996) defines an organization's center of gravity as arising "...from the firm's initial success in the industry in which it grew up" (Mintzberg, 1996, p. 323). First Combat Engineer Battalion's center of gravity lies in its combat engineering skills and knowledge, which equates specifically to mobility, countermobility, survivability, and general engineering. Division Reconnaissance Company's center of gravity lies in its ability to conduct ground and amphibious reconnaissance, while 1st/3rd LAR Battalions center of gravity lie in armored reconnaissance. By developing an engineer reconnaissance core competency, either of these organizations could maintain its center of gravity but diversify into an activity in a related functional area. Mintzberg (1996) describes this process as related diversification, whereby an organization diversifies into a new, but related, functional area while retaining its original center of gravity. This process allows the organization to develop a diversified portfolio of capabilities while retaining a common command and organizational structure.

Creating a core competency at one of the divisions subordinate reconnaissance organizations through related diversification may not completely solve the problem, however. The division may have to employ this core competency as part of a reconnaissance process, suggesting that interdependencies will still exist between reconnaissance organizations. The remainder of this chapter addresses the importance of coordination mechanisms to effectively employ an engineer reconnaissance core competency.

C. TASK UNCERTAINTY AND INFORMATION REQUIREMENTS

Galbraith's (1973) treatment of the organizational design problem addresses how task uncertainty and information requirements affect designing an organization. When designing an organization to accomplish a specific task, he suggests that the effect of task uncertainty on the information required to execute the task determines the design framework. In this case, the organization is 1st Marine Division, and the task is conducting engineer reconnaissance. Galbraith defines uncertainty associated with a task as "...the difference in the amount of information required to perform the task and the amount of information already possessed by the organization" (Galbraith, 1973, p. 5). He suggests that if "...the task is well understood prior to performing it, much of the activity can be pre-planned" and that "the basic effect of uncertainty is to limit the ability of the organization to preplan...activities in advance of their execution" (Galbraith, 1973, p. 4). Chapter II described the roles of 1st Marine Division's subordinate reconnaissance organizations and suggested that their extensive SOPs imply a good understanding of reconnaissance tasks. Applying Galbraith's argument to executing the engineer reconnaissance task, uncertainty exists *between* rather than *within* the division's

reconnaissance organizations. This supports the premise that 1st Marine Division lacks coordinating mechanisms to combine knowledge and skill sets resident in subordinate reconnaissance organizations for successful task execution. The following section discusses methods for achieving inter-organizational coordination between the division's subordinate reconnaissance organizations.

D. INTER-ORGANIZATIONAL COORDINATION

This section discusses two types of coordination and some mechanisms to achieve lateral coordination between an organization's subordinate elements. It addresses vertical and lateral coordination as they relate to 1st Marine Divisions reconnaissance function, and introduces Galbraith's concept of applying lateral processes based on degrees of task uncertainty and information requirements. The section concludes by discussing skill standardization as an additional method of improving inter-organizational coordination.

1. Vertical and Lateral Coordination

Bolman and Deal (1991) address two primary means of achieving coordination between elements in an organization; vertical coordination and lateral coordination. Vertical coordination involves individuals at higher levels coordinating and controlling subordinates activities through authority, planning, regulations, and established procedures (Bolman and Deal, 1991). Most existing coordination measures for reconnaissance are vertical in nature and exist within the division's subordinate reconnaissance organizations. For example, Division Reconnaissance Company, 1st/3rd LAR Battalions, and 1st CEB all have unit leaders, SOPs, and METLs that specifically define reconnaissance tasks and processes within each organization. These exist at the

division level, as well, but require lateral coordination mechanisms to promote effective coordination between 1st CEB and other reconnaissance organizations.

Lateral coordination mechanisms are generally more flexible, less formal, and developed to fill coordination voids not addressed by vertical mechanisms. Galbraith (1973) addresses several lateral mechanisms that organizations may apply to improve coordination between subordinate elements or organizations. The three mechanisms most applicable to the engineer reconnaissance problem are:

1. Direct contact between leaders sharing a common problem.
2. Establishing coordinating roles or liaison positions between organizations.
3. Creating temporary task forces to address specific problems or projects.

Galbraith recommends organizations apply these mechanisms sequentially and cumulatively as uncertainty increases. For example, conducting certain close engineer reconnaissance missions may involve a limited amount of uncertainty and only require direct coordination between platoon commanders from 1st LAR and 1st CEB. A more complex, deep reconnaissance mission involving multiple organizations increases the degree of uncertainty, however, and establishing sufficient coordination to execute the task may require involvement of liaison officers or even a task force of personnel from each organization.

Figure 3.1 illustrates the lateral coordination requirements between 1st CEB, the Division Reconnaissance Company and the LAR Battalions necessary to incorporate engineer reconnaissance in the division reconnaissance function. Positioning of organizational blocks in Figure 3.1 is not intended to suggest primacy of any one organization, only that lateral coordination must occur between these organizations. The

only "formal" lateral coordination mechanism currently in place to facilitate engineer reconnaissance is the combat engineer officer billet at the LAR battalions. No similar billet exists at Division Reconnaissance Company to promote lateral coordination for engineer reconnaissance purposes.

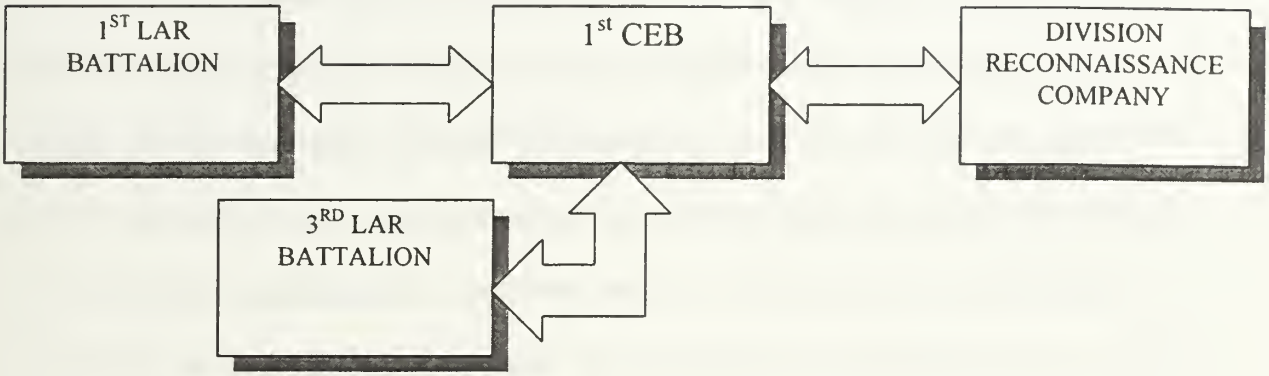

Figure 3.1. Lateral Coordination Requirements for Engineer Reconnaissance.

These concepts suggest that establishing a combination of vertical and lateral coordination mechanisms within the division and between its subordinate reconnaissance organizations would improve the division's engineer reconnaissance capability.

2. Skill Standardization

Mintzberg (1996) suggests standardization of skills as another method for achieving coordination within and between organizations. This involves standardizing the procedures followed by an operator rather than the product produced. Although each reconnaissance organization standardizes reconnaissance skills *within* the particular organization, the type of reconnaissance conducted, environment, and equipment often limit inter-operability (or operational coordination) *between* organizations. This is precisely the condition that exists between 1st CEB and the Division Reconnaissance Company, and to a lesser degree between 1st CEB and the LAR battalions.

First Combat Engineer Battalion standardizes engineer reconnaissance training internally through the Sapper Leader Course. The battalion created this course to teach a variety of combat engineer skills including engineer reconnaissance, advanced demolitions, basic assault climbing, communications, land navigation, and basic patrolling (1st CEB, Sapper Leader Course SOP, 1996). The battalion receives few, if any, quotas to the formal schools habitually attended by Reconnaissance Marines (specifically the Basic Reconnaissance Course (BRC)) and developed the Sapper Leader Course in part to improve its engineer reconnaissance capability. This school has dramatically improved the battalions engineer reconnaissance capability, but most students have no opportunity to habitually cross-train with Reconnaissance Marines to maintain and improve their skills following graduation. This stems in part from the high operational tempo (op tempo) within the battalion and division, and the lack of a reconnaissance organization within 1st CEB to facilitate training.

The Division Reconnaissance Company standardizes reconnaissance training during an Individual Training Phase that makes use of both internal and external training assets. This six-month period involves a series of formal and informal schools that provide Marines with the basic skills they must master prior to operating as a member of a reconnaissance team. The Individual Training Phase revolves around each member of the organization completing the BRC that qualifies them as a 0321 Reconnaissance Marine (Cunniffe, 1997) (Anderson, 1997). First Combat Engineer Battalion has extremely limited access to BRC school quotas, resulting in very few combat engineers qualified as 0321 Reconnaissance Marines. Similarly, 1st CEB receives no quotas to schools attended by LAR battalion scouts or the LAV Leaders Course designed to

familiarize Marines with light armored operations and LAV variants. The reconnaissance engineers could improve lateral coordination and interoperability with other reconnaissance organizations by attending this and other reconnaissance-specific schools.

E. PROBLEM STATEMENT AND CHAPTER SUMMARY

The preceding sections outlined aspects of the organizational design problem posed by improving the engineer reconnaissance capability of 1st Marine Division. Specifically, 1st Marine Division requires an engineer reconnaissance core competency and effective coordination mechanisms among subordinate reconnaissance organizations to improve integration of engineer reconnaissance into the division's reconnaissance function. Creating this core competency at one of the existing reconnaissance organizations will require some organizational diversification, ideally around an existing center of gravity. Employing a core competency may require mechanisms to coordinate various groups of knowledge and skill sets for effective task execution. Chapter IV develops potential structural, training, and coordination solutions to 1st Marine Divisions engineer reconnaissance problem.

IV. ALTERNATIVE SOLUTIONS

A. INTRODUCTION

This chapter presents four alternative solutions to the engineer reconnaissance problem as stated in Chapter III. The first alternative creates an engineer reconnaissance core competency within 1st CEB through structural modification, and involves training and use of liaison roles to promote coordination with other reconnaissance organizations. The second alternative creates an engineer reconnaissance core competency in the Division Reconnaissance Company through structural modification but does not require significant use of liaison roles. The third alternative creates an engineer reconnaissance core competency in a new, hybrid light armored "Raider" organization that involves significant structural and equipment modifications. The fourth alternative creates an engineer reconnaissance capability in the division through cross training between existing organizations.

B. ENGINEER RECONNAISSANCE SECTION AT 1st CEB

This alternative solution involves developing an engineer reconnaissance core competency by designing an engineer reconnaissance element within 1st CEB's existing organization. The level of analysis focuses on this structural element relative to the battalion and other reconnaissance organizations with which it must coordinate. Figure 4.1 depicts a formal engineer reconnaissance structure resident within 1st CEB that must coordinate not only internally but also with adjacent reconnaissance organizations. The coordination arrows within and between organizations represent both tactical and administrative coordination requirements.

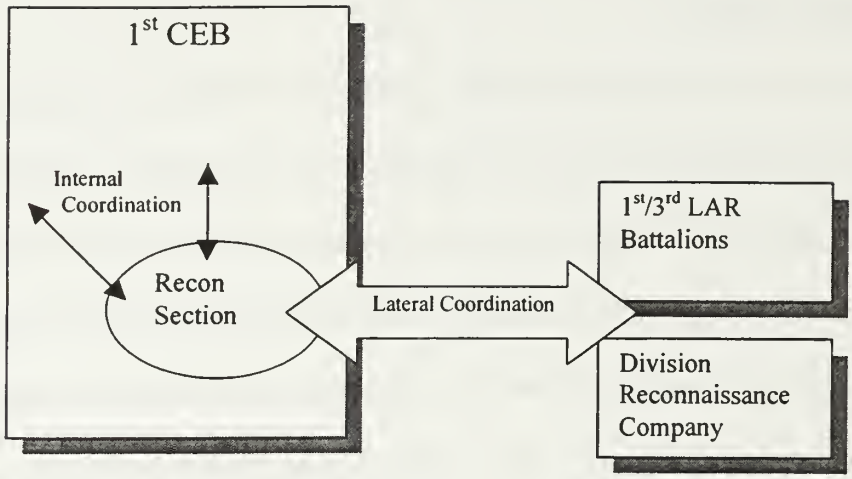

Figure 4.1. Coordination Requirements for an Engineer Reconnaissance Section Within 1st CEB.

Virden (1997) proposes developing an engineer reconnaissance section within 1st CEB. This proposal develops an engineer reconnaissance core competency within the battalion capable of conducting independent engineer reconnaissance operations across the geographic depth of the battlefield. These reconnaissance engineers would be capable of independent operations in the close and rear battlefield areas that are under the division's control. For deep engineer reconnaissance operations in areas not under the division's control, this proposal requires task organizing reconnaissance engineers into either a LAR unit or Division Reconnaissance Company team. Despite this task organization requirement for deep reconnaissance, Virden's proposal groups individuals into a unit by the combat engineering function for training, administration, and most employment purposes. While the battalion's center of gravity remains combat engineering, creation of this engineer reconnaissance section involves a related

diversification process into engineer reconnaissance. This requires combat engineers to learn reconnaissance skills and procedures to coordinate with other divisional reconnaissance organizations, thus introducing the training component of this solution.

Virden addresses this briefly and references a similar proposal by Sapp (1995) that outlines training requirements in greater detail. Sapp cites the coordination and interoperability requirement to justify his recommendation of reconnaissance engineers attending many of the same schools that reconnaissance Marines attend during their Individual Training Phase. This suggests that creation of an engineer reconnaissance section must involve a training component to develop skill standardization for coordination with other division reconnaissance organizations. The following sub-sections identify personnel and training requirements associated with this alternative.

1. Personnel Requirements

Virden's proposal forms the engineer reconnaissance section around the existing Sapper School instructor cadre in 1st CEB. The proposal recommends a section composed of two six-man teams and a three-man headquarters (HQ) element as illustrated in Table 4.1. The six-man team size mirrors the six-man size of a Division Reconnaissance Company team and is compatible with LAR operations. This team size also promotes coordination within 1st CEB as it facilitates these Marines continuing to conduct their Sapper School instructor duties. The inclusion of one 1141 Electrician enhances each team's ability to evaluate power systems and power requirements at enemy or friendly facilities of interest to the MAGTF. Virden suggests that a 1371 Gunnery Sergeant possesses the requisite "...grade and experience to coordinate with adjacent units, provide guidance, and effectively manage a new program such as

this"(Virden, 1997, p. 3). Virden specifically recommends permanently attaching the 3535 driver and 8404 corpsman to the section based on mission essential need. This makes sense, given that normal Sapper School operations require corpsman and driver support.

Element	Quantity	Rank	MOS	Billet
HQ	1	GySgt	1371	NCOIC
	1	Cpl/LCpl	3535	Driver/Training
	1	HM-3/HM-2	8404	Corpsman
Team 1	1	SSgt/Sgt	1371	Team Leader
	1	Sgt/Cpl	1371	Asst. Team Leader
	2	Cpl/LCpl	1371	Scout/Observer
	1	Cpl/LCpl	1141	Scout/Observer
	1	Cpl/LCpl	2531/1371	Radio Man
Team 2	1	SSgt/Sgt	1371	Team Leader
	1	Sgt/Cpl	1371	Asst. Team Leader
	2	Cpl/LCpl	1371	Scout/Observer
	1	Cpl/LCpl	1141	Scout/Observer
	1	Cpl/LCpl	2531/1371	Radio Man
Total =	0 / 15 / 1			

Table 4.1. 1st CEB Engineer Reconnaissance Section Personnel Requirements.

2. Training Requirements

Virden's proposal references an earlier proposal by Sapp (1995) with respect to training requirements for Marines assigned to the engineer reconnaissance section. These requirements focus primarily on developing reconnaissance skills through attendance at formal schools in order to standardize skills for interoperability with other reconnaissance

organizations. While Sapp proposed attendance at a plethora of reconnaissance-related schools, Virden proposes a more realistic curriculum reflected in Table 4.2.

School	Attended By
Basic Reconnaissance Course	All
Combat Water Survival School	All
Assault Climbers School	2 per Team
Heliborne Rope Suspension Training (HRST) Master School	Team Leader/Assistant Team Leader

Table 4.2. Engineer Reconnaissance Section Formal School Requirements.

Virden acknowledges the requirement for basic reconnaissance skill standardization but limits skills acquired to those most likely to be used by reconnaissance engineers operating independently or with other reconnaissance organizations. While skill standardization promotes coordination and interoperability at the "operating core," liaison roles promote planning and employment coordination between reconnaissance organizations.

3. Lateral Coordination Requirements

Any coordination between reconnaissance organizations will involve some form of direct contact between unit leaders. This may take a variety of forms to include an informal discussion of employment options or an initial planning conference. Marines serving in liaison roles with adjacent organizations assist unit leaders with lateral coordination by developing effective training and employment plans, and providing organizational leaders with experience and expertise unique to their MOS. By developing an engineer reconnaissance core competency within 1st CEB, Virden's

proposal benefits from the established combat engineer liaison position at 1st/3rd LAR Battalions. Virden's proposal does not require any change in the liaison positions at the LAR Battalions, only an increased use of them to coordinate engineer reconnaissance section training and employment with light armored reconnaissance operations. Recent training exercises such as the LAR community's Deep Maneuver Exercise included engineer "scouts" from 1st CEB and suggest an improvement in tapping the liaison officer coordination resource.

Although not addressed by Virden or Sapp, creating a similar liaison position in the operations section at the Division Reconnaissance Company would promote lateral coordination with 1st CEB. Assigning an appropriately qualified staff sergeant or gunnery sergeant to this billet would fill the liaison requirement and provide the Division Reconnaissance Company with an "in-house" source of combat engineering expertise to assist with engineering-related aspects of training such as demolitions. Marines assigned this role should:

1. Have a detailed knowledge of amphibious and ground reconnaissance operations (ideally gained from previous experience working with reconnaissance and combat engineer organizations).
2. Be an articulate proponent of the engineer reconnaissance sections capabilities and limitations.
3. Add value to the Division Reconnaissance Company's Individual and Unit Training Phases, particularly by providing instruction on landmine warfare, demolition charges for specific targets, and booby-trap techniques.

C. ENGINEER RECONNAISSANCE CAPABILITY AT DIVISION RECONNAISSANCE COMPANY

This alternative solution develops an engineer reconnaissance core competency by assigning combat engineers to the Division Reconnaissance Company. This alternative relieves 1st CEB of the close and deep engineer reconnaissance missions by consolidating them in the Division Reconnaissance Company. No existing proposals address this alternative, which entails creating an engineer reconnaissance element within the existing Division Reconnaissance Company organization. This alternative involves grouping by function to create a core competency, although the functions differ slightly at the platoon and company levels. Individuals are grouped together in the engineer platoon by the engineer reconnaissance function while the engineer platoon is grouped into the Division Reconnaissance Company by the divisions stealth reconnaissance function. The Division Reconnaissance Company retains its reconnaissance center of gravity, while diversifying into the related field of engineer reconnaissance.

Figure 4.2 depicts a hypothetical platoon-sized engineer reconnaissance element subordinate to the Division Reconnaissance Company. This alternative internalizes most coordination requirements for close and deep engineer reconnaissance within the Division Reconnaissance Company, although certain missions may require coordination with 1st/3rd LAR Battalions. This alternative effectively removes 1st CEB from the execution of close and deep engineer reconnaissance missions, but provides them with critical engineering information necessary to best support the division or supported MAGTF.

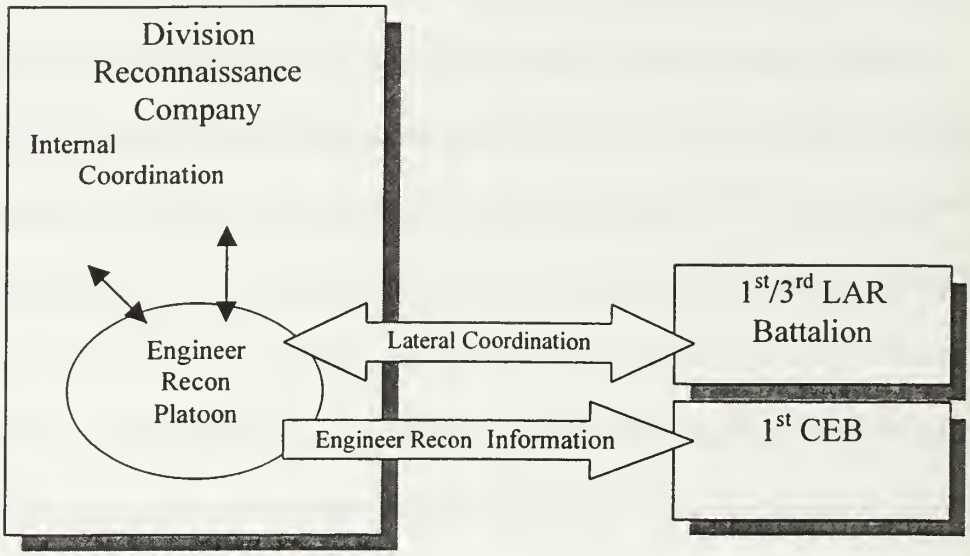

Figure 4.2. Coordination Requirements for an Engineer Reconnaissance Platoon Within the Division Reconnaissance Company.

1. Personnel Requirements

This engineer reconnaissance platoon may mirror the structure of a standard reconnaissance platoon composed of a headquarters section and three six-man reconnaissance teams. Table 4.3 depicts the personnel requirements by rank and billet. The platoon commander's role warrants the rank of a senior lieutenant, preferably one with previous experience as a platoon commander in 1st CEB and a sound knowledge of engineer reconnaissance requirements and techniques. Both the platoon commander and platoon sergeant must be proficient in small unit tactics, infantry skills, and reconnaissance techniques to maintain credibility in a reconnaissance organization. While

the reconnaissance engineers must be dual qualified as both engineers and reconnaissance Marines, they should ideally have served with a combat engineer line company prior to

Element	Quantity	Rank	MOS	Billet
HQ	1	1stLt	1302	Platoon Commander
	1	SSgt	1371/0369	Platoon Sergeant
	1	Sgt/Cpl	1371/0321	Equipment NCO
	1	Cpl	2531/0321	Field Radio Operator
	1	HN	8404	Corpsman
Team 1	1	Sgt	1371/0369	Team Leader
	1	Cpl	1371/0321	Asst. Team Leader
	2	LCpl	1371/0321	Recon Engineer
	1	LCpl	1141/0321	Recon Engineer
	1	LCpl	1371/0321	Recon Engineer/Driver
Team 2	1	Sgt	1371/0369	Team Leader
	1	Cpl	1371/0321	Asst. Team Leader
	2	LCpl	1371/0321	Recon Engineer
	1	LCpl	1141/0321	Recon Engineer
	1	LCpl	1371/0321	Recon Engineer/Driver
Team 3	1	Sgt	1371/0369	Team Leader
	1	Cpl	1371/0321	Asst. Team Leader
	2	LCpl	1371/0321	Recon Engineer
	1	LCpl	1141/0321	Recon Engineer
	1	LCpl	1371/0321	Recon Engineer/Driver
Total =	1 / 21 / 1			

Table 4.3. Personnel Requirements for Engineer Reconnaissance Platoon at Division Reconnaissance Company.

assignment to the reconnaissance platoon. This ensures that only qualified Marines with the requisite MOS skills, maturity, and reliability are selected to progress into the reconnaissance community.

2. Training Requirements

Prior to this assignment to the Division Reconnaissance Company, combat engineers should attend 1st CEBs Sapper Leader Course (or an equivalent school) to develop the engineer-specific reconnaissance expertise and skill sets required to effectively conduct engineer reconnaissance operations. Once assigned, internal skill standardization requirements within the company would require that combat engineers assigned to the reconnaissance platoon complete the company's individual training phase mentioned in Chapter III. Table 4.4 lists specific school requirements and the required number of students for the proposed engineer reconnaissance platoon.

Upon completion of the individual training phase, the engineer reconnaissance platoon would conduct unit training similar to that conducted by reconnaissance platoons in the unit training phase. This phase... "develop(s) the platoon into a cohesive unit with fully established SOPs and trained to accomplish the company's METL" (Cunniffe, Enclosure 3, 1997). Actual employment of the engineer reconnaissance platoon (either as a whole or as teams attached to other platoons) will dictate the scope and extent of the unit training phase detailed by Cunniffe (1997).

3. Lateral Coordination Mechanisms

The platoon commander and platoon sergeant serve as informal liaison officers in their capacity as unit leaders. While this alternative solution relieves 1st CEB of directly supporting the close and deep engineer reconnaissance mission requirements, they continue to support it indirectly by providing the Division Reconnaissance Company with trained engineers via the Sapper Leader Course. Thus the platoon commander and platoon sergeant serve as lateral coordination links with 1st CEB for personnel and

procedural issues related to engineer reconnaissance, and coordinate with 1st/3rd LAR Battalions and other divisional units on operational issues involving engineer reconnaissance.

Course Name	Number per Platoon
Basic Reconnaissance Course	All Members
USMC Combatant Dive School	15 (including Plt Cmdr, Plt Sgt, Equipment NCO)
Survival Evasion Resist Escape (SERE) School	6 (2 per team)
HRST Master	3 (including Plt Cmdr, Plt Sgt, Equipment NCO)
Helocast Master	3 (Plt Cmdr, Plt Sgt, Equipment NCO)
Dive Supervisor Course	2
HMMWV/Ammunition Driver	3 (1 per team)
Soils Analysis Course	3 (1 per team)
Special Forces Engineer NCO	As Available
Ranger School	As Available
Mountain Leaders Course	As Available

Table 4.4. Individual Training Phase School Requirements for Division Reconnaissance Company Engineer Reconnaissance Platoon (After Cunniffe, Enclosure 3, 1997).

D. ENGINEER RECONNAISSANCE CAPABILITY IN A LIGHT ARMORED RAIDER BATTALION

This alternative solution stems from a concept paper by Feldmeier and Yunker (1996) that redesigns the current LAR battalions as "Raider Battalions." The Raider Battalion is a "...wheeled combined arms force that is designed to make deep penetrations to address operational objectives..."(Feldmeir and Yunker, p. 46, 1996). One of this conceptual battalions missions is to "...identify surfaces and gaps at the

boundary and beyond the tactical area of influence" (Feldmeir and Yunker, p. 46, 1996), which inherently involves many aspects of engineer reconnaissance. To this end, the authors include a combat engineer platoon in the battalions task organization to provide the battalion with engineer reconnaissance, mobility/countermobility, and demolition capabilities. This develops an engineer reconnaissance core competency in the Raider Battalions capable of conducting close and deep engineer reconnaissance missions. This alternative also removes 1st CEB from executing close and deep engineer reconnaissance missions and internalizes most coordination requirements within the Raider Battalion. This concept maintains the existing LAR battalions basic center of gravity but involves diversifying into several related specialties, one of which is engineer reconnaissance. This concept groups individuals by combat engineer and light armored reconnaissance functions within the platoon. The basis for grouping the platoon into the Raider Battalion, however, is less clear. Mission related process interdependencies between the engineer platoon and other elements of the Raider Battalion organization suggest that the battalion's subordinate elements are grouped by market (or the process by which the organization accomplishes its mission).

The organizations mobility requirements and fairly autonomous method of operation involve significant quantities of personnel and equipment. The following sections outline these structural requirements, as well as briefly address anticipated training needs and lateral coordination concerns.

1. Personnel Requirements

Feldmeir and Yunker suggest a reinforced engineer platoon in support of the conceptual Raider Battalion organization. Table 4.5 lists personnel requirements to man

Element	Quantity	Rank	MOS	Billet
Platoon HQ	1	Capt	1302	Platoon Commander
	1	1stLt	1302	Asst. Platoon Commander
	1	GySgt	1371	Platoon Sergeant
	1	SSgt	1371	Asst. Platoon Sergeant
	1	SSgt	1371	Platoon Guide
	1	Sgt	1371	Asst. Platoon Guide
	3	LCpl-PFC	0313/2147	Vehicle Driver
1st Squad	1	Sgt	0313	Vehicle Commander
	1	Cpl	0313	Vehicle Gunner
	1	LCpl-PFC	0313	Vehicle Driver
	1	Sgt	1371	Squad Leader
	2	Cpl	1371	Team Leader
	6	Cpl-PFC	1371	Combat Engineer
	1	CPL-PFC	1345	Backhoe Operator
	1	HM3-HN	8404	Corpsman
2nd Squad	1	Sgt	0313	Vehicle Commander
	1	Cpl	0313	Vehicle Gunner
	1	LCpl-PFC	0313	Vehicle Driver
	1	Sgt	1371	Squad Leader
	2	Cpl	1371	Team Leader
	6	Cpl-PFC	1371	Combat Engineer
	1	Cpl-PFC	1345	Backhoe Operator
	1	HM3-HN	8404	Corpsman
3rd Squad	1	Sgt	0313	Vehicle Commander
	1	Cpl	0313	Vehicle Gunner
	1	LCpl-PFC	0313	Vehicle Driver
	1	Sgt	1371	Squad Leader
	2	Cpl	1371	Team Leader
	6	Cpl-PFC	1371	Combat Engineer
	1	Cpl-PFC	1345	Backhoe Operator
	1	HM3-HN	8404	Corpsman
Total =	2 / 46 / 3			

Table 4.5. Personnel Requirements for Raider Battalion Engineer Platoon (After Feldmeir and Yunker, pg. 26, 1996).

this platoon. This task organization boasts relatively senior leadership for a platoon, with a captain filling what is normally considered a lieutenants billet. The additional officer and three SNCOs in the platoon headquarters provide the organization with the requisite knowledge, leadership, and maturity for deep operations. Of note is that only 36 of the total 51 personnel in this proposed task organization are combat engineers, with light armored infantrymen and corpsmen comprising the remaining 15 personnel. This generates additional potential training requirements for combat engineers to operate effectively with their light armor counterparts.

2. Training Requirements

Feldmeir and Yunker do not address training for combat engineers assigned to a Raider Battalion. Their reconnaissance oriented mission suggests these engineers all attend the Sapper Leader Course, while their light armored mode of transportation suggests they attend a light armored scout course taught internally by the Raider Battalion. The platoon leadership should attend the LAV Leaders Course to develop proficiency in planning and conducting light armored operations. This mix of training provides a base standardization of skills both within the platoon and between the platoon and the other elements of the Raider Battalion. Table 4.6 lists training requirements by schools and quotas that are in addition to basic MOS training. The platoon leadership would attend additional light armored tactical, vehicle, or maintenance related training as available to further standardize their skill and knowledge sets with the remainder of the battalion.

Name Course	Quotas/Attendees
Sapper Leader Course	9 (All Engineer Squad Members)
Light Armored Scout Course	9 (All Engineer Squad Members)
LAV Leaders Course	6 (Plt Cmdr through Asst. Plt Guide)

Table 4.6. Raider Battalion Engineer Platoon Training Requirements.

3. Equipment Requirements

The Raider Battalion concept mounts the engineer platoon on a mix of three LAV Engineer variants and three LAV Dual GAU-19 variants to provide a balanced combination of mobility, hauling capacity and firepower. While this appears to be an ideal method of transporting engineers on the battlefield, both of these variants are conceptual and would require extensive modification of the existing LAV Logistics or LAV 25 variants prior to forming this organization. The platoon also requires an assortment of common engineer demolition kits, hand tools, mine detectors, and various other equipment items found in a combat engineer platoons table of equipment.

4. Lateral Coordination Requirements

This alternative minimizes lateral coordination requirements between 1st CEB and the Raider Battalion by virtue of consolidating the close and deep engineer reconnaissance responsibilities in one organization. Direct contact between the Raider Battalion engineer platoon leaders and 1st CEB must still occur, however, to coordinate training of Raider engineers and ensure currency in engineer reconnaissance procedures and requirements. The fairly large Raider engineer platoon headquarters is more than

sufficient in terms of experience, knowledge, and manpower to effectively coordinate with 1st CEB on such issues.

E. DEVELOPING AN ENGINEER RECONNAISSANCE CAPABILITY THROUGH CROSS TRAINING

This alternative requires no structural modification to any divisional reconnaissance organization, but relies on cross training between existing organizations to develop an engineer reconnaissance capability. It allows each organization to maintain its center of gravity with minimal diversification beyond that inherent to current task organization doctrine. This alternative posits that 1st CEB supports the close and deep engineer reconnaissance missions by attaching trained combat engineers to either a LAR battalion or the Division Reconnaissance Company. Rather than developing a formal engineer reconnaissance element within 1st CEB, however, engineers from line companies cross train with the LAR battalions while engineers assigned to MEU platoons cross train with MEU platoons from the Division Reconnaissance Company. This cross training develops a degree of skill standardization for close and deep engineer reconnaissance missions between operators at each organization. Individuals are grouped into existing organizations by their traditional MOS function (engineering, armored reconnaissance, and amphibious/stealth reconnaissance) for administrative and training purposes. During periods of cross training or attachment for operational requirements, elements of these organizations are grouped by market due to the interdependence created between organizations by the engineer reconnaissance function. Figure 4.3 illustrates the cross training relationships between reconnaissance organizations. This alternative relies heavily on direct contact and liaison mechanisms for lateral coordination between

organizations to conduct effective training and develop a viable engineer reconnaissance capability. The following sections address training relationships, training and time requirements, and coordination mechanisms.

1. Cross Training with MEU Platoons

Smith (1997) suggests that the division can develop a solid close and deep engineer reconnaissance capability by initiating a cross training program between Division Reconnaissance Company and 1st CEB MEU platoons during pre-deployment

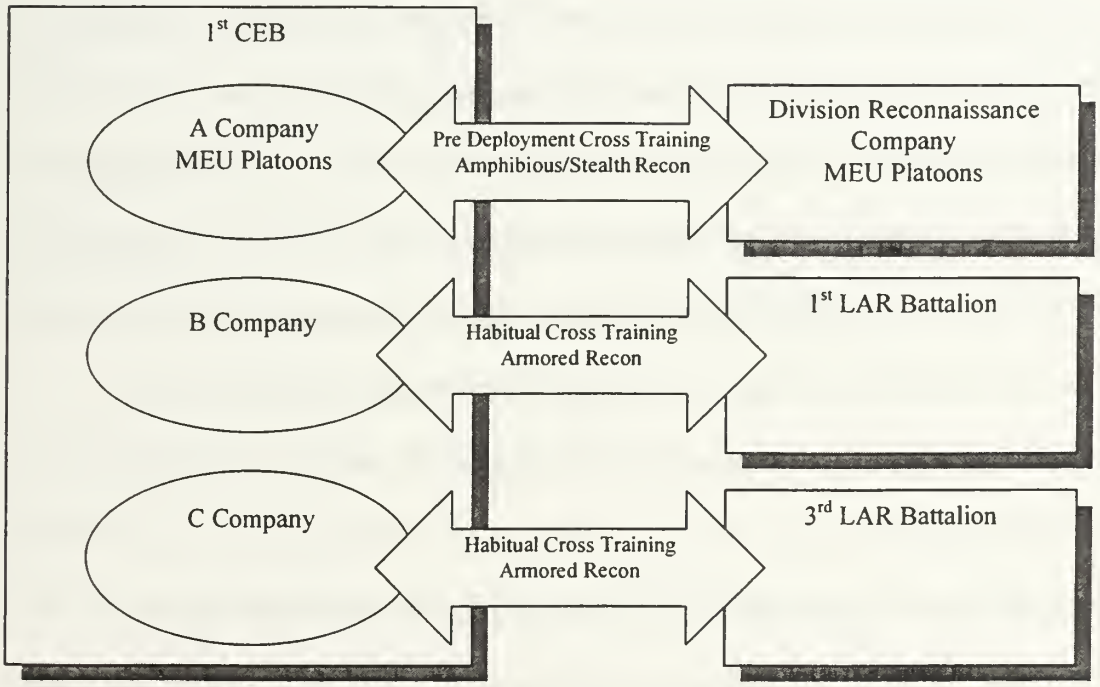

Figure 4.3. Cross Training Relationships for Engineer Reconnaissance.

training phases. These phases normally consist of a three to six month period of training conducted under the auspices of 1st CEB and the Division Reconnaissance Company, followed by a six month period of training with the Battalion Landing Team (BLT) and

MEU. The engineer and reconnaissance platoons could participate in mutually complementary training events currently conducted independently. Specifically, these are portions of 1st CEBs four week Sapper Leader Course, and the Division Reconnaissance Company's one week amphibious training package and two week platoon patrolling package. Reconnaissance Marines participating in the Sapper Leader Course benefit from advanced demolitions training and an introduction to engineer reconnaissance, while combat engineers attending the patrolling and amphibious training packages benefit from exposure to specific skills, techniques and SOPs related to amphibious and stealth reconnaissance operations. This alternative results in an initial time investment of four to six weeks with each platoon hosting the other for approximately two to three weeks of focused training. Once a MEU forms, the engineer and reconnaissance platoons will have a basis for continued joint training during the six-month MEU work-up training cycle to polish an engineer reconnaissance capability. As Cunniffe states, reconnaissance platoon "...training opportunities with the Battalion's infantry companies and attachments should be exploited to the maximum extent possible" (Cunniffe, 1997).

Although a MEU is operationally and administratively detached from the division, the relationships and capabilities formed during MEU training and deployments should directly carry over to support the division reconnaissance function. This alternative is supported by one of the divisions top priorities: forming and preparing BLTs and their attachments for service with the MEUs (Libutti, 1994). While this cross training supports engineer aspects of amphibious and stealth reconnaissance, cross training with LAR battalions supports engineer aspects of armored reconnaissance.

2. Cross Training With LAR Battalions

Gallagher (1997) suggests that combat engineers cross training with LAR battalion scouts will improve the divisions close and deep engineer reconnaissance capability. He promotes LAR scouts attending 1st CEBs Sapper Leader Course to develop a baseline of knowledge and skill levels required for engineer reconnaissance missions, followed by increased cross-training with combat engineers from 1st CEB line companies during normal unit training and scheduled exercises. The resulting habitual working relationship between the engineer and LAR communities strengthens the process interdependence and minimizes task uncertainty between the two organizations for conducting close and deep engineer reconnaissance from an armored platform. This armored engineer reconnaissance capability complements the previously discussed amphibious and stealth engineer reconnaissance capability to provide the division with an engineer reconnaissance capability across the division's operational spectrum.

3. Lateral Coordination Mechanisms

This alternative exercises both direct leader contact and the LAR battalion engineer liaison officer positions to coordinate effective cross training between 1st CEB and the LAR battalions. Lacking a formal engineer liaison position at the Division Reconnaissance Company, a temporary task force of personnel from 1st CEB and the Division Reconnaissance Company could form to develop and coordinate cross training processes between the MEU platoons. Once the training plan is established, direct contact between leaders at the platoon level maintains continued lateral coordination and ensure proper execution.

F. CHAPTER SUMMARY

This chapter identified and discussed four alternative methods of developing an engineer reconnaissance capability in 1st Marine Division. Table 4.7 summarizes the four alternatives in terms of:

1. The organization(s) that contains the engineer reconnaissance capability and any related diversification involved.
2. Number of personnel (Marine officer/Marine enlisted/Navy enlisted) required to develop new structure (if any) within the organization(s).
3. Relative degree and type of additional training required to develop this capability.
4. Relative degree and type of mechanisms used to insure lateral coordination between organizations.

Having identified these four alternatives, Chapter V provides a cost and benefit analysis of these alternatives and ranks them by their cost/benefit ratios.

Alternative	Capable Organization(s)/ Diversification Involved	Personnel Required for New Structure	Degree and Type of Training Required	Lateral Coordination Mechanisms
1st CEB Engineer Recon Section	• 1st CEB • Diversifies into reconnaissance function	0 / 15 / 1	• Significant use of formal schools • Regular follow-on training with LAR and DivRecCo for sustainment	Significant use of • Direct contact • Liaison officers at LAR and DivRecCo.
Division Reconnaissance Company Engineer Platoon	• Division Reconnaissance Company • Diversifies into engineering function	1 / 21 / 1	• Significant use of formal schools • Unit training	Minimal use of • Direct contact • Liaison officers at 1st CEB and LAR
Engineer Platoon in Raider Battalion	• Raider Battalion • Diversifies into engineering function	2 / 46 / 3	• Minimal use of formal schools • Unit training	• Minimal use of direct contact
Cross Training Between Existing Organizations	• Primary capability with 1st CEB • Shared with LAR, DivRecCo • 1st CEB diversifies into armored and stealth recon • LAR diversifies into engineering • DivRecCo diversifies into engineering	0 / 0 / 0	• Minimal use of formal schools • Maximum use of cross training	Extensive use of • Direct contact • Liaison officers Initial use of temporary task force

Table 4.7. Summary of Four Alternative Solutions.

V. ANALYSIS OF ALTERNATIVE SOLUTIONS

A. INTRODUCTION

This chapter evaluates the alternative solutions presented in Chapter IV to determine the best solution to the engineer reconnaissance problem. The chapter develops criteria for use in an additive weighting and ranking method of cost/benefit analysis to determine each solution's cost/benefit ratio. An ordinal ranking of these ratios provides a relative ranking of the alternative solutions, with the optimal solution having the lowest ratio value.

B. ANALYSIS CRITERIA IDENTIFICATION

This section identifies cost and benefit criteria to measure each alternative solution against the others. Criteria were selected based on the ability to measure them either qualitatively or quantitatively as well as their applicability to the engineer reconnaissance problem and each alternative solution.

1. Cost Criteria

Chapter IV described each alternative solution in terms of personnel and training requirements for the specific organizations involved. These translate into measurable "costs" for the division and its subordinate reconnaissance organizations. The third cost criterion is the degree of lateral coordination each alternative requires and involves a more subjective approach for measurement and comparison purposes.

a. Personnel Requirements

This criterion measures the relative number of personnel required for any new structure added to a reconnaissance organization. As stated in Chapter I, this thesis assumes that personnel structure in the Marine Corps and 1st Marine Division is a "zero-

sum game" and personnel additions to one or more organizations necessarily require equal personnel reductions from other organizations. This assumption applies to intra-organizational personnel issues, as well. Therefore, an alternative that requires more personnel relative to other alternatives will incur a greater "cost" to the organization(s) involved.

b. Training Requirements

This criterion measures the relative amount of formal school training, cross training, and sustainment training required by an alternative. Training is also a "zero-sum game" in terms of time and resources required, both of which are finite and relatively fixed in quantity. Therefore, an alternative that requires more training relative to other alternatives will incur a greater "cost" to the organization(s) involved.

c. Lateral Coordination Requirements

This criterion measures the relative amount of lateral coordination required by an alternative. Lateral coordination has time and personnel components, and may be complicated by location. The variability of these factors make lateral coordination requirements more difficult to measure from a purely objective standpoint and require a large degree of subjectivity to compare alternatives in terms of these requirements. Similar to personnel and training requirements, however, an alternative that requires more lateral coordination relative to other alternatives will incur a greater "cost" to the organization(s) involved. This is particularly true if the alternative organization is more centrally designed and structured than other alternative organizations.

2. Benefit Criteria

This section establishes four benefit criteria to evaluate the relative benefits of each alternative solution. These criteria are quality, acceptability, applicability, and maintainability. The following sub-sections define each criterion and address the subjective approach to measure each alternative in terms of the specific benefit criterion.

a. Quality

Quality is the degree to which an alternative solution provides a better quality engineer reconnaissance capability to 1st Marine Division. A quality measurement of engineer reconnaissance focuses on an alternative's ability to collect required engineer information in a timely manner. The primary factor influencing this is the degree of expected engineer expertise based on the positioning of the "reconnaissance engineers" within the division structure relative to 1st CEB. First Combat Engineer Battalion is the division's center of gravity for combat engineer knowledge and skill and should provide the highest quality engineer information. Alternatives that remove the engineer reconnaissance function from 1st CEB are expected to provide engineer information of lower quality due to the reconnaissance engineers separation both physically and (to varying degrees) professionally from the divisions engineering center of gravity. Therefore an alternative that retains the engineer reconnaissance function in 1st CEB will provide the greater quality benefit to the division's reconnaissance function compared to an alternative that removes the engineer reconnaissance function from 1st CEB. Quality measurements for alternatives that separate reconnaissance engineers from 1st CEB will rely on the seniority of leadership of the engineer reconnaissance element. Those alternatives that have more senior leadership would be expected to have a more

developed and diverse body of engineering knowledge and skills and would likely produce a higher quality engineer reconnaissance product than alternatives with less experienced leadership.

b. Acceptability

Acceptability is the degree to which an alternative solution interferes with operations within reconnaissance organizations. This is synonymous with the degree of negative change the engineer reconnaissance function will introduce to an organizations current operations. This interference is a subjective measure of the relative degree of deviation from existing methods and patterns of operations caused by incorporating the engineer reconnaissance function into one or more organizations. Therefore an alternative that causes relatively little interference will be considered more acceptable than an alternative that causes a high degree of interference.

c. Employability

Employability is the degree to which an alternative can be applied in projected operational environments. This entails a subjective measurement of the employability of an alternative in amphibious, mechanized, motorized, heliborne and foot-mobile operations in all conceivable environments. An alternative that is employable across more of the operational spectrum and in more environments than other alternatives will provide the division a greater benefit.

d. Maintainability

Maintainability measures the ease of maintaining an engineer reconnaissance capability once it is established. This involves maintaining both the engineering skill and knowledge sets as well as the reconnaissance skill and knowledge

sets required to effectively conduct engineer reconnaissance missions for the division. This is a subjective measure that involves access to engineer and reconnaissance centers of gravity, access to training resources, and personnel career pattern issues that enhance or detract from maintaining engineer reconnaissance skills.

C. METHOD OF ANALYSIS

This thesis analyzes costs and benefits using the additive weighting and ranking technique. This technique assigns weights between zero and one to criteria according to their relative degree of importance to the analysis, with the sum of the weights equaling one. The four alternative solutions under analysis are then ordinally ranked by each cost or benefit criteria, with the most favorable alternative assigned a value of four and the least favorable alternative assigned a value of one. Multiplying the criteria weight by the criteria rank yields a weighted rank for each of the criteria, which are then summed for each alternative to yield an overall score. For both cost and benefit analyses, the alternative with the *highest* overall score is the *most* favorable while the alternative with the *lowest* overall score is the *least* favorable. This thesis applies this technique first to evaluate alternatives with respect to cost criteria, and then to evaluate alternatives with respect to benefit criteria. Dividing each alternatives overall benefit score by its overall cost score produces a ratio; visual inspection of these ratios identifies the alternative with the lowest ratio as the most favorable alternative. For ease of discussion, the following sections will refer to each alternative solution by the following numbering system:

1. Engineer reconnaissance section at 1st CEB.
2. Engineer reconnaissance platoon at Division Reconnaissance Company.

3. Engineer platoon in LAV Raider Battalion.

4. Cross training solution.

D. COST ANALYSIS

1. Criteria Weighting

Section B identified four cost criteria for evaluating each alternative solution. Table 5.1 assigns a weight to each cost criterion based on its relative importance to overall "cost" to the division or subordinate reconnaissance organizations. The finite number of personnel available make personnel requirements most costly, followed by training requirements and lateral coordination requirements.

Cost Criteria	Weight Assigned
Personnel Requirements	0.5
Training Requirements	0.3
Lateral Coordination Requirements	0.2

Table 5.1. Cost Criteria Weighting.

2. Ranking Alternatives by Personnel Requirements

Table 5.2 reviews personnel requirements associated with each alternative as discussed in Chapter IV and summarizes rank scores assigned to each alternative. Alternative four does not require any additional personnel and incurs the lowest personnel cost on the division. Accordingly it receives the highest rank score of four. Alternative one requires a total of 16 personnel (0/15/1) and incurs the next lowest cost on the division for a rank score of three. Alternative two requires 23 personnel (1/21/1)

and receives a rank score of two, while alternative three requires 51 personnel (2/46/3) and receives the lowest rank score of one.

Alternative	1	2	3	4
Personnel Requirements	0/15/1	1/21/1	2/46/3	0/0/0
Rank Score	3	2	1	4

Table 5.2. Personnel Requirements and Rank Scores per Alternative.

3. Ranking Alternatives by Training Requirements

Table 5.3 reviews training requirements associated with each alternative as discussed in Chapter IV and summarizes rank scores assigned to each alternative. Alternative three requires the least amount of formal and cross training outside of the Raider Battalion organization. It incurs the lowest training "cost" and receives the highest rank score of four. Alternative one requires slightly more formal school training and significantly more cross training and receives the next highest rank score of three.

Alternative	1	2	3	4
Training Requirements	• Significant use of formal schools • Regular follow-on and sustainment training	• Significant use of formal schools • Unit training	• Minimal use of formal schools • Unit training	• Minimal use of formal schools • Maximum use of cross-training
Rank Score	3	2	4	1

Table 5.3. Training Requirements and Rank Scores per Alternative.

Alternative two requires a significant amount of formal school and internal unit training, and receives a rank score of two. Alternative four requires minimal formal school training but extensive cross training, which is complicated by the complexity of scheduling effective cross-training between several organizations. It receives the lowest rank score of one.

4. Ranking Alternatives by Lateral Coordination Requirements

Table 5.4 reviews lateral coordination requirements associated with each alternative as discussed in Chapter IV and reflects rank scores assigned each alternative. Alternative three requires a relatively small amount of lateral coordination and receives

Alternative	1	2	3	4
Training Requirements	Significant use of • Direct contact • Liaison officers	Minimal use of • Direct contact • Liaison officers	Minimal use of • Direct contact	Extensive use of • Direct contact • Liaison officers Initial use of • Temporary task force
Rank Score	2	3	4	1

Table 5.4. Lateral Coordination Requirements and Rank Scores per Alternative.

the highest rank score of four. Alternative two requires slightly more lateral coordination via direct contact and liaison officers and receives a rank score of three. Alternative one requires significant use of direct contact and liaison officers to achieve lateral coordination and receives a rank score of two. Alternative four requires extensive

use of direct contact, liaison officers, and possibly a short-term task force to establish cross training programs. Accordingly, it receives a rank score of one.

5. Additive Weighting and Ranking of Alternatives

Table 5.5 depicts the additive weighting and ranking technique for evaluating the relative costs of alternative solutions. Based on the given weights for cost evaluation criteria and the alternative rankings, alternative one incurs the lowest overall cost to the division in terms of personnel, training, and lateral coordination requirements. Alternatives three and four incurred relatively equal costs, while alternative two incurred the greatest cost.

Alternative→		1		2		3		4	
Cost ↓	Weight	Rank	Weighted Rank	Rank	Weighted Rank	Rank	Weighted Rank	Rank	Weighted Rank
Personnel	0.5	3	1.5	2	1.0	1	0.5	4	2.0
Training	0.3	3	0.9	2	0.6	4	1.2	1	0.3
Lateral Coordination	0.2	2	0.4	3	0.6	4	0.8	1	0.2
Totals →	1.0	Score = 2.8		Score = 2.2		Score = 2.5		Score = 2.5	

Table 5.5. Additive Weighting and Ranking of Alternatives by Cost Criteria.

E. BENEFIT ANALYSIS

1. Criteria Weighting

Section B identified four benefit criteria for evaluating each alternative solution. Table 5.6 assigns weights to each criterion based on its relative importance to the overall "benefit" realized by the division or its subordinate reconnaissance organizations. Quality

and employability are the most important benefits to the division, followed by maintainability and acceptability. Weights assigned to these criteria are subjectively based on this hierarchy.

Benefit Criteria	Weight Assigned
Quality	0.3
Employability	0.3
Maintainability	0.25
Acceptability	0.15

Table 5.6. Benefit Criteria Weighting.

2. Ranking Alternatives by Quality

Table 5.7 summarizes rank scores for quality assigned to each alternative. Alternative one retains the highest degree of engineer knowledge and skill by virtue of the engineer reconnaissance sections location in 1st CEB. This gives alternative one the best access to the divisions engineering center of gravity, for which it receives the highest rank score of four.

Alternative	1	2	3	4
Rank Score	4	1	2	3

Table 5.7. Ranking Alternatives by Quality.

Alternative four also retains the engineer reconnaissance function in 1st CEB but relies on extensive cross training rather than developing a specific reconnaissance organization within the battalion. For this reason it receives a rank score of three. Alternatives two

and three both remove the engineer reconnaissance function from the divisions engineering center of gravity, but alternative three boasts substantially more senior and experienced leadership than alternative two. For this reason, alternative three receives a rank score of two and alternative two a rank score of one.

3. Ranking Alternatives by Employability

Table 5.8 summarizes rank scores for employability assigned to each alternative. Alternatives one and two are nearly equal in terms of employability across the operational spectrum in most environments. Alternative two provides a slightly more employable capability, however, by virtue of its amphibious reconnaissance mission and capabilities. Alternative two, therefore, receives a rank score of four while alternative one receives a rank score of three. Alternative three is slightly hampered in employability by its association with and reliance upon the LAV platform, which tends to limit employability to motorized/mechanized operations in physical environments that support wheeled mobility. Alternative four, therefore, receives a rank score of two while alternative three receives a rank score of one.

Alternative	1	2	3	4
Rank Score	3	4	1	2

Table 5.8. Ranking Alternatives by Employability.

4. Ranking Alternatives by Maintainability

Table 5.9 summarizes maintainability rankings for each alternative. Alternative one provides excellent access to the engineering center of gravity and does not

significantly affect current career patterns for combat engineers. Assuming division support for the concept, it provides good access to reconnaissance centers of gravity

Alternative	1	2	3	4
Rank Score	4	1	2	3

Table 5.9. Ranking Alternatives by Maintainability.

through direct contact and liaison mechanisms. It provides excellent access to 1st CEB training resources, and good access to other divisional training assets. For these reasons it provides the division with the highest level of maintainability and receives a rank score of four. Alternative four lacks the organizational structure to ensure continued focus on engineer reconnaissance training with dedicated personnel and assets but retains excellent access to the engineering center of gravity. It has no major impact on established engineer career patterns, and assumes good access to training assets and reconnaissance centers of gravity given a favorable command climate. Alternative four, therefore, receives a rank score of three. Alternative three boasts excellent access to the armored reconnaissance center of gravity and should retain good access to the engineering center of gravity. Expected similarities in missions and METLs between the Raider Engineer Platoon and a 1st CEB line company suggest engineers should be able to migrate between the two communities with little impact on career patterns. This does not hold true to the same degree between 1st CEB and the Division Reconnaissance Company, where engineers assigned to a reconnaissance platoon run a higher risk of being absorbed into the reconnaissance community. This creates an imbalance in the number of engineers available to fill engineer line numbers and limits the alternatives maintainability. For this

reason, alternative three receives a rank score of two while alternative two receives a rank score of one.

5. Ranking Alternatives by Acceptability

Table 5.10 summarizes acceptability rankings for each alternative. The conceptual nature of the Raider Battalion allows alternative three to claim the least amount of interference or change within a reconnaissance organization. It is difficult to interfere with an organization that exists only on paper or as an ad-hoc version approximated by a LAR battalion during training exercises. For this reason alternative three receives an acceptability rank score of four. Alternative one would involve only minimal change to operations within the S-3 Training section of 1st CEB and some burden to incorporate cross training with other reconnaissance organizations. Alternative one, therefore, receives a rank score of three. Alternative four would create a moderate degree of change with training schedules for all reconnaissance organizations, while alternative two would involve a significant degree of change only in the Division Reconnaissance Company's current operations. This suggests that alternative two receive a rank score of two, and alternative four a rank score of one.

Alternative	1	2	3	4
Rank Score	3	2	4	1

Table 5.10. Ranking Alternatives by Acceptability.

6. Additive Weighting and Ranking of Alternatives

Table 5.11 depicts the additive weighting and ranking technique for evaluating the relative benefits of alternative solutions. Based on the subjective weights assigned to the

benefit criteria and the alternative rankings, alternative one provides the greatest benefit in terms of quality, employability, maintainability, and acceptability. Alternative four provided the next greatest degree of benefit, followed by alternatives two and three.

Alternative→		1		2		3		4	
Benefit ↓	Weight	Rank	Weighted Rank	Rank	Weighted Rank	Rank	Weighted Rank	Rank	Weighted Rank
Quality	0.3	4	1.2	1	0.3	2	0.6	3	0.9
Employability	0.3	3	0.9	4	1.2	1	0.3	2	0.6
Maintainability	0.25	4	1.0	1	0.25	2	0.5	3	0.75
Acceptability	0.15	3	0.45	2	0.3	4	0.6	1	0.15
Totals →	1.0	Score = 3.55		Score = 2.05		Score = 2.0		Score = 2.4	

Table 5.11. Additive Weighting and Ranking of Alternatives by Benefit Criteria.

F. SELECTION OF OPTIMAL ALTERNATIVE

Table 5.12 summarizes the cost and benefit scores resulting from the additive weighting and ranking technique used to evaluate each alternative by cost and benefit criteria. The cost-to-benefit to ratio provides a relative measure of optimality between the alternatives. Comparison of the cost-to-benefit ratios reveals that alternative one provides the greatest benefit at the lowest cost, followed by alternatives four, two and three.

Alternative	1	2	3	4
Cost Scores	2.8	2.2	2.5	2.5
Benefit Scores	3.55	2.05	2.0	2.4
Cost/Benefit Ratio	.78	1.07	1.25	1.04

Table 5.12. Cost and Benefit Score Summary.

G. CHAPTER SUMMARY

This chapter evaluated the relative costs and benefits of each alternative solution using an additive weighting and ranking technique to identify an optimal solution. Alternative one, creating an engineer reconnaissance section at 1st CEB, provided the greatest benefit at the least cost across the evaluation criteria. The cross training alternative provided the next most favorable outcome, followed by creating an engineer reconnaissance platoon at the Division Reconnaissance Company (alternative two) and the Raider engineer platoon (alternative three). Chapter VI presents some conclusions and recommendations for implementation and further study.

VI. CONCLUSIONS, LIMITATIONS, AND RECOMMENDATIONS

A. CONCLUSIONS

The purpose of this thesis was to identify possible means of improving the engineer reconnaissance capability of 1st Marine Division. Based on the alternative solutions developed and method of analysis, this study concluded that developing an engineer reconnaissance section at 1st CEB provides the division with the greatest engineer reconnaissance benefit at the lowest cost. This alternative is largely in keeping with current doctrine that assigns the engineer reconnaissance mission to 1st CEB and attaches "reconnaissance engineers" to reconnaissance teams from other organizations for specific missions. It does entail significant enhancements to this doctrinal concept, however, specifically with the formation of a formal reconnaissance section at 1st CEB and the additional training and coordination requirements necessary to ensure employability across the battlefield and in all operational environments.

Historic precedent and anticipated future mission requirements suggest a valid need for the division to have this capability. The current focus on tactical mobility and operational maneuver supports the requirement to maintain a rapidly employable engineer reconnaissance capability that can provide maneuver commanders with information necessary to make sound mobility and countermobility decisions. The environments in which 1st Marine Division will likely fight vary from the open desert plains of SWA to the rugged mountains of the Korean Peninsula, each of which poses unique mobility concerns and opportunities for potential foes to limit our movement. This capability will enhance the division's ability to retain the mobility initiative, avoid

enemy surfaces and strike at gaps in offensive operations. When forced to assume a defensive posture, this capability assists maneuver commanders with siting obstacles designed to shape enemy actions on the battlefield and determining his offensive engineering capability.

Some may view engineer reconnaissance teams as discussed in this thesis as an effort to encroach upon traditional reconnaissance unit missions. As Brabham (1981) states, however, this is not the intent; "...it should be emphasized that the engineer reconnaissance team does not duplicate or usurp the mission or functions of the division reconnaissance battalion. Rather, its role is to augment those elements of vital combat intelligence information available to the maneuver commander." In this sense, engineer reconnaissance is a *force multiplier* for the division that enhances its ability to operate in all environments. A small investment in time and resources provides the division with a significant return in its collection abilities.

B. LIMITATIONS

While this study reached this conclusion through careful analysis of available information, the following factors and considerations may limit its applicability:

1. Although significant efforts were made to include the views and opinions of infantry officers serving with or having knowledge of reconnaissance organizations, this study was prepared from a combat engineer officer's perspective. Accordingly, it may contain biases with respect to the importance of engineer reconnaissance and how it should be conducted that are not shared by others.

2. The alternative solutions developed are representative of general organizational and training solutions. Specifically, others reviewing this research may recommend different personnel, training, and coordination requirements based on their perspective of mission requirements and the organizational needs of 1st Marine Division.
3. This thesis did not investigate specific table of equipment requirements and costs associated with each alternative. These would range from substantial for the Raider battalion alternative to minimal for the cross training alternative. While these would obviously have a large impact on alternative selection, they were beyond the scope of this thesis's treatment of the organizational design problem.
4. While the division's current formal reconnaissance function is decentralized among four primary organizations, the ongoing efforts to restructure the reconnaissance community may result in centralizing all reconnaissance functions in one organization within the division. Whether by design or through omission, current literature on this does not address inclusion of engineer reconnaissance with centralization of other reconnaissance functions. Further consideration of the relationship between engineer and other forms of reconnaissance conducted by the division may impact the applicability of this study.

C. RECOMMENDATIONS

1. Recommendations for Further Action

In addition to implementing the engineer reconnaissance section alternative, the following actions are recommended:

1. Convene a panel of combat engineer and infantry specialists (officer and enlisted) with expertise or interest in reconnaissance operations to review the relationship and required linkages between engineer reconnaissance and other types of reconnaissance conducted within the division.
2. Allocate quotas for the Basic Reconnaissance Course and other formal reconnaissance-related schools to 1st CEB to improve the ability of combat engineers to integrate with reconnaissance organizations when required.
3. Once this capability is established, incorporate engineer reconnaissance "play" into unit training and major exercises to realistically exercise this capability and prove its value to maneuver commanders.

2. Recommendations for Further Study

The following areas are recommended for further study:

1. Exploring the role of engineer reconnaissance in the very shallow water environment, particularly with respect to fixed and explosive obstacles associated with anti-landing defenses.
2. Study the requirement for and current effectiveness of engineer reconnaissance in FSSG and ACE engineer units, and what benefits (if any) cross training with division engineer reconnaissance teams may yield.

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