A STUDY OF THE NAVAL CONSTRUCTION FORCE PROJECT MATERIAL SUPPLY CHAIN

by

Steven J. Stasick, P. E.

Bachelor of Civil Engineering
Cleveland State University, 1995

Submitted to the Department of Civil and Environmental Engineering
In partial fulfillment of the requirements for the degree of:

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ABSTRACT

The Naval Construction Force (NCF) performs construction projects in all areas of the world during both peacetime and war. While some of these projects occur in populated areas where project materials are readily available, many of these projects occur in remote areas or war zones, where project materials must be procured from the United States or elsewhere and shipped to the unit performing the construction. The construction scopes also vary from projects as small as concrete sidewalks to projects as large as full utility system installations, or complete facility and base construction. As a result of the diverse locations and project types that the Naval Construction Force experiences, the logistics of providing project material and construction equipment to multiple global locations is a major challenge. The Naval Construction Force still experiences delays and inefficiencies in supplying construction materials to its various projects and units deployed throughout the world, which in turn reduces the overall productivity of the deployed Construction Battalions.

This research explores the current supply chain that the NCF has in place for obtaining construction project materials. It also explores the latest initiatives in information technology and construction supply chain management that are being applied in the commercial sector. The two systems are compared to determine what private practices and technologies can be applied to the Navy system to make it more efficient. Since the Navy is restricted by Federal Acquisition Regulations, and has unique funding streams authorized by Congress, it will not have the ability to fully operate as a private construction company, and these restrictions are addressed. The issue of outsourcing and privatization is also studied, and the feasibility of outsourcing the entire construction material process is considered.

Thesis Supervisor: Fred Moavenzadeh
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I would like to thank Arlin for hanging in there, supporting, and believing in me when I was at my worst. Mahal na mahal kita maganda!!

BIOGRAPHICAL NOTE

Steven J. Stasick is currently a Lieutenant in the United States Navy Civil Engineer Corps. He graduated from Cleveland State University with a Bachelor of Civil Engineering Degree in June 1995, and also holds an Associate of Science Degree in Construction Technology. He entered the Navy through the Civil Engineer Corps Collegiate Program and was commissioned through Officer Candidate School, Pensacola, Florida in November 1995.

Lieutenant Stasick was first assigned to the Navy Public Works Center in Pensacola, Florida as an Activity Civil Engineer from April 1996 to June 1998. He was responsible for completion of construction projects totaling over eight million dollars per year in a seven state region. His next assignment was with NMCB FORTY from June 1998 to June 2000. During his tour, he served as Assistant Operations Officer, Bravo Company Commander, CBR Officer, Delta Company Commander, and Detail Lemoore OIC. His next assignment was to the THIRTY-FIRST Naval Construction Regiment in Port Hueneme, California from June 2000 to June 2002. At the Regiment, he served as Operations Officer and Mobilization Officer. During that tour, he was responsible for mobilizing over 300 reserve Seabees in support of OPERATION ENDURING FREEDOM. He reported to Engineering Field Activity, Mediterranean in June of 2002, as the Resident Officer in Charge of Construction for Naval Support Activity, Bahrain, where he oversaw 12 million dollars of construction work in place that was in direct support of OPERATION IRAQI FREEDOM. He was chosen as Engineering Field Activity Mediterranean 2003 Military Engineer of the Year.

Lieutenant Stasick is a Seabee Combat Warfare Officer. His decorations include the Navy Commendation Medal with two gold stars, Navy Achievement Medal with two gold stars, Navy Unit Commendation, Armed Forces Expeditionary Medal, National Defense Service Medal, Overseas Deployment Ribbon with one bronze star, Navy Expert Rifleman Medal, and Navy Pistol Marksman.

Steven Stasick is a registered Professional Engineer in the State of Ohio. He is a member of the American Society of Civil Engineers, the Society of American Military Engineers, and is an alumnist of Tau Beta Pi National Engineering Honor Fraternity.

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

CHAPTER 1: INTRODUCTION

"If we knew what it was we were doing, it would not be called research, would it?"
-Albert Einstein

1.1 BRIEF HISTORY OF THE NAVY SEABEES AND CIVIL ENGINEER CORPS

A brief historical background is provided on the Seabees and Civil Engineer Corps to provide the reader with an understanding of the historical significance and need for these important units in the United States Navy.

1.1.1 History of the Seabees

Prior to World War II, the United States Navy used civilian labor to perform their construction in war zones, and this was considered acceptable practice. However, prior to the entry of the United States into World War II, international law changed. The law made it illegal for any civilian workforce to resist enemy attacks. If the civilians resisted enemy attacks, they could be tried as guerrillas in the international courts with a punishment of execution.

As a result of the new international requirements, Rear Admiral Ben Moreell, Chief of the Navy's Bureau of Yards and Docks, requested that the Secretary of the Navy allow him to setup a military construction force in December of 1941. He envisioned this new force to be comprised of active duty military personnel who were capable of performing large-scale construction as well as being trained in weaponry and capable of defending themselves. In January of 1942, he was given the approval to begin recruiting men from the construction trades for his new construction force. This was the birth of the Navy **C**onstruction **B**attalions, more commonly referred to as the Navy Seabees.

During that initial period, the recruits were older men who had worked on some of the largest projects in the country during peacetime, such as the Hoover Dam and the nation's highway system. Although the ability to fight was important, these early recruits were chosen more for their construction skill than for their physical condition and military experience because of the large-scale projects that were required during World War II. As a result, the average age of a Seabee was 37, with the legal age ranging from 18 to 50[1]. During World War II, over 325,000 men served in the Seabees and were responsible for construction

of airstrips, hospitals, roads, bridges, and other major facilities on six continents and hundreds of islands[2].

The Seabees have been a part of every major conflict since World War II, and have repeatedly demonstrated their ability to construct camps, aircraft aprons, runways, bridges, and virtually anything else that they may be called upon to construct during wartime. In peacetime, the Seabees maintain their construction skills and war readiness by deploying overseas and performing construction on United States Navy and Marine Corps bases around the world. The Seabees are also known as "The Navy's Goodwill Ambassadors" because of their ability to deploy on short notice and provide construction and relief support to parts of the world that become devastated by natural catastrophes[3]. For more than 60 years, the Seabees have lived up to their motto of Construimus Batuimus, which translates to "We Build, We Fight."

1.1.2 History and Overview of the Navy Civil Engineer Corps

In the early years of the United States Navy, civilian engineers were appointed to perform the planning, construction, and maintenance for all naval bases. In 1842, the Navy created the Bureau of Yards and Docks, which became the organization responsible for construction and maintenance of all naval facilities. At first, only civilian engineers were assigned to oversee it. However, on March 2, 1867, Congress passed an act authorizing that Navy civil engineer positions could be held by commissioned naval officers[4]. These officers would be commissioned by the President of the United States, with the consent of the Senate. This was similar to the other commissioned officers in the Department of Defense, except that the civil engineer officers were not considered line officers, and therefore could not be give positions for commanding troops. This congressional act marked the birth of the Navy Civil Engineer Corps.

When Admiral Ben Moreell created the Seabees in 1942, they were units of enlisted personnel, and the Navy required them to be overseen by officers. Since the Civil Engineer Corps were not line officers, the Navy faced a dilemma over who would lead the Seabees. Admiral Moreell maintained his persistence, and was able to convince Navy leadership that the Civil Engineer Corps was the best choice, and in March of 1942, the Secretary of the Navy authorized the Civil Engineer Corps to command the Seabee units.

Today, the Bureau of Yards and Docks has been replaced by Naval Facilities Engineering Command (NAVFAC), which consists of both military and civilian engineers working side by side. The Navy Civil Engineer Corps is comprised of approximately 1100 active duty officer personnel responsible for managing the Seabees as well as managing public works, and overseeing construction contracts on Navy and Marine Corps bases all around the world.

1.2 FOCUS AREAS

This paper will focus on logistics and supply chain management concepts, and will research how the civilian construction industry is currently applying these concepts to improve efficiency and competitiveness. The paper will also research the information technology initiatives that have been developed, and are currently being developed to improve supply chain management in construction. Focused Logistics is a new paradigm that could lead to a transformation of logistics in the Department of Defense. Therefore, the concept will be thoroughly reviewed and its impacts on the Naval Construction Force project material will be analyzed. This paper will perform a detailed analysis on the current process for Naval Construction Force project material logistics, and will provide recommendations for improved efficiency in that process. Leveraging of civilian information technology and supply chain management techniques will be considered, and the issue of outsourcing or privatizing the construction material process will also be considered.

The Construction Best Practice Programme is an organization in the United Kingdom that is dedicated to making the construction industry more efficient. They have developed a five-step cycle that can be used by any company, large or small, to identify current processes and implement efficiencies. This paper will focus on the first two steps in the process, which are to diagnose and plan. Diagnose means to breakdown and analyze your current system to understand how the process is currently being done, and why it is being done the way it is. The second step is to plan what can be done to improve the inefficiencies that were found in the diagnosis stage. Figure 1-1 provides an illustration of the five-step cycle developed by the Construction Best Practice Programme[5]. The remaining three steps deal with implementation of the recommendations. After the changes are implemented, a system of measure should be put in place to see if the changes are in fact improving efficiency. From

these measurements, the system can be reviewed for further changes, and the cycle begins again.

Depending on the scope of recommendations provided in this paper, the implementation steps can take many years for the Navy to accomplish, because of the processes and restrictions that a government agency is subject to. Therefore, this paper will focus on a complete analysis of the current system, as well as recommendations for leveraging information technology and construction supply chain initiatives. This will provide the Naval Construction Force leadership with the information they need to determine the future of the Naval Construction Force project material logistics and execute the "do" phase of the cycle.

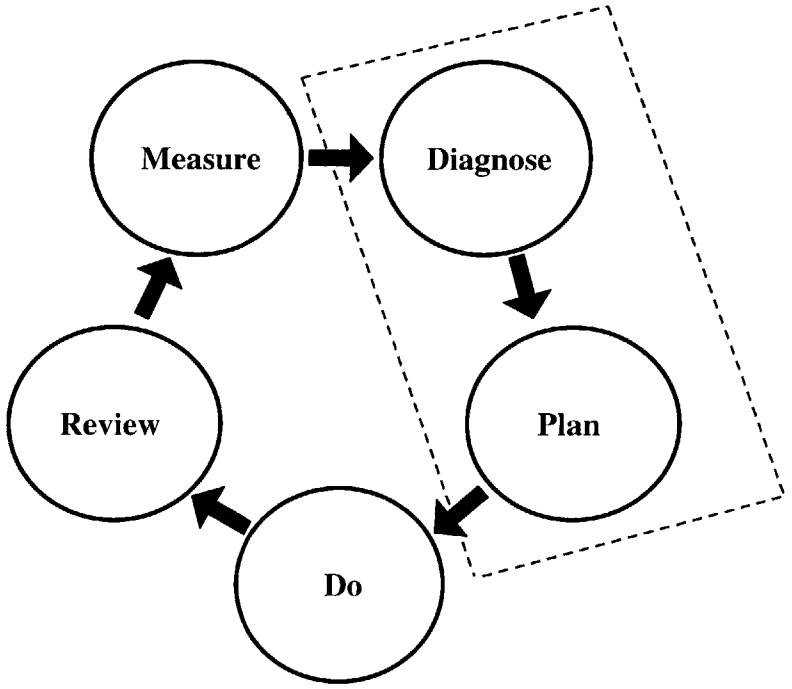


FIGURE 1-1: FIVE-STEP CYCLE FOR CONSTRUCTION BEST PRACTICE[5]

1.3 HYPOTHESIS

Over the years, the Naval Construction Force has traditionally experienced many challenges and difficulties with its ability to provide construction materials to its deployed units around the world in a timely and efficient manner. These challenges have consistently been present for construction projects during peacetime, humanitarian operations, as well as

wartime. The source for some of the difficulties is caused by the contracting restrictions that a government entity must follow, which reduces the flexibility of that the Naval Construction Force in the procurement of its construction material. However, there are many problems that are caused by communication and process inefficiencies. These problems are not restricted by contracting laws, and can be changed to improve the efficiency of the process. The hypothesis of this research is:

By researching current construction industry supply chain initiatives and providing a detailed analysis of the current Naval Construction Force construction material system, inefficiencies in the current system will be identified that can be improved upon. By leveraging the latest concepts, practices, and information technology that is being used in the civilian construction industry, the Naval Construction Force project material supply chain can operate more efficiently thereby reducing the cost and time that is currently required to provide construction material to Seabees in the field.

1.4 RESEARCH APPROACH

A thorough review of literature and case studies were used to identify and examine the current supply chain and logistics initiatives that are being applied in the civilian construction industry. Commercial information technologies were also reviewed and software solutions in the area of construction supply chain management were analyzed for their effectiveness and potential in providing efficiencies to the Naval Construction Force project supply chain.

Department of Defense instructions, publications, and joint doctrine in the area of supply and logistics were reviewed for identifying future initiatives in the DOD, and the impacts that they would have on the Naval Construction Force. The Department of Defense documents combined with a detailed review of Construction Battalion lessons learned and interviews with personnel involved in various steps of the Naval Construction Force supply chain were used to develop the detailed analysis of the current construction material process as well as the development of recommendations provided in this paper.

1.5 THESIS OVERVIEW

This paper will begin with an overview of Department of Defense initiatives as well as civilian construction industry initiatives. It will then perform a detailed analysis of the current Naval Construction Force project material process and offer recommendations for improvement based on the research performed in the initial chapters. The format of the paper is as follows:

Chapter 2: Introduction and overview of the Naval Construction Force, military logistics and future Department of Defense initiatives in logistics. This chapter provides the necessary background information for understanding the Naval Construction Force supply chain analysis that will follow.

Chapter 3: Introduction and overview of supply chain management concepts, and how they are being applied to the construction industry. This chapter will also cover the challenges that are being experienced with the implementation of supply chain management in the construction industry.

Chapter 4: Provide a study of specific bold initiatives that are currently underway in the civilian construction industry. This includes two companies that have centered their business plans around supply chain management concepts and have taken completely different approaches. A study of the latest information technology initiatives, which focus on project collaboration are also reviewed.

Chapter 5: Provides a detailed analysis of the current Naval Construction Force project material process by using the techniques identified in chapter 3. These include mapping the entire construction supply chain as well as performing a value chain and value system analysis of the key players in the value chain.

Chapter 6: Utilizes the analysis provided in Chapter 5, combined with the information identified in chapters 2 through 4 to offer recommendations for improved efficiency in the supply chain. These recommendations will include the possibility of leveraging information technology and civilian initiatives to improve the supply chain, and will also include the possibility of outsourcing and privatization.

Chapter 7: Provides conclusions and offers recommended future areas of research.

CHAPTER 2: BACKGROUND INFORMATION ON NAVAL CONSTRUCTION FORCE AND DoD LOGISTICS INITIATIVES

"The only problem with Seabees is I don't have enough of them."
-Gen. Douglas MacArthur
General of the Army
World War II

2.1 CHAPTER INTRODUCTION

The purpose of this chapter is to introduce the reader to background information on various Department of Defense topics that will be necessary for understanding the analysis that will be performed in Chapters 5 and 6. This chapter will focus on the overall organization and various units of the Naval Construction Force. It will cover the basic deployment cycles and construction projects that Seabees perform as well as the level of training and reasons why construction material is a challenge in the current Department of Defense system.

The chapter will provide an overview of the material classifications utilized by the Department of Defense and explain how Seabee material and equipment fit into these classifications. Finally, the chapter will conclude with an overview of the key future logistics initiatives that the Department of Defense is focusing on, to ensure that all analysis and recommendations provided in this paper will be consistent with future Department of Defense policies.

2.2 OVERVIEW OF THE NAVAL CONSTRUCTION FORCE

During their early years in World War II, the Seabees were organized as one Brigade with numerous Battalions working under it. Over the years, the Seabees have evolved by adding many specialty units, expanding their mission capabilities, and developing a force structure that is much different than what they originally started with. They are now officially known as the Naval Construction Force (NCF), although Seabees is the term that is still most commonly used to describe these units. Figure 2-1 illustrates the current organizational chart for the Naval Construction Force.

The topics covered in this paper will make reference to various Naval Construction Force units because the current construction project material supply chain is interconnected, with many of the units owning a major, specific responsibility in the chain. Therefore, a brief overview of the organizational chart, and an explanation of the missions for the key units is necessary for a thorough understanding of the construction material process. Note that the complete Seabee construction project material supply chain will be described and mapped in detail in Chapter 5.

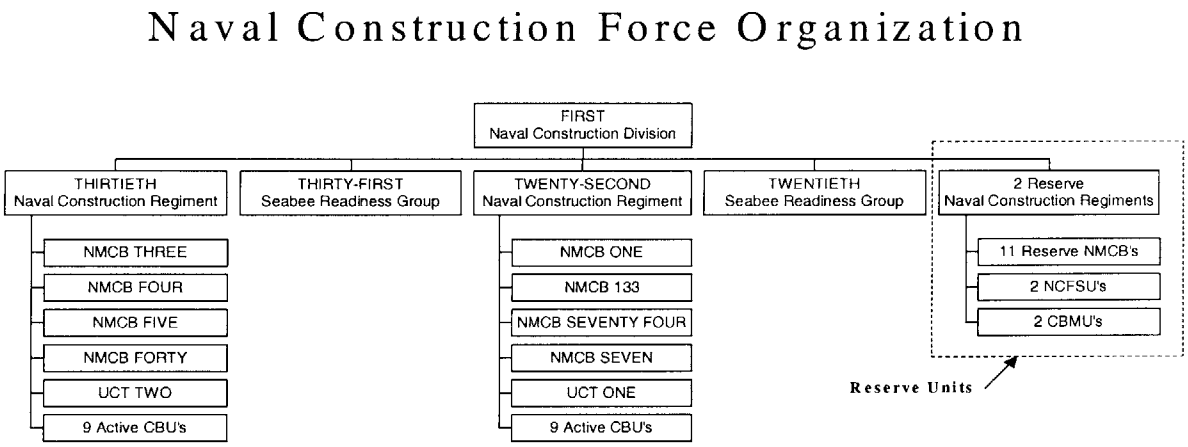


FIGURE 2-1: NAVAL CONSTRUCTION FORCE ORGANIZATION

2.2.1 FIRST Naval Construction Division

The FIRST Naval Construction Division is the head organization and is responsible for development of the overall policy and oversight for the Naval Construction Force. This organization is located in Norfolk Virginia.

2.2.2 Naval Construction Regiments

The active duty and reserve Naval Construction Regiments (NCR's) fall under the Division. These Regiments can deploy rapidly with their full table of allowance, within 10 days of notice, and are responsible for providing command and control to their subordinate

units. They will not deploy unless two or more subordinate units are sent to the same theater of operation in a contingency or war. The Regiments are responsible for handling the administrative issues, construction project tasking and management, and logistical support of their subordinate units. The Regiments are also responsible for planning the movements of Seabee personnel and equipment[6]. There are currently two active duty Regiments with the 30th Naval Construction Regiment being located in Pearl Harbor Hawaii, and the 22nd Naval Construction Regiment located in Gulfport, Mississippi. Figure 2-2 provides a map showing the geographical location of these units.

Recently, the Naval Construction Force has undergone a reorganization, and the two active duty Regiments are now responsible for the procurement and logistics of Seabee construction project material. Construction project material was handled by the Seabee Readiness Groups, in the past. The same personnel are performing the work in the same geographical locations as in the past, however the organization that they fall under has changed. This is mentioned for clarification because the key personnel responsible for construction material logistics for the 30th NCR are not at the same geographical location as their parent command and both play key roles in the Seabee construction material supply chain.

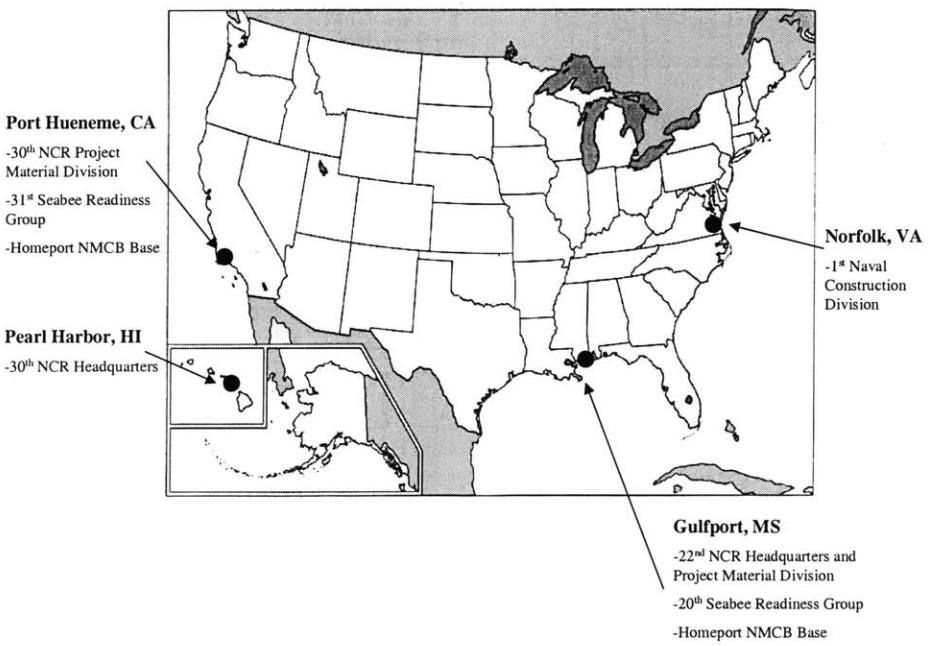


FIGURE 2-2: GEOGRAPHICAL LOCATIONS OF KEY NCF UNITS

2.2.3 Naval Mobile Construction Battalions

The Naval Mobile Construction Battalions (NMCB's) are the most common and recognizable units of the Naval Construction Force, and will be referred to as Construction Battalions in this paper. The Construction Battalions are the units that can deploy rapidly, within 48 hours, and perform a majority of the construction for the Navy and Marines in both peace and wartime. They also maintain an armory of weapons and are trained to fight as well as perform construction in wartime. The Division and Regiments are more or less managers, while the Construction Battalions are the executors. These units consist of approximately 600 personnel in peacetime, and absorb a reserve augment, which makes them approximately 800 personnel strong in wartime. The Construction Battalion is a self sustaining unit that consists of all major construction trades, medical, dental, legal, messing, administrative, and supply personnel. Figure 2-3 provides the typical organizational chart for a Construction Battalion.

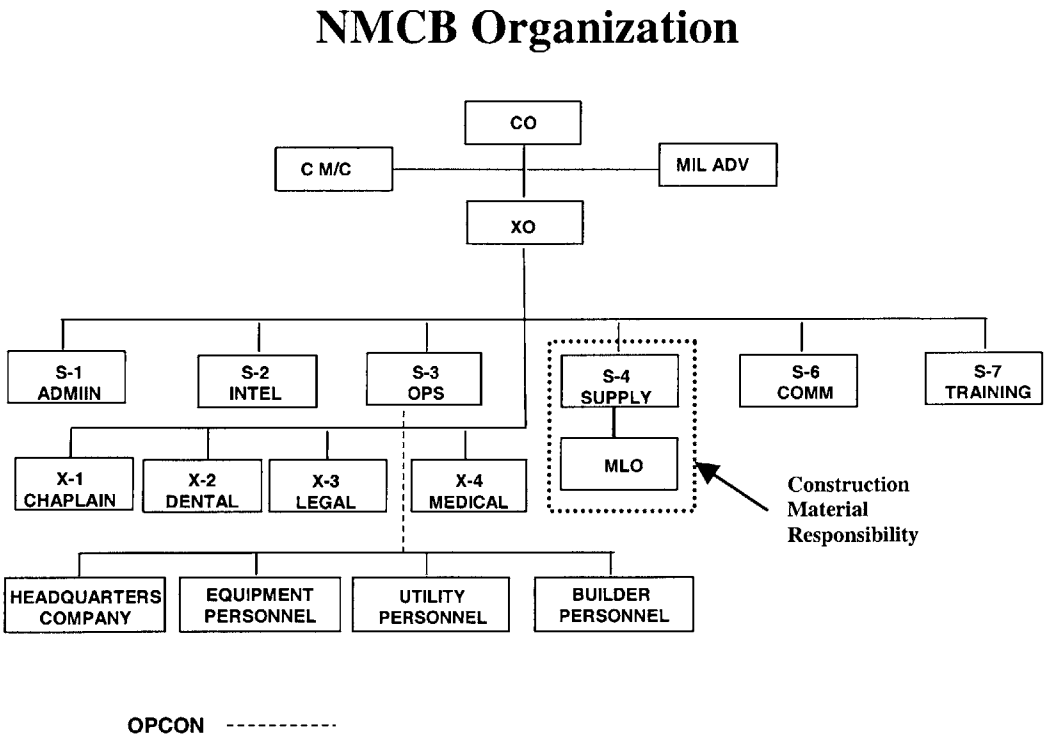


FIGURE 2-3: NAVAL MOBILE CONSTRUCTION BATTALION ORGANIZATION

Note that in the Supply Department there is an organization called Material Liaison Officer (MLO). This organization is responsible for working with the various construction tradesman and providing the construction material requirements for each project. After material requirements are defined, the MLO then coordinates with the Regiment Project Materials Divisions to arrange for ordering, shipping, and receipt of all construction material. On a typical deployment, a Construction Battalion usually has over twenty projects that occur simultaneously. Therefore, it is instrumental that the project material process be as smooth as possible.

2.2.4 Seabee Readiness Groups

The Seabee Readiness Groups (SRG's) are responsible for all homeport training that the Construction Battalions require. They also perform training for the other Naval Construction Force units subordinate to the Regiments. Until recently, the two Seabee Readiness Groups were responsible for the ordering and shipping of Seabee construction materials. These units were the focal point for Seabee project material, and were the organizations that coordinated with the Regiments and individual Construction Battalions on all project material issues. As stated previously, the personnel who performed the functions for Seabee project material now organizationally fall under the Regiments. However, the personnel still work out of the same geographical locations where the Seabee Readiness Groups are located. Figure 2-2 shows the geographic locations of the Regimental Project Material Divisions and Seabee Readiness Groups.

2.2.5 Other Units

The units described in sections 2.1.1 to 2.1.3 are the ones that have a key role to play in the Seabee construction material supply chain. The other units identified in the organizational chart provided as figure 2-1 are either reserve units that augment active duty Construction Battalions and therefore use the active duty Construction Battalions to handle their project material acquisition, or they are specialty units, such as the Construction Battalion Units (CBU's) and Underwater Construction Teams (UCT's) that have specific taskings and therefore, they have unique, unit specific material requirements that do not directly apply to the analysis in this paper.

The CBU's do not deploy in peacetime, and in wartime, they deploy specifically to build field hospitals. The field hospitals are prepared kits that have a majority of the materials necessary to construct them in the field, and therefore construction material support is not a major issue for the CBU's. However, in peacetime, the personnel in the CBU maintain their skills by performing construction projects on the base that they are stationed. This does result in a construction material requirement. Since the units are all located in the United States, the challenges that are identified in Chapters 5 and 6 are not as applicable to these units because they can leverage the Base Supply Department or local Prime Vendor contract for all of their material needs. The Underwater Construction Teams are small diving teams, and they also deploy for very specific tasking in which their tasking is very specialized, so they do not require or experience the same construction material challenges that the other units face.

2.3 SEABEE TRAINING AND EXPERIENCE

Another issue that is necessary to point out is the training and level of experience that current active duty Seabees have. After World War II, the rules for recruiting Seabees changed, and the Navy only obtains its Seabee personnel from Selective Service, in other words, through the traditional boot camp method. As a result, the average age has dropped considerably, and the personnel entering the Seabees do not have the level of construction expertise that the original Seabees had. Therefore, training programs had to be developed. The Navy has two Naval Construction Training Centers (NCTC's) that train young men and women the basics of being an electrician, plumber, carpenter, equipment operator, equipment mechanic, steelworker, or engineering technician. However, after learning the basics there is an important requirement for on the job training in order to fully understand the trade, similar to an apprentice or journeyman in the civilian construction trades. Therefore, it usually takes several years, for Seabee personnel to become proficient in understanding their trade. This training does have an impact on the construction material supply chain and will be covered in greater detail in Chapter 6.

2.4 CONSTRUCTION BATTALION PROJECTS AND DEPLOYMENTS

In the Naval Construction Force, the Construction Battalions perform deployments in both peacetime and wartime, whereas the Division and Regiments will only deploy during wartime. There are two homeport locations in the US, and each location is home to four active duty Construction Battalions. Gulfport, Mississippi, is the south-east base, and Port Hueneme, California is the west coast base; See Figure 2-2 for locations.

Each Construction Battalion is on a standard six-month deployment and ten-month homeport cycle during peacetime. In the event of a contingency or humanitarian crisis, the Construction Battalions that are currently deployed, will be the first to be relocated to provide support to the effort. If additional support is required, the homeported battalions will be deployed in the order of which one is closest to their scheduled deployment, as well as which one is most ready to go as far as meeting their training and personnel requirements.

In the standard peacetime deployment, there are three overseas deployment sites that a Construction Battalion deploys to. These deployment sites are Guam, Okinawa (Japan), and Rota (Spain). Appendix A provides a sample peacetime Seabee deployment schedule. Furthermore, there are usually at least ten detachments that break off from the main body and travel to other bases around the world to do construction during the deployment. The size of these detachments is determined by the scope of projects at each location. Also, the detachments are manned by the necessary construction trades required to successfully accomplish the work at the location. The detachments are usually headed and run by a Civil Engineer Corps officer.

To offer a comparison to the civilian community, a deployed Construction Battalion is similar to a large construction company with a head office in Guam, Japan, or Spain, and at least ten satellite offices spread out around the world. As a result, supporting all of these units with materials and equipment poses a challenge. The Naval Construction Force currently has a process in place for supporting Construction Battalions with their construction material, but the process has inefficiencies.

2.5 SEABEE CONSTRUCTION WORK IN PLACE

In order to provide the reader with an understanding of the magnitude of the construction material operation that will be discussed in this paper, the Seabee construction work in place is probably the best indicator of the amount of construction work performed per year by the Seabees.

The amount of construction work in place that was completed by the Naval Construction Force in Fiscal Year 2003 was found to be approximately $60.85M. Figure 2-4 provides a breakdown of the construction work in place for the Naval Construction Force[7]. While the work in place is slightly higher than other years due to the war, it provides an outstanding indicator of the type of year that should be taken into account for planning changes to the system, because it includes the typical overseas base construction as well as contingency operations in support of the war on terrorism. It should also be noted that the Construction Battalion Units accounted for approximately 15% of the total work in place, with the remainder representing work completed by the deployed Construction Battalions. Also, from historical work in place calculations by the Naval Construction Force, construction material, accounts for approximately 40% of the total work in place[8]. Therefore, the total construction material requirement by the Naval Construction Force was approximately $25M for Fiscal Year 2003.

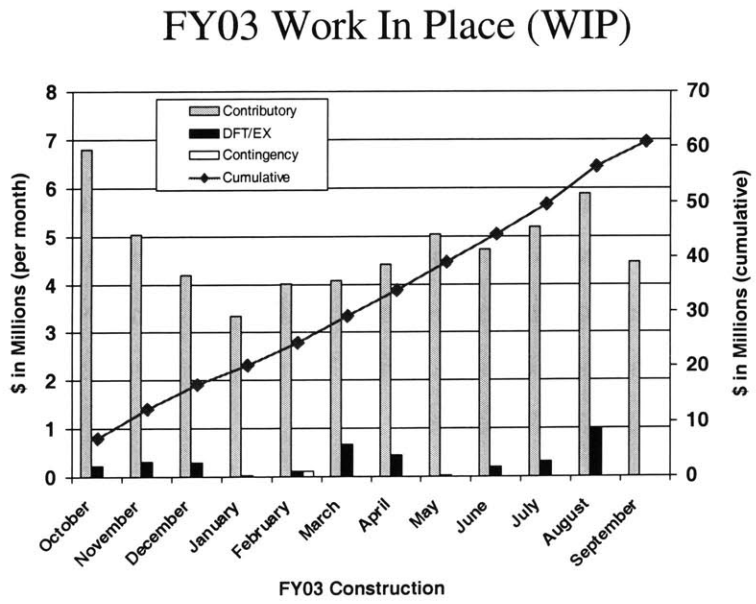


FIGURE 2-4: FISCAL YEAR 2003 SEABEE CONSTRUCTION WORK IN PLACE[7]

From Figure 2-4, it is apparent that a majority of the construction work was considered contributory support, which means that it was in direct support of base facility requirements. The second largest contributor of construction work in place was for contingency operations, which were in direct support of OPERATIONS IRAQI AND ENDURING FREEDOM. Figure 2-5 provides a breakdown of the types of work that Seabees completed in Fiscal Year 2003. Based on the information provided, the base support construction is by far the largest sector of work for the Naval Construction Force, and will therefore be a major focus of this paper.

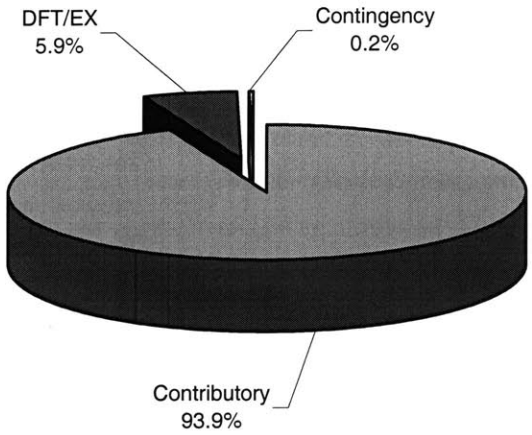


FIGURE 2-5: BREAKDOWN OF CONSTRUCTION TYPE FOR FY 2003

2.6 CLASSES OF MATERIEL

A brief overview of the DoD classes of supply is necessary because this paper will make periodic reference to the different classes. In US military logistics, there are two different supply class systems that are used regularly. The US class of supply is a ten-class system that allows Seabee table of allowance materiel to be divided into more specific classifications. The other method of materiel classification is the North Atlantic Treaty Organization (NATO) classification, which is a five-classification system, and is beneficial when dealing with multinational forces. A comparison breakdown of both classification

systems is provided as Table 2-1[9]. This section will provide a definition of the various classes of materiel and explain why Seabee construction material creates such a challenge.

NATO Class of Supply	Description	US Class of Supply	Description
I	Items which are consumed by personnel at an approximate uniform rate irrespective of local change in combat or terrain conditions.	I	Subsistence, to include potable water
		VI	Personal demand items (non-military sales items.
II	Supplies for which allowances are established by tables of organization and equipment. Examples: clothing, weapons, mechanics' tools, spare parts, and vehicles.	II	Clothing, individual equipment, tentage, tool sets and tool kits, hand tools, administrative and housekeeping supplies and equipment. Includes items of equipment, other than principal items, prescribed in authorization/allowance tables and items of supply (not including repair parts).
		VII	Major end items: A final combination of end products which is ready for its intended use; principle items such as launchers, tanks, mobile machine shops, and vehicles.
		VIII	Medical materiel including medical repair parts.
		IX	Repair parts and components to include kits, assemblies and subassemblies, and repairable and nonrepairable items required for maintenance support of all equipment.
III	Fuels and lubricants for all purposes, except for operating aircraft or for use in weapons such as flame throwers. Examples: petroleum products such as gasoline, kerosene, diesel oil, fuel oil, lubricating oil and greases, and solid fuels such as coal, coke, and wood. For Air Force (III A): aviation fuels and lubricants.	III	POL: Petroleum fuels: lubricants, hydraulic and insulating oils, preservatives, liquid and compressed gasses, chemical products, coolants, deicing and antifreeze compounds, together with component additives of such products and coal.
IV	**Supplies for which initial issue allowances are not prescribed by approved issue tables. Normally such suplies include fortification and construction materials, as well as additional quantities of items identical to those authorized for initial issue.**	**IV**	**Construction: Construction materials to include installed equipment and all fortification/barrier materials.**
		X	Material to support non-military programs if not included in Classes V to IX.
V	Ammunition, explosives, and chemical agents of all types.	V	Ammunition of all types (including chemical, radiological, and special weapons), bombs, explosives, land mines, fuzes, detonators, pyrotechnics, missiles, rockets, propellants

TABLE 2-1: CLASSES OF SUPPLY[9]

2.6.1 Construction Battalion Table of Allowance

Focusing on the United States supply classifications, when a Construction Battalion deploys, it requires materiel from all classifications except for class X. Each Construction Battalion has a Table of Allowance (TOA) that it deploys with, and this table of allowance contains all of the essential items that are required for the unit to perform its mission such as weapons, uniforms, tents, vehicles, construction tools and equipment. The items in the table of allowance are class II, VII, VIII, and IX. To provide the reader with an indication of the total size of the table of allowance that a Construction Battalion deploys with, it has 288 vehicles, which includes items such as HMMV's, construction equipment, and flatbed trucks. All other items are packaged in standard 20'x8'x8' shipping containers (CONEX Boxes), and there are a total of 181 containers in every Construction Battalion table of allowance[10].

Other than the items that have a short shelf life, like medical supplies, the table of allowances are packed and staged at various locations around the world, so that they can be easily accessed and sent to any location in the world on short notice. This is what allows the NMCB's to be able to deploy rapidly. When a Construction Battalion deploys, it also deploys with enough supplies to be fully self-sustaining until it can augment with supporting units in the area of operation. Table 2-2 provides a breakdown of duration that a Seabee unit can be self-sustaining.

Materiel Classification	Self Sustaining Duration
Class I (Subsistence)	5 days
Class III (POL)	3 days
Class V (Ammunition)	15 days

TABLE 2-2: SEABEE SELF SUSTAINING MATERIEL

With the supplies identified in Table 2-2, the unit is self-sustaining for at least 3 days, at which time it is dependant on the theater of operation for POL. Since Seabees rarely deploy alone, and there are usually other Marine Corps or Army units in need of the same supplies, The Class I, III, and V logistics are worked out jointly among the units, and resupply of these items is fairly smooth.

2.6.2 Construction Battalion Class IV Material:

Supply class IV items are defined as construction materials, and will be the main focus of this paper. Since wartime construction is usually not clearly defined, it is not practical to maintain stockpiles of construction materials all over the world, similar to the way Construction Battalion table of allowances are handled. Plus, as will be discussed in a later section, the Department of Defense is moving away from warehousing of materials and is focusing on real-time delivery. Even if it was decided to stockpile supplies, most construction supplies have a shelf life, and it would be extremely costly to the government to stockpile all necessary construction supplies, which could potentially be thrown away if not used.

Supply class I, III, and V materials for Seabees are very straightforward and have clearly defined quantities and specifications. Therefore, it is fairly easy to acquire these materials in time for wartime deployment. Unfortunately, with construction materials, many times the Construction Battalion doesn't even know what construction material will be required in the case of a contingency or war until the unit gets to the site, performs a site visit, and develops a material take off. Also, the Construction Battalion can join with other Department of Defense (DoD) logisticians in the area of operation to acquire Class I, III, and V supplies because they are required by everyone. However, construction materials are usually a unique item that only the Seabees require to accomplish their mission. Therefore, it is difficult to partner with other DOD units because, although they may help, when it comes down to it, in a war, there are usually more requirements, than personnel to process all of the requirements, therefore, other DOD units will put their requirements first, and project material for them will not be a priority.

In reviewing the lessons learned that were compiled for OPERATION ENDURING FREEDOM and OPERATION IRAQI FREEDOM, the issue of working through other logisticians for local procurement of construction materials was identified many times as an area of concern. Many of the Construction Battalions were dependant on the Marine Expeditionary Force for procurement of their class IV material. The Construction Battalions explained that the Marine Expeditionary Force viewed construction material as "just another class of supply," and even split responsibility for the class IV material between two separate staffs[11]. This caused great delays and confusion for the material liaison staffs of the

Construction Battalions that were trying to track and receive the construction material through the Marine logisticians.

Depending on the location of the war, the Seabees may be able to acquire materials in the local area. However, many times, the materials must be ordered from the United States and shipped to the war zone. The Seabees have an infrastructure and process in place to handle local as well as United States procurement issues, but it has many inefficiencies, and this will be covered in Chapters 5 and 6.

2.7 JOINT VISION 2020

In order to determine a viable, future solution for Seabee class IV material, it is necessary to research and understand the direction that Department of Defense (DOD) logistics initiatives are headed, so that all recommended process improvements in this paper will be consistent with, and will integrate with the future vision of the United States military's top leadership.

The Joint Chiefs of Staff recently published its *Joint Vision 2020*, in which they outlined their vision for the United States military for the next twenty years. The overall goal of the Joint Chiefs in this document is "the creation of a force that is dominant across the full spectrum of military operations-persuasive in peace, decisive in war, preeminent in any form of conflict"[12] In order to achieve "full spectrum dominance," the Joint Chiefs identify four key operational capabilities that must be developed through innovation and technology. Figure 2-6 provides a summary graphic of the four capabilities, and how they must be driven by innovation and information superiority[13].

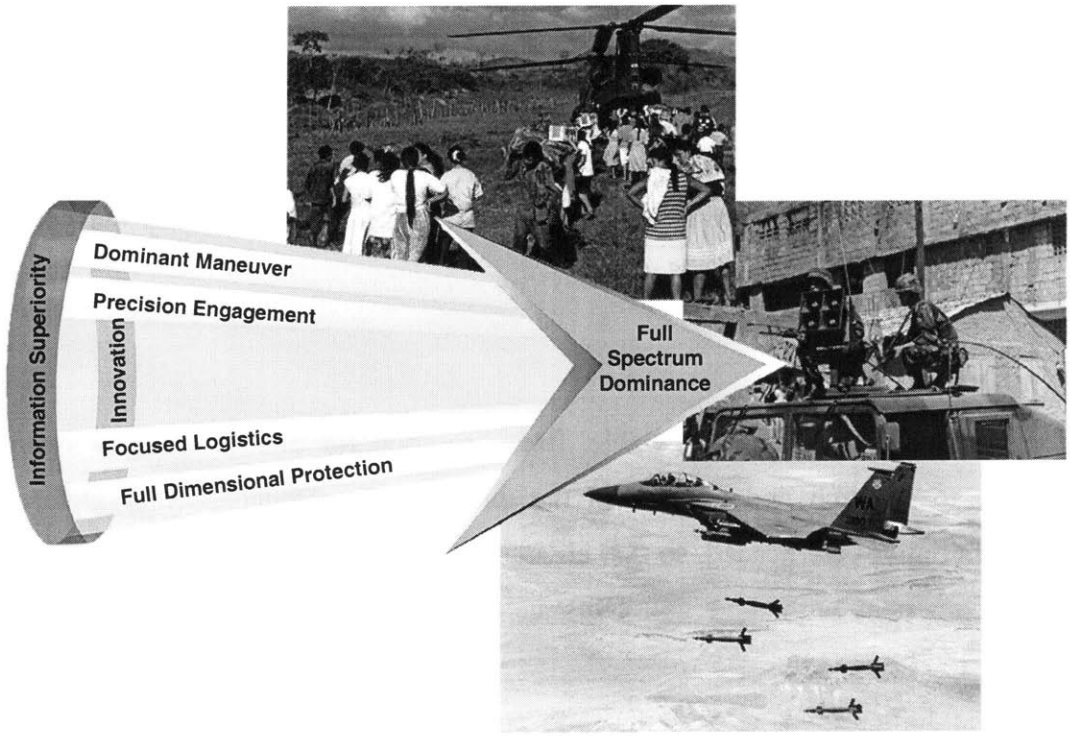


FIGURE 2-6: JOINT VISION 2020 OVERVIEW[13]

"Focused Logistics" is identified as one of the main capabilities and is defined by the Joint Chiefs as "the ability to provide the joint force with the right personnel, equipment, and supplies in the right place, at the right time, and in the right quantity across the full range of military operations."[14] The Joint Chiefs envision focused logistics being accomplished by the use of real-time, web based information systems that provide Total Asset Visibility to all members of the supply chain.

2.7.1 Focused Logistics

The concept of focused logistics was first introduced in the *Joint Vision 2010*, which was the predecessor to the *Joint Vision 2020.* In the *Joint Vision 2010* document, a detailed ten-year plan for Department of Defense logistics was laid out, and is referred to as the "Joint Logistics Roadmap." In *Joint Vision 2020*, the Joint Logistics Roadmap was addressed and endorsed as still being a viable plan for execution, and the way ahead for Department of

Defense logistics. Figure 2-7 provides a graphical overview of the focused logistics initiatives[15].

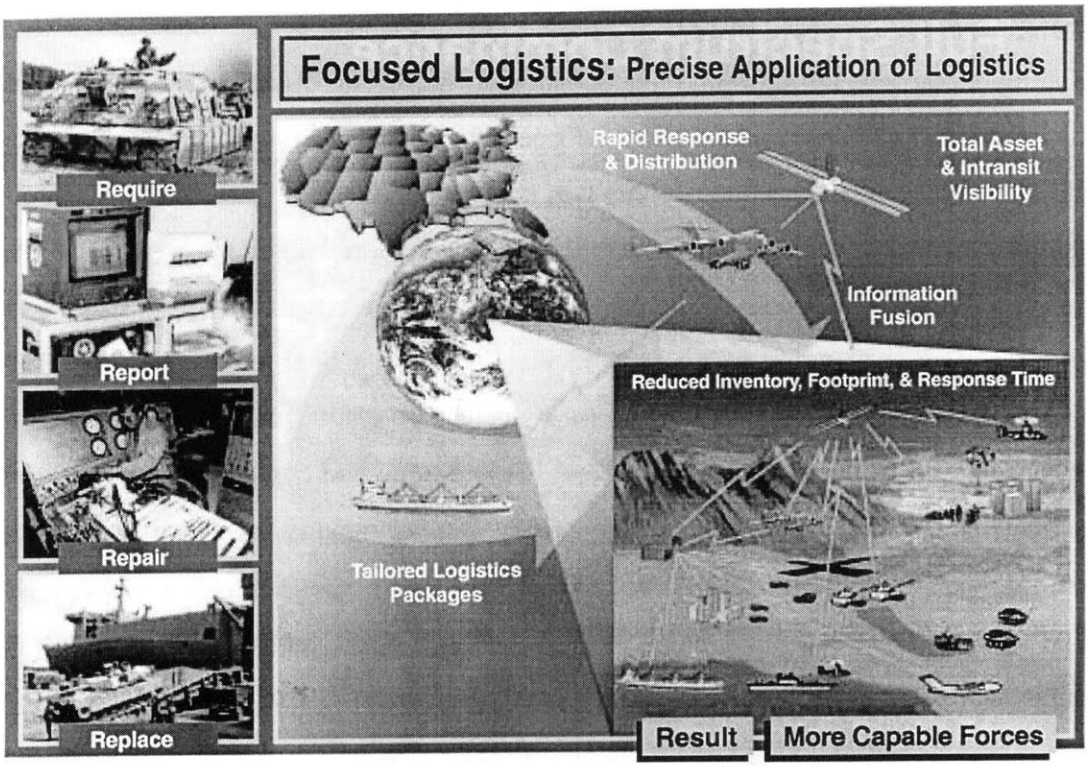


FIGURE 2-7: FOCUSED LOGISTICS OVERVIEW[15]

The Joint Logistics Roadmap is extremely detailed and lengthy, and many of the items in it pertain more to war fighting issues such as weapons systems and troop movements. However, there are four key items from the Joint Logistics Roadmap that will definitely have an affect on Seabee class IV material in the future. The first item is the concept of Joint Total Asset Visibility. The second item is the initiative by DOD to outsource or privatize logistics as much as possible. The third item is contingency contracting, and the final item is reduced inventory, "just in time" logistics. These items will definitely have an effect on Seabee class IV material. They will be defined with a short overview in this section, and covered in much greater detail in Chapter 6.

2.7.1.1 Joint Total Asset Visibility

The concept of Total Asset Visibility was first initiated by the United States Army after Operation Desert Storm, and is a direct result of the Army lessons learned after the war. During Operation Desert Storm, most materials were shipped in standard 8' x 8'x 20' shipping containers, but poor and inadequate record keeping caused chaos in the Middle East when thousands of containers had to be opened and re-inventoried because nobody in the field had a clear understanding of what was in each container[16]. This wasted valuable supply personnel mandays that should have been spent on more important tasks, and negatively impacted the responsiveness of the supply system on new orders. Another result of the poor logistical records was that many units in the field would double or triple-order the supply items that they needed as a safety factor, because they could not count on a single order arriving without getting lost in the system. This double and triple ordering in turn caused a snowball effect and extra burden on the supply system, making the system worse as the war went on.

Interestingly enough, Construction Battalion lessons learned identify these exact same problems with their Class IV material. Tracking of material that is purchased in the United States and shipped overseas creates many problems that will be identified in Chapters 5 and 6. One of the lessons learned from a Construction Battalion that was in OPERATION IRAQI FREEDOM was to over order and stockpile standard construction material, like nails and lumber, because the logistics system could not meet the requirements fast enough[17]. These issues will be discussed in Chapters 5 and 6 of the paper.

Upon completion of the war, the Army decided that an automated tracking system was necessary so that a supply manager, anywhere in the world, could log onto the world wide web and access a database that allowed the manager to find out where his/her piece of material was, similar to the systems that UPS and FEDEX have in place. This led to the Army launching the initial Total Asset Visibility initiative. In this initiative, the Army developed a system in which bar codes, radio frequency tags, and database technology were combined to create a system in which all items were scanned prior to loading in a container. Through the use of bar codes scanners, the container packers are able to create a complete inventory of everything in the container, which is also automatically entered into the database. A radio frequency tag is attached to every container so that the container can be

tracked and located at any point in its journey. The tracking system automatically updates the database when the container passes an identification point.

In Bosnia in 1999, the Army Total Asset Visibility system worked well and therefore, the Joint Chiefs have made Joint Total Asset Visibility part of their Joint Logistics Roadmap. The Joint Chief's vision is that the Total Asset Visibility technology and current infrastructure will be expanded so that all services will be able to use the same system, and therefore improve the efficiency of joint operations. The Global Combat Support System (GCSS) is currently under development, and this will be the information technology system that drives Joint Total Asset Visibility. Figure 2-8 provides a graphical illustration of the proposed Joint Total Asset Visibility Model[18].

The concept of Joint Operations is nothing new. It has been around since the days of Alexander the Great, and was used quite extensively in our Civil War and many other succeeding battles[19]. In the past, each Department of Defense branch of service had their own systems, policies, and procedures for accomplishing their missions, which caused some problems, but overall the missions were met. However, in recent years, the changes in battlefield techniques and increased dependence on technology by the various branches of the United States military has emphasized the importance of technological interoperability among the Department of Defense branches of service. In the future, most battles will be fought jointly, and logistics is a critical element of joint operations. Therefore, Joint Total Asset Visibility is an important initiative, and one that the Department of Defense is taking seriously. In an Office of the Inspector General audit in March 2002, the inspecting officer identified the following[20]:

- $43.5 million has been programmed for the development and sustainment phase of the Joint Total Asset Visibility Program through fiscal year 2005.
- The current Joint Total Asset Visibility Program system links 77 out of a total of 130 required data sources, and still requires 53 links.
- More funding will be required to complete the Global Combat Support System properly.

Upon receipt of the findings, the Deputy Under Secretary of Defense (Logistics and Materiel Readiness) concurred and agreed to obtain the additional funding required. This audit illustrates the commitment that the Department of Defense has to the program.

Since Seabees will be operating in a joint environment, it is important that they will be structured to be a part of the Joint Total Asset Visibility, especially for their Class II (table of allowance) items, because those items will be most critical for successful operations. However, the individual units must provide funding to make their infrastructure compatible with the Joint Total Asset Visibility, and therefore, the Naval Construction Force must budget funds for the required infrastructure.

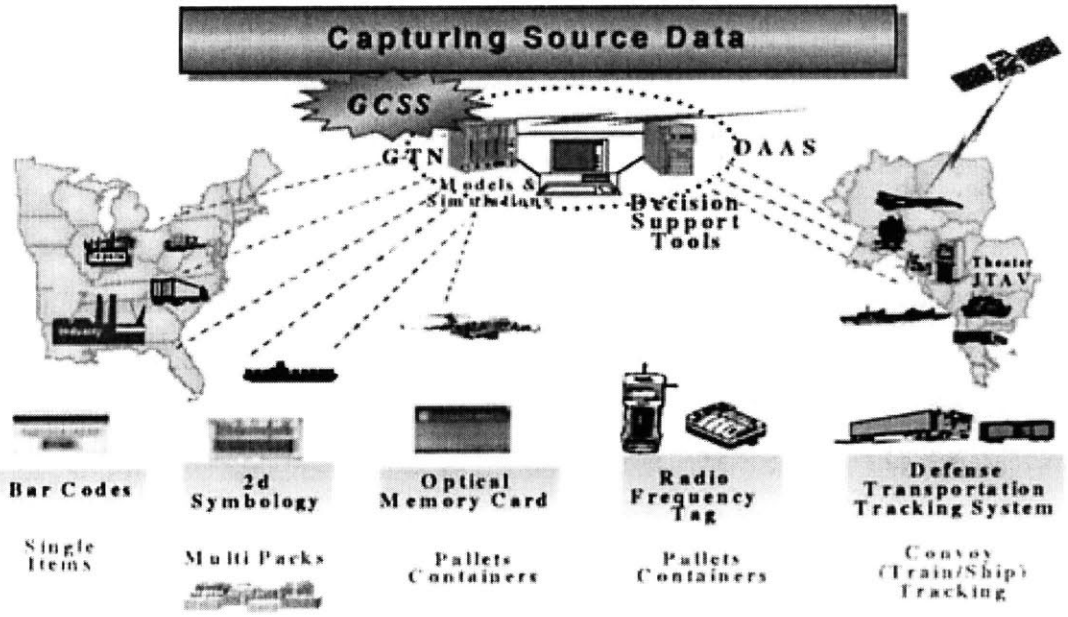


FIGURE 2-8: TOTAL JOINT ASSET VISIBILITY MODEL[18]

2.7.1.2 *Outsourcing and Privatization*

Outsourcing and privatization initiatives have consistently increased and grown in popularity in the Department of Defense over the past decade. In 1995, the Commission of Roles and Missions of the Armed Forces encouraged the Department of Defense to pursue outsourcing and privatization to generate savings that could be used for force modernization and improvement of mission readiness. Through various studies, the Commission of Roles and Missions identified that the government could save approximately 20% by outsourcing

activities that were currently performed by a government workforce[21]. Outsourcing is officially defined as "the transfer of a support function previously performed by a government activity to a private service provider[22]." Privatization is defined as "a type of outsourcing involving the transfer of government assets to the private sector as the government sheds the capability to perform the function[23]."

This push toward privatization and outsourcing is not implying that the government employees are lazy and that the government is incapable of functioning efficiently. The theory behind outsourcing and privatization is that if there is a civilian contractor who currently performs a service in the civilian sector, both the government and contractor can benefit by leveraging the infrastructure that the contractor already has in place. Take hotel management for example. There are civilian contractors that already have invested in development of automated computer system for reservations and checking in and out, and have a complete management infrastructure in place to perform this function. The government can realize a savings by hiring that contractor with his computer system, employee management, and infrastructure for less money than it would be for the government to create and maintain a computer system, and handle the human resources associated with managing its own employees. Hotel management is an area in which the Department of Defense has benefited from outsourcing, because most bases have barracks, which are run similar to the way that a hotel is run. Supply and logistics functions are also popular services for privatization and outsourcing, and many have already been privatized. The Naval Construction Force construction material process has not been privatized or outsourced, but it is an option. *Joint Vision 2020* encourages the continued push for privatization and outsourcing in the Department of Defense. While there are many benefits to privatization and outsourcing, there are also many challenges and pitfalls that must be considered. Therefore, the potential for outsourcing or privatizing Seabee class IV material logistics will be studied and discussed in detail later in this paper.

2.7.1.3 Contingency Contracting

Joint Vision 2020 also addresses contingency contracting, and emphasizes the fact that the trend of the future is that United States and coalition troops will deploy in joint operations in areas of the world without logistics support structures. Contingency

contracting is defined as "the art and practice of employing contractual tools and concepts for any broad range of logistics support[24]. *Joint Vision 2020* includes contingency, humanitarian, and peacekeeping operations under this topic. These are all operations and missions that the Seabees must be capable of performing. Therefore, the concepts covered under contingency contracting are also important to Seabee class IV logistics.

The vision for contingency contracting consists of three main options that a force commander can employ. The options are as follows[25]:

1. Use of active duty and reserve force personnel to accomplish all requirements in the area of operation.
2. Use host nation support for accomplishment of requirements
3. Use contracting support vehicles for supplies, such as government credit cards, Prime Vendor contracts, or Army Logistics Civil Augmentation Program (LOGCAP).

Depending on the size and location of the mission, the force commander can use one single option, or a combination of options to determine the best method for accomplishment of the mission. For the construction portion of a mission, options 1 and 3 apply to the Seabees, and these factors must be taken into consideration when determining the future plan for Seabee class IV material.

2.7.1.4 Reduced Inventory

The Department of Defense in its *Defense Reform Initiative* wants to replace the "just-in-case" mindset for logistics with the "just-in-time" mindset[26]. As stated previously, many units double or triple order in contingencies "just-in-case" an item gets lost in the process. This process applies to inventories as well, because many units maintain large inventories, "just-in-case." The Department of Defense has called for inventories to be reduced, because it was estimated that they had an inventory that totaled over $107 billion in 1989, and *Joint Vision 2020* has called for that figure to drop by approximately 60%[27]. Joint Vision 2020 calls for the Department of Defense to improve inventory management through technological advances, expanded use of commercial support, and improved management techniques.

Although the Seabees do not maintain an inventory of their class IV material, this topic was identified, because many of the initiatives that will come out of this topic will have an effect on Seabee class IV material. Privatization, outsourcing, and technological initiatives are all proposed initiatives for reducing inventory, and will be discussed in this paper. The topic of lean construction, a related concept that is gaining popularity in the civilian construction industry will be discussed in Chapter 3.

2.8 *NAVAL FACILITIES ENGINEERING COMMAND STRATEGIC PLAN*

The Naval Facilities Engineering Command (NAVFAC) has also developed a strategic plan for Fiscal Years 2003 to 2009 that is more specific to the Naval Construction Force, but in line with the initiatives identified in the *Joint Vision 2020.* As stated in the introduction, The Naval Construction Force is a part of NAVFAC, and therefore the *NAVFAC Strategic Plan* has a direct affect on the future vision of Seabee class IV material.

The NAVFAC plan calls for "a well trained and equipped Naval Construction Force with world class logistics systems" and "technology-leveraged advice and solutions that integrate all aspects of facilities/contingency engineering.[28]" The plan specifically calls for seeking out opportunities for efficiency through privatization and outsourcing, as well as developing partnerships and professional alliances with industry, government, and academia. The plan calls for personnel to seek out opportunities for innovation and efficiency in current business and financial systems, and to leverage and incorporate web-based enterprise systems. This paper will attempt to address these plan initiatives and incorporate them in all recommendations.

2.9 CHAPTER SUMMARY

This chapter provided an overview of the Department of Defense issues pertinent to understanding the discussions that will follow in this paper. The reader now has an understanding of the various units that comprise the Naval Construction Force as well as the Construction Battalion deployment process. The definitions of the various classifications of materials were defined. Understanding of these topics will be necessary when the Seabee construction material supply chain is mapped. The future vision of Department of Defense logistics was also presented and is important for ensuring that analysis performed in this paper is consistent with the future vision.

Now that the reader has the necessary background on the Department of Defense and Naval Construction Force, the next chapter will discuss some of the key initiatives that are occurring in the private sector construction industry. An understanding of these initiatives will be necessary for developing a plan for Seabee logistics to operate more like the commercial sector.

CHAPTER 3 SUPPLY CHAIN MANAGEMENT AND VALUE CHAINS IN CIVILIAN INDUSTRY PRACTICE

"Any customer can have a car painted any color that he wants so long as it is black. I cannot say that anyone agreed with me "

-Henry Ford
1922

3.1 CHAPTER OVERVIEW

This chapter will focus on supply chain management, which is a concept that has gained much popularity in the civilian sector as a valuable tool for improving efficiency in logistics and increased productivity. The chapter will present an overview of supply chain management, and how it has become an important management tool in many industries. This chapter will also review the value chain and value system concepts of Michael Porter because they are excellent analysis tools that can be used by a company to better understand its supply chain.

Although supply chain management has gained popularity in many industry sectors, it has not experienced the same level popularity and widespread application in the construction industry. This chapter will present some of the major challenges that the civilian sector construction industry is experiencing with applying supply chain management techniques. Despite the challenges, there are potential benefits that the construction industry can receive from the application of supply chain concepts. As a result, the industry is beginning to show signs that it is taking large steps to implement supply chain management techniques, and this chapter will discuss the general concepts that the industry is focusing on. The next chapter will provide examples of specific construction supply chain initiatives in the industry. The information and techniques described in this chapter will be applied to the Naval Construction Force construction supply chain analysis provided in Chapters 5 and 6.

3.2 SUPPLY CHAIN MANAGEMENT

Over the past two decades, supply chain management is a concept that has grown into a popular management tool in industries that rely on manufacturing, production, and distribution functions, such as food retailing and the automotive industry. The reason for its growth in popularity was that increased competition and globalization have caused companies to place a greater emphasis on the efficiency and responsiveness of their supply functions[29].

Prior to supply chain management, manufacturing companies focused their competitive strategy on providing a product and brand name that people would associate with quality. Very few leaders and top managers of companies were worried about the details of the logistics involved in how raw materials were purchased, received, and warehoused. As long as the production line was moving, and products were being made at a sufficient rate to meet demand, the details of managing supplies were important, but usually delegated to the logisticians in a company. Focus on the actual manufacturing of the product was important to the top management of a company, but the follow on logistics of warehousing the finished product and moving the manufactured product to its purchasers were again delegated to lower management and logisticians.

Prior to supply chain management, the traditional corporations maintained separate departments that were, for the most part, independent of one another. For example, companies would have departments for marketing, purchasing, manufacturing, and distribution. These departments usually had different objectives, which did not always mirror and complement one another. Also, each department placed focus on its portion of the business, and did not place emphasis on the overall company process. This mind set created efficient running departments within the company, but not necessarily the most efficient system for the company as a whole.

While the companies in this era were still concerned about cost, they were more concerned about finding a savings in the production of their merchandise, and not necessarily in the warehousing and the internal logistics associated with the production. The typical logistics manager of the 70's and early 80's was concerned with ensuring that production was sufficient to meet the demand, and it was common practice to accept the fact that hidden costs would creep into the logistics system, and that these hidden costs could be borne by the

company[30]. Therefore, waste and inefficiencies in the supply system were generally viewed and accepted as necessary costs for doing business, and for the most part, the markets allowed it because everyone did it.

However, the recent boom in the use of internet and computer technology has ushered in the new era of globalization. Globalization caused the entire playing field to change. With the birth of globalization came the growth of competition. Quality was now something that was assumed and expected by an increasingly demanding and knowledgeable customer. Therefore, making a quality, brand name product was no longer a guarantee for success, and those companies who wanted competitive advantage in the global economy had to find a new way to achieve it.

3.2.1 Globalization and Increased Competition

The growth of globalization and increased competition caused many changes in the manufacturing industry. Firms were now looking for a way to gain a competitive advantage in this new marketplace. Those companies who were able to apply technology, the internet, and effective management to their entire supply process, from raw material to delivery of the end product to the client, found the competitive advantage that they were looking for. This meant breaking down the cultural and organizational barriers that existed among the various, individual departments in the company, and getting everyone in the company to view the process as a system of interlinked organizations working together for a common purpose and the same goals.

The companies who were able to successfully map and efficiently manage their supply chains gained a competitive advantage over others in their industry. This led to an increase in the level of competition in their respective industries. The increased competition, in turn, caused more companies to place emphasis on their supply chains in order to stay competitive in their industry, which led to the widespread growth and popularity of supply chain management.

The growth of globalization also allowed companies to gain a competitive advantage in their supply chains, by using the same tools that their customers were using to increase competition on them. The Singer Sewing Machine Company is a good example of this process. In manufacturing its sewing machines, Singer buys its motors from Brazil, its

sewing machine shells from the United States, its drive shafts from Italy, and manufactures the machines in Taiwan[31]. It then sells the machines to the entire global community. Through effectively using the competitive global markets, Singer can produce a quality product at a lower cost. Singer is an example of a company that has used supply chain management and globalization to gain a competitive advantage in its industry.

Other companies have leveraged the latest in information technology to develop their supply chain competitive advantage. A good example of this is Wal-Mart. Wal-Mart was able to develop an efficient supply chain by developing automated links with its multitude of suppliers. Through the use of barcode technology, the supplies are automatically notified in real time when one of their items is sold at a Wal-Mart. The supplier then knows the remaining inventory at the store, and knows when to provide a resupply. This system created strategic relationships with suppliers, and allowed Wal-Mart to gain efficiencies, which it could, in turn, pass along to the customer in the form of lower prices. K-Mart, the main competitor of Wal-Mart, tried to match Wal-Mart in prices to remain competitive in the industry, but did not have the same efficiencies in their supply chain, and were forced to declare bankruptcy in 2002.

Throughout the evolution and growth of the supply chain management concept, there have been many definitions of what is included in a supply chain. The following definition by Ganeshan and Harrison provides a concise and inclusive explanation of a supply chain:

> "a network of facilities and distribution options that performs the functions of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of these finished products to customers. Supply chains exist in both service and manufacturing organizations, although the complexity of the chain may vary greatly from industry to industry and firm to firm.[32]"

Supply chain management has become a complex subject with many companies mapping and monitoring their complex supply chains that can span the globe. Figure 3-1 provides a simplified, generic illustration of the basic supply chain for the manufacturing industry[33]. This figure illustrates how the entire process from raw material to finished product is taken into consideration in supply chain management.

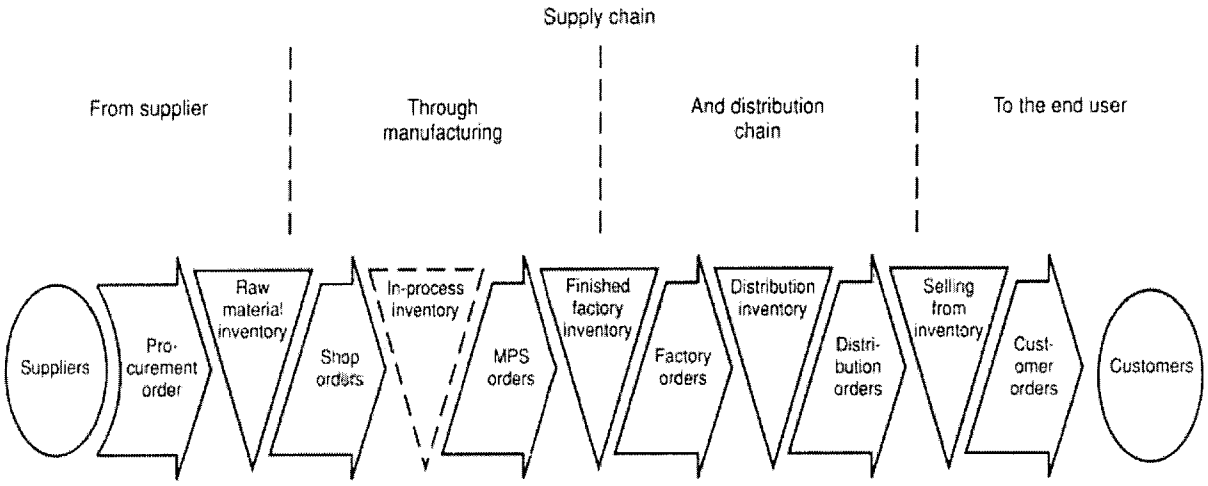


FIGURE 3-1: GENERIC MANUFACTURING SUPPLY CHAIN[33]

3.2.2 Logistics and Supply Chain Management

The terms "logistics" and "supply chain management" are used interchangeably by many people. However, there is a definite distinction between logistics and supply chain management, and this distinction was clarified by the Council of Logistics Management in 1998[34]. While logistics refers to the flow of supplies, supply chain management is the "integration of key business processes from end user through original product suppliers that provides products, service, and information that add value for customers and other stakeholders.[35]" In other words, a supply chain is the inter-relationship between all of the processes that are required to deliver a finished product to an end user. To take it one step further, logistics management is concerned with optimizing material flows within an organization whereas supply chain management recognizes the flexibility and responsiveness of marketplaces, and incorporates the entire process including all outsourcing and subcontracting that is also involved with the process[36].

3.3 CONSTRUCTION SUPPLY CHAINS

While supply chain management has grown in popularity for the manufacturing, production, and distribution industries, it has not experienced the same level of popularity in the construction industry[37]. There are many factors that contribute to why the construction industry has experienced less success than other industries in implementing supply chain management principles. The major factors prohibiting widespread implementation of construction supply chain management concepts is that the construction industry is a fragmented and highly competitive industry that produces a one-time, project specific commodity, and has no standard method for measuring the efficiency and success of its supply chains.

3.3.1 Fragmented Industry

One of the major hurdles to implementing supply chain management in construction is the fact that it is a fragmented industry, with many different players on each project. By applying the analysis techniques of renowned Harvard professor and author, Michael Porter, in his book *Competitive Strategy*, it is evident that the construction industry is a "fragmented industry[38]." In other words, there is no one company in the industry that has a significant market share, and can influence the industry outcome, similar to the way Wal-Mart has in the retail industry.

Because there are low entry barriers, minimal diversification, and such a high level of competition among companies, the industry is driven by low cost. As a result, each construction project usually consists of a different team of contractors, subcontractors, architects, engineers, and suppliers. This situation makes it difficult to form long-term relationships and develop strategic alliances, which are necessary to realize the advantages of supply chain management. Figure 3-2 provides an illustration of the application of Michael Porter's Five Forces Model to the construction industry. It shows that the construction industry is highly competitive, which results in low profitability for companies in the industry.

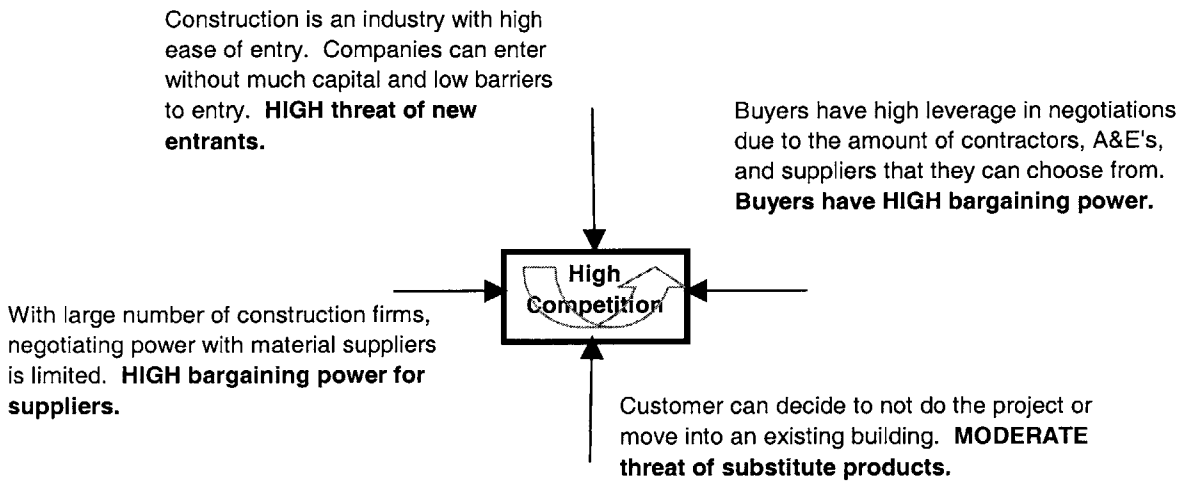


FIGURE 3-2: FIVE FORCES MODEL FOR CONSTRUCTION INDUSTRY

The high level of competition results in low profit margins for the organizations involved in the project, which in many cases, leads to mistrust and adversarial relationships among the players. There is more of a tendency for organizations in the supply chain of a construction project to look out for their own best interest and not the best interest of the project as a whole, especially when they know that they will be working with a different team on the next project. For example, in the traditional design-bid-build process, the architectural firm will usually get paid a flat fee to design a facility for a client. Therefore, the architectural firm is concerned with turning a profit on the project, and in most cases is not concerned with spending large amounts of time, effort, and money on meeting with contractors and suppliers to explore efficiencies in the design that a contractor can take advantage of later in the chain.

The mistrust and dynamically changing environment of the construction industry makes it difficult to achieve the same type of strategic alliances that have allowed firms in the manufacturing, production, and distribution industries to be so successful with supply chain management.

3.3.2 Project Specific Industry

Another major difference between the construction industry and the manufacturing industry is that in construction, the supply chain is working to create a single, unique product for a single end user who is driving the project. In the manufacturing industry, on the other hand, the supply chain is working to create mass production of the same product for multiple end users. Another way to look at it is that construction is a "make to order" industry whereas the manufacturing industry is a "make to stock" industry[39].

Construction is a customer driven industry, where in most cases, the customer is not experienced in the construction process and therefore relies on architects and consultants to assist in developing the unique product and to provide technical experience and support. Therefore, the customer does not have the expertise or knowledge to setup an efficient construction supply chain for his or her project in the early stages of planning. Many times the material suppliers and contractors who will be involved in the construction of the final product do not have any input in the design of the unique product. This is definitely the case in the traditional design-bid-build format. However, in the design-build format, and some of the other new delivery methods in construction, it is possible to bring the contractors and suppliers into the project early to benefit from their insight and expertise, which is developing into a method that the construction industry can use to benefit from supply chain management.

The construction process is also very dynamic and changes during the production phase. As a construction project is being built, the customer usually decides to make changes. Also unforeseen site conditions can force changes to the project that nobody expects or even wants. These changes are usually unpredictable and result in members of the supply chain scrambling to make rapid changes to the design and changing material orders. This unpredictable nature of construction creates inherent inefficiencies in the construction supply chain, which add to time and cost of the project.

The fact that each construction project is unique and goes through a dynamic design and construction process in which there are no assembly lines, or mass production techniques makes the construction industry much different than the manufacturing industry. This difference makes it extremely difficult for a construction supply chain to map and realize

efficiencies in the supply chain management process, like the manufacturing and production industries can.

3.3.3 Knowledge Base

Since the organizations in a construction supply chain change after each project, the knowledge that has been gained by the team throughout the construction process is not applied to future improvements because the members of the team view their effort as a one-time affair. In the manufacturing industry, on the other hand, the supply chain can be mapped and benchmarking or metrics can be applied to the various links in the supply chain for analysis. After sufficient data is gathered, the supply chain can then be adjusted to obtain more efficiency based on the knowledge gained by studying the trends of the current supply chain.

3.3.4 Differences Between Manufacturing and Construction Industry

The previous discussion provided the main reasons for why construction supply chains are different than the tradition manufacturing supply chains. There are many differences between the two industries, and many reasons for why the construction supply chain is unique. Table 3-1 provides a summary comparison of the two industries[40].

Manufacturing Industry	Construction Industry
Build to Stock is Predominant Method of Production	Build to Order is Predominant Method of Production
Less Specific End Product With Mass Production	Specific and Defined End Product With One Time Production
High Degree of Standardization and Repeatability	Project Unique Design and Material Specifications With Little or No Repeatability
Reliable Planning and Demand Forecasting Can Be Performed.	Uncertain Demand and Inadequate Tools for Forecasting
Metrics or Benchmarking Can Be Performed	One Time Project Makes Metrics and Benchmarking Difficult
One Organization Has Overall Responsibility for Production	Many Organizations Share Responsibility in Various Facets of the Process
Predefined Supplier and Distribution Networks	Project Specific Suppliers and Distributors

TABLE 3-1: CONSTRUCTION INDUSTRY VS MANUFACTURING INDUSTRY[40]

3.4 CONSTRUCTION SUPPLY CHAIN INITIATIVES

As discussed in the previous section, the construction industry is much different than the manufacturing, production, and distribution industries, and the construction industry presents unique challenges to implementation of supply chain management. However, in recent years, increasing efforts have been made to incorporate supply chain management techniques into the construction industry. These efforts have been growing in popularity, and have even resulted in the creation of companies whose business plan is based on construction supply chain techniques, as well as the development of many e-business software solutions. This section will explore the general trends for application of construction supply chain principles, and the next chapter will present specific examples of companies and products that have been developed.

3.4.1 Construction Supply Chain Definition

In the United Kingdom, for example, the Construction Best Practice Programme (CBPP) has performed a substantial effort in studying and promoting construction supply chain management in the United Kingdom and the rest of the world. The Construction Best Practice Programme has developed a comprehensive definition of the construction supply chain, and this definition is as follows:

> "A way of working in a structured, organized, and collaborative manner, shared by all participants in the supply chain. Each company is a link in a chain of activities, adding value at each stage, designed to satisfy end customer demand in a win/win scenario. The activities are all those associated with moving goods from raw materials stage through to acceptance of the product or service by the end customer. This process also embraces all of the information systems necessary to support and monitor these activities [41]"

3.4.2 Construction Supply Chain

Based on the definition of a construction supply chain provided in the preceding section, a generic construction supply chain can be developed to illustrate the relationship of the various players that are associated in a typical construction supply chain. In the civilian construction industry, each supply chain can vary considerably, based on the specific requirements of each project and client. However, the generic construction supply chain can

be used to illustrate the many important relationships that are applicable to most construction projects, and can be used to identify areas of efficiency in specific construction project value chains. Figure 3-3 provides an illustration of the generic supply chain[42].

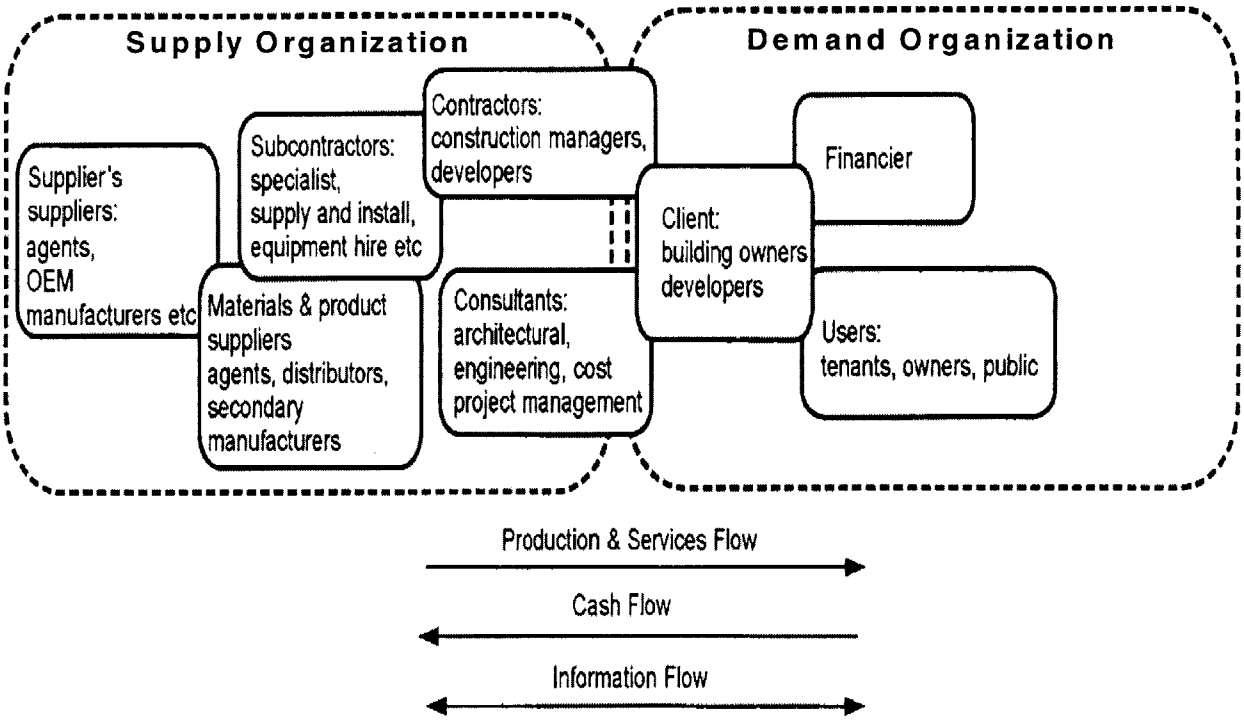


FIGURE 3-3: GENERIC CONSTRUCTION SUPPLY CHAIN[42]

3.4.2.1 *Supply and Demand Organizations*

The generic construction supply chain in Figure 3-3 shows the major players and their inter-relationship to one another. It also shows that all of the players can be divided up into two specific organizations, a supply organization, and a demand organization. The supply organization contains the players in the supply chain, that are involved with providing construction materials and ensuring that the facility gets built. The demand organization contains the client, banks or other financers, and any other individual or organization that is producing a requirement for the facility being constructed. For example, in real estate development, the rental market in a city could be booming and therefore resulting in a shortage of availability for new tenants. This increase in demand in the rental market would

cause real estate developers to initiate construction projects to build more rental space to meet the increasing demand[43].

Also, notice that the there are a few players that overlap into both the supply and demand organization. These are the general contractors, architects, and project managers. This is an important point because these players represent a link between the supply and demand organization and they have the greatest potential to create and realize efficiencies in the construction supply chain. This concept will be discussed in greater detail in the analysis of the Naval Construction Force Class IV material supply chain in Chapter 5.

3.4.2.2 *Resource Flow Through the Construction Supply Chain*

The generic construction supply chain in Figure 3-3 also illustrates how the various resources flow through the chain. The information flow is identified as moving both ways in the chain. This is very important because the better the information flow among all the players, the more efficient the chain will operate. A construction supply chain can improve its information flow through using the latest technology in e-business collaboration software and web based applications. A supply chain can also improve communication through enhancements in the more traditional forms of communication such as e-mail, PDA's, and cellular technology.

The flow of payments is also an important aspect of any supply chain. Figure 3-3 illustrates the flow of cash from the demand organization through to general contractor into the supply organization, and down through the subcontractors and suppliers. The product and service flow is the reverse of the cash flow, and begins with the suppliers, moving through the contractor and subcontractor, and ending with the client and end users of the facility. By automating the flow of invoices and payments, efficiencies can be realized in the supply chain, and there are many collaboration software applications that are attempting to automate this process.

There have been may software applications developed to improve the flow of information and cash through the supply chain. For example, Primavera PrimeContract is software designed specifically to improve this flow of communication among the various players. It is a web-based application that allows all users access to project information and results in a streamlined construction process and improved communication and cash flow. In

addition, The Naval Facilities Engineering Command has recently awarded an $8.5 million contract to Primavera for consulting and subscriptions of PrimeContract for use in Navy Public Works Departments and construction contracting offices[44]. The Primavera PrimeContract application and its potential benefits to the Naval Construction force will be discussed later in the paper.

3.4.3 Construction Supply Chain Areas of Focus

Since the construction industry is fragmented, and organizations change for every project, Norman Fisher and Roy Morledge in *Best Value in Construction* emphasize what they consider to be two important factors that must be taken into consideration for a construction supply chain to be successful, and these factors are "partnering" and "communication.[45]"

3.4.3.1 *Partnering*

As discussed previously, construction teams change for each project, and many times clients are not experienced in construction. Therefore, it is important for all members of the construction team to work together and to have a definite understanding of each others needs and requirements. By assembling a construction team early, and including contractors, subcontractors, and suppliers in the initial planning stages, cost savings can be realized, and an efficient supply chain can be developed for the project. The problem is that this partnering concept does not work well in the traditional design-bid-build method because contractors are usually not brought into the supply chain until after the design is complete, but partnering can work well in a design-build project.

Fisher and Moreledge do caution that historical and cultural mistrust and adversarial relationships among the players in a construction supply chain is a major hurdle that must be overcome. However, they feel that it is necessary to overcome that hurdle in order to realize the true potential of construction supply chain management.

The Naval Facilities Engineering Command has emphasized partnering with its contractors. Furthermore, Navy leadership has worked hard to overcome the tradition "us vs. them" mentality between government personnel and contractors[46]. Therefore, partnering with a material supplier contractor is a viable alternative for the Naval Construction Force,

and this topic will be covered in much greater detail later in the paper under the outsourcing section.

3.4.3.2 *Communication*

Fisher and Moreledge emphasize that each construction project is different, and each client has different expectations. Therefore communication among all members of the supply chain is necessary. Effective communication is necessary to ensure that the entire process from obtaining the client's requirements, to the material arriving on the construction site on time is efficient. Communication was covered in the previous section and will be covered in greater detail later in the paper when the Seabee construction value chain is mapped and analyzed in Chapters 5 and 6.

3.4.4 Supply Chain Mapping

An important aspect of any supply chain analysis is that the supply chain must be mapped. The first step in developing an efficient supply chain is to map the supply chain that is currently in place so that strengths and weaknesses can be identified and a more efficient supply chain developed. The more detail that a manager can incorporate into the map of his/her supply chain, the more effective the map will be for identifying areas of improvement.

When mapping the supply chain, there are four items that should be taken into consideration, and included on the map if possible[47]. These items are:

1) The sources for resources and supplies
2) The steps involved in processing and handling
3) The time frames associated with the steps
4) The value added along the way.

Identifying the sources for resources and supplies is necessary for determining the relationships between suppliers and others in the supply chain, as well as helping to identify the level of competition among the various suppliers. By identifying the steps in handling and processing, there is an opportunity to discover that some steps may be unnecessary or can be combined with other steps to improve efficiency. The timeframes associated with each step aid the manager in determining the time required for the entire flow as well as locating bottlenecks in the supply chain. The value added along the way is also an important

step for a manager, because there is potential for identifying certain activities that do not provide value to the system, and those can be removed or reorganized to provide value to the supply chain. The Seabee Class IV supply chain will be mapped in Chapter 5, and these factors will all be taken into consideration in the analysis.

3.5 VALUE CHAIN ANALYSIS

Value chain analysis is a management tool developed by Michael Porter in his book *Competitive Advantage*. It is a method designed to assist a firm in developing its competitive strategy through evaluation of its internal processes. The value chain analysis provides a systematic method to identify the activities that a firm performs, and evaluate how those activities are inter-related. The value chain analysis presented by Michael Porter is a related concept to supply chain analysis and can therefore be used as an effective tool to assist in studying a construction supply chain. This paper will also employ the value chain techniques in the analysis of Naval Construction Force class IV material. Figure 3-4 provides an illustration of Porter's generic value chain[48].

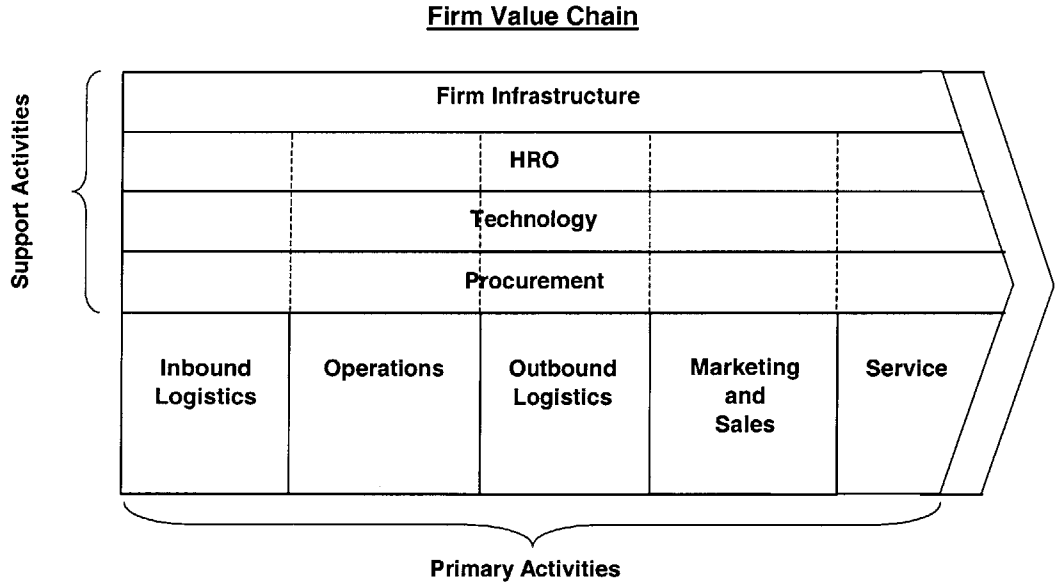


FIGURE 3-4: GENERIC VALUE CHAIN[48]

The value chain identifies the activities of a firm from incoming raw materials through production, marketing, and distribution and lays out the activities in a systematic format for easy analysis. Figure 3-4 shows that Porter breaks his value chain into five primary activities and four supporting activities. The primary activities fall along the horizontal portion of the chain and these are the activities involved in the actual physical creation and distribution of the company's product. The vertical activities in the value chain are the support activities that are necessary for the firm to perform its primary functions. These support functions include the procurement methods for the supplies necessary to accomplish that primary activity. The human resource management refers to the hiring, management, training, and compensation for the employees required for the primary activity. Technological development refers to the technology that the firm is using to assist in performing the primary function. The firm infrastructure refers to the overhead or management functions, and this support function supports all of the primary activities.

Michael Porter uses "value" and not cost as a measurement of a firm's competitive position. He defines value as "the amount buyers are willing to pay for what the firm provides them.[49]" He uses value as a measurement of competitiveness, because not all firms use a low cost strategy approach to gain their competitive advantage.

3.6 VALUE SYSTEM

The generic value chain described in the previous section is used to define the relationships between activities within a company. Michael Porter also expands his value chain concept into the value system. The value system is a series of value chains that are used to analyze how other companies interact with and affect a company. The value system can be developed in a general form in which it shows how a company fits into the overall value system from raw materials to end user. This is similar to the supply chain analysis described earlier. Figure 3-5 illustrates a generic value system[50].

Porter's value system also allows a detailed analysis of value chains, where the relationships between the primary activities of suppliers and buyers are identified. In other words, the outbound logistics, marketing, and service primary activities for the value chain of a supplier to a firm are related to the inbound logistics of the value chain for the firm. In turn, the firm creates a product, and its outbound logistics, marketing, and service primary

activities are related to its buyer's inbound logistics. This detailed value system analysis allows a firm to identify its interdependence with its suppliers and buyers. This in turn allows the firm to determine ways to create a competitive advantage through these relationships.

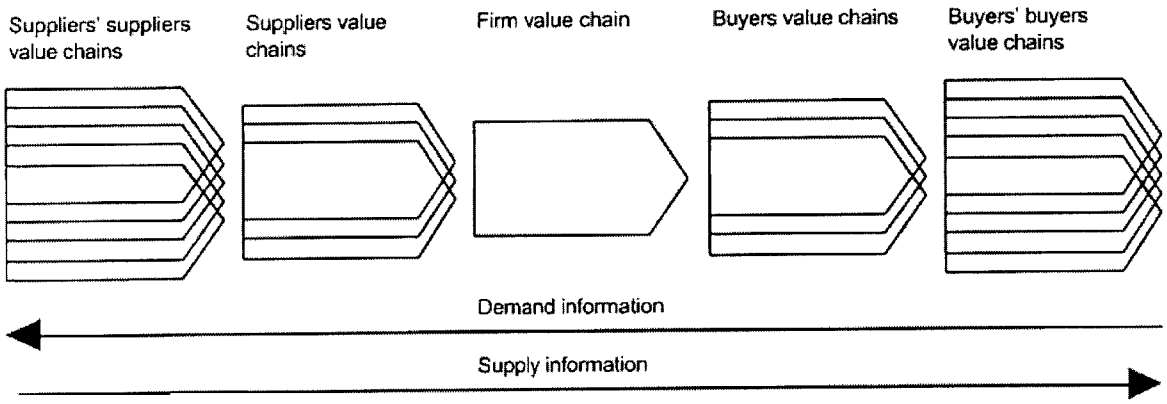


FIGURE 3-5: GENERIC VALUE SYSTEM[50]

3.7 LEAN CONSTRUCTION

Another related concept to supply chain management that has gained popularity in the manufacturing field is lean production. This concept has grown in popularity in Japan where it is a widely used and accepted practice. It is best exemplified in the Toyota Production System in which many of the pioneering efforts on lean production were developed[51]. The underlying principle of lean production is to provide the customers exactly what they want at the exact time that they want it. Lean production combines mass production techniques with the ability of a firm to provide custom ordering capabilities. In order to achieve lean production, firms must focus on improving flow and flexibility along the entire supply chain as well as reducing the amount of waste by requiring less warehousing and stronger management control in the supply chain.

The concept of lean production has also found its way into the construction field. For example, many construction material suppliers apply the concepts of lean production and just-in-time delivery in their manufacturing process. This is especially true for suppliers that provide custom fabrication services, such as glass suppliers and cabinet makers. However,

these suppliers are only a small part of the overall construction supply chain. There have been efforts underway to expand this concept to the entire construction supply chain. The lean construction movement gained popularity in 1993 and has continued to be evaluated and studied with the International Group for Lean Construction leading the efforts.

As explained in previous sections, the construction industry practices are much different than manufacturing and production industry practices. Therefore, lean construction practices are more focused on two main concepts. Lean construction focuses on eliminating waste in construction, and improving workflow[52]. There have been many theories and different approaches presented for how to best accomplish eliminating waste, and improving workflow. Although there is no single, decisive solution, the techniques described in previous sections can be applied to move a company toward meeting the two objectives. Lean construction is successful if the entire construction supply chain is flexible, and can communicate well. Therefore, the communication techniques and partnering concepts can also be used to accomplish lean construction. Chapter 2 also presented that in the Department of Defense *Joint Vision 2020*, "just in time logistics" concepts was part of the future vision of the Department of Defense. Therefore, this concept is very important, and will be taken into consideration in the analysis of the Seabee construction supply chain analysis in Chapters 5 and 6.

3.8 CHAPTER SUMMARY

This Chapter provided an overview of the concepts and necessary background information associated with supply chain management and how it is currently being applied in the civilian sector. The causes for the rapid growth of supply chain management, globalization and increased competition were discussed. Michael Porter's concepts of a firm value chain and value system were also explained and discussed.

The chapter also compared and contrasted the differences between the construction industry, and the manufacturing industry. It explored some of the major challenges that the construction industry faces in implementing construction supply chain management techniques, which are that construction is a fragmented industry that produces a specific, one of a kind item, with no common standards for measuring efficiency. However, despite the challenges, there are potential benefits to applying supply chain management concepts to the

construction industry and many companies are attempting to realize that potential, and improve their competitiveness in the construction industry.

The next chapter will present three specific companies that have focused a large amount of effort and resources into development of organizations and products that are focused on construction supply chain management. By studying how these firms are implementing construction supply chain practices, can provide insight into better and more efficient methods that can be used by the Naval Construction Force to more efficiently manage its construction supply chain.

This chapter provided the background information necessary for understanding of the various analysis techniques that will be employed throughout this paper to analyze the Seabee class IV material supply chain.

CHAPTER 4 CIVILIAN SECTOR CONSTRUCTION SUPPLY CHAIN INITIATIVES

"Construction is a unique industry with significant potential to develop its own tools based on imported concepts which have been successfully used elsewhere"

-S. Mohamed[53]

4.1 CHAPTER OVERVIEW

Despite the concerns outlined in chapter three, many civilian construction and software firms feel there is a potential market for construction supply chain management. As a result, some companies have made large investments in tools and initiatives that are specifically created for improving the construction supply chain. A large United States construction company, Turner Construction, has created a wholly owned subsidiary that is totally dedicated to improving the supply chain process for its clients called Turner Logistics. The Beck Group, also has a bold initiative called DESTINI that is intended provide a faster and more cost effective facility through focusing on providing an efficient construction supply chain. The Beck Group is taking a much different approach than Turner Logistics to attack a similar problem, and the two approaches will be explored in this chapter.

There are also many companies that are designing e-business software that will enable construction supply chains to operate more efficiently through web-based information sharing and collaboration. Project collaboration is a concept that has been gaining recent popularity in the construction industry, and it will be discussed and explained in this chapter. Primavera PrimeContract is an excellent example of software products that are being designed to improve the efficiency of the construction supply chain, and will be studied in this paper because the Naval Facilities Engineering Command has recently awarded a multi-million dollar contract to use the Primavera software.

These three initiatives will be examined in greater detail because they help to provide an understanding of the most aggressive private sector initiatives that are currently being undertaken by commercial industry, and provide valuable insight on how the industry is approaching the problem of incorporating supply chain management into current construction practices. These companies can also be studied from the viewpoint of being potential tools that can be utilized by the Naval Construction Force through the use of government contracts

or procurement as part of the privatization and outsourcing initiatives that were identified in the *Joint Vision 2010, Focused Logistics Roadmap.*

4.2 TURNER LOGISTICS

Turner Logistics is a wholly owned subsidiary of the Turner Construction Company, and was started in 2001 with a focus on mechanical and electrical equipment. At first, they only provided these services to clients of Turner Construction. However, as a result of early success, they have now opened their services to all customers worldwide. They have also greatly expanded their focus to include a large range of construction materials, which include the following[54]:

- **Hospital and Lab Equipment**
  - Imaging equipment (MRI, CT, cath labs, linear accelerators)
  - Sterilizing equipment (autoclaves, cage & rack wash, glass wash)
  - Fixed medical equipment
- **Architectural Products**
  - Carpet and access flooring
  - Fixed seating systems
  - Furnishings, fixtures and equipment (FF&E)
- **Mechanical and Plumbing Products**
  - Chillers and cooling towers
  - Computer room AC units (CRACs)
  - Air Handling units (custom and package)
  - Boilers
  - Pumps
  - Fans
  - Refrigeration equipment
  - Plumbing fixtures (porcelain and chrome components)
- **Electrical Products**
  - Generators
  - ATS / Paralleling switchgear
  - Switchgear / Transformers / Panelboards
  - Uninterruptible power supplies (UPS)
  - Power distribution units (PDUs)
  - Light fixtures / Site fighting poles

The business concept of Turner Logistics is that they will provide their clients with a one stop shop for procurement and delivery of construction materials. What makes them different from other construction material suppliers is that they are focused on providing their service by using construction supply chain management techniques. Turner Logistics employs technical experts who manage the entire process from purchasing, expediting,

tracking, scheduling delivery, and dealing with warranty issues, to managing closeout. The company focuses on providing the client with three specific goals: time savings, cost savings, and a wide range of product selection.

As stated in Chapter 3, continued relationships through partnering is a key to success in supply chain management. Communication among all members of the supply chain is also a major key to success. Turner Logistics advertises a time savings for the customer that is realized through developing vendor relationships and utilization of information technology. Through leveraging the large size and reputation of their parent company, Turner Logistics is able to develop continuous relationships with construction material vendors. These relationships allow Turner Logistics to procure construction materials more efficiently. Additionally, Turner Logistics has automated the shop drawing submittal and approval process. The shop drawing documents that must be reviewed are submitted electronically to all required members of the supply chain, and all submittals are scheduled and tracked automatically. This electronic tracking ensures that lag times are reduced and ensures that the submittals are approved in time for fabrication and on time delivery. It also eliminates the inefficient paper trail that existed under the hard copy shop drawing review process. Turner Logistics estimates that on a typical project, they can save a client between eight and sixteen weeks in time through use of their automated process and purchasing alliances with vendors[55].

Turner Logistics also advertises that they provide a cost savings to the customer. They can do this through leveraging the construction volume and size of their parent company to establish long-term relationships with construction material vendors. Their parent company performed over $6.2 billion in construction projects worldwide in 2002, and was the leading general contractor in the United States[56]. Due to the large volume of construction that the parent company performs, Turner Logistics is able to perform aggregate purchasing, in which it can negotiate discount pricing with construction material vendors. Turner's worldwide network also allows the company to work with construction material suppliers all around the world, and benefit from the competition created through globalization that was discussed in Chapter 3. This cost savings that Turner Logistics achieves through their strategic supplier relationships can be passed along to its customers.

Turner Logistics advertises that it also provides the customer with an outstanding selection of products. They base this claim on the fact that their large size and technical expertise gives them access to many vendors worldwide, plus they research and employ the latest worldwide technologies in the industry. Also, Turner Logistics employs a team of experts that meet with clients early on in the design process. As stated in Chapter 3, early involvement of suppliers and contractors in the process will improve efficiency in the construction supply chain. By meeting with the customers early on in the process, Turner Logistics personnel can give the client a full understanding of the various types of construction materials that are available, and can work with the client to incorporate the best solution into the original design.

Turner Logistics and the initiatives that they are undertaking present an outstanding model for construction supply chain management. Although the Naval Construction Force does not perform the immense amount of construction that Turner Construction performs, the Naval Construction Force can still learn some valuable lessons from this business model. The Seabees do perform construction worldwide, and can potentially benefit from contracting with a company such as Turner Logistics or a similar competitor to provide construction material to the worldwide construction efforts. If outsourcing or privatization of Seabee class IV material is not found to be the best option, the strategies of vendor alliances and technical innovation can be employed by the Naval Construction Force to improve efficiency in the current process. These various strategies will be discussed in detail in Chapter 6.

4.3 DESTINI

The Beck Group began as a general contractor, but in recent years has expanded its practices to include real estate, and has also expanded to providing a client with multiple services in the construction value chain. The Beck Group formed DESTINI to "focus on integration of the design, estimating, and construction disciplines, within the real estate delivery process.[57]" The Beck Group through DESTINI, is also hoping to gain a competitive advantage over its competition through successful construction supply chain management that will make its services more efficient and cost effective for the client.

Although the goals are similar between Turner Logistics and the Beck Group, the approach is very different. While Turner Logistics was focused on the more traditional applications of supply chain management, such as strategic alliances with vendors and the leverage it can gain from the immense size of its parent company, the Beck Group has focused on technology and the benefits that it can gain from combining many of the construction supply chain players under the roof of one organization. In other words, the Beck Group is taking more of a vertical integration approach to creating efficiency in the construction supply chain. The Beck Group merged with an architectural firm, and built an in-house real estate development capability. Additionally, the Beck Group has obtained exclusive rights to a 3D modeling software, and invested millions of dollars to develop engineering and cost rules to augment the 3D modeling program[58].

The Beck Group believes that through the coordinated efforts of their in-house members of the supply chain, combined with the powerful 3D technology, they can design, engineer, estimate, procure, and construct projects much faster than the traditional approach. Also, by effective use of the 3D modeling technology, they can work closely with a client to identify the best and most efficient designs. The Beck Group is focused on the design portion of the supply chain, and feels that through development of an efficient design, the cost and time savings in the construction phase can be realized. They also believe that through development of an efficient design, the operations costs can be reduced, and provide the client with a long term cost savings. They have based their strategy on the fact that the design portion of the project has the highest level of influence on the entire chain, which is illustrated by figure 4-1[59].

The DESTINI initiative by the Beck Group is a case that can also provide valuable lessons to the Naval Construction Force. The Seabees do not perform nearly enough construction to justify the costs associated with the development or purchase of a 3D modeling program. Furthermore, the construction that the Seabees perform is not complex enough to warrant contracting projects to take advantage of 3D modeling software, which is more advantageous for large-scale construction projects. However, the concept of vertical integration is one that the Naval Construction Force can consider. This will also be covered in more detail later in the paper.

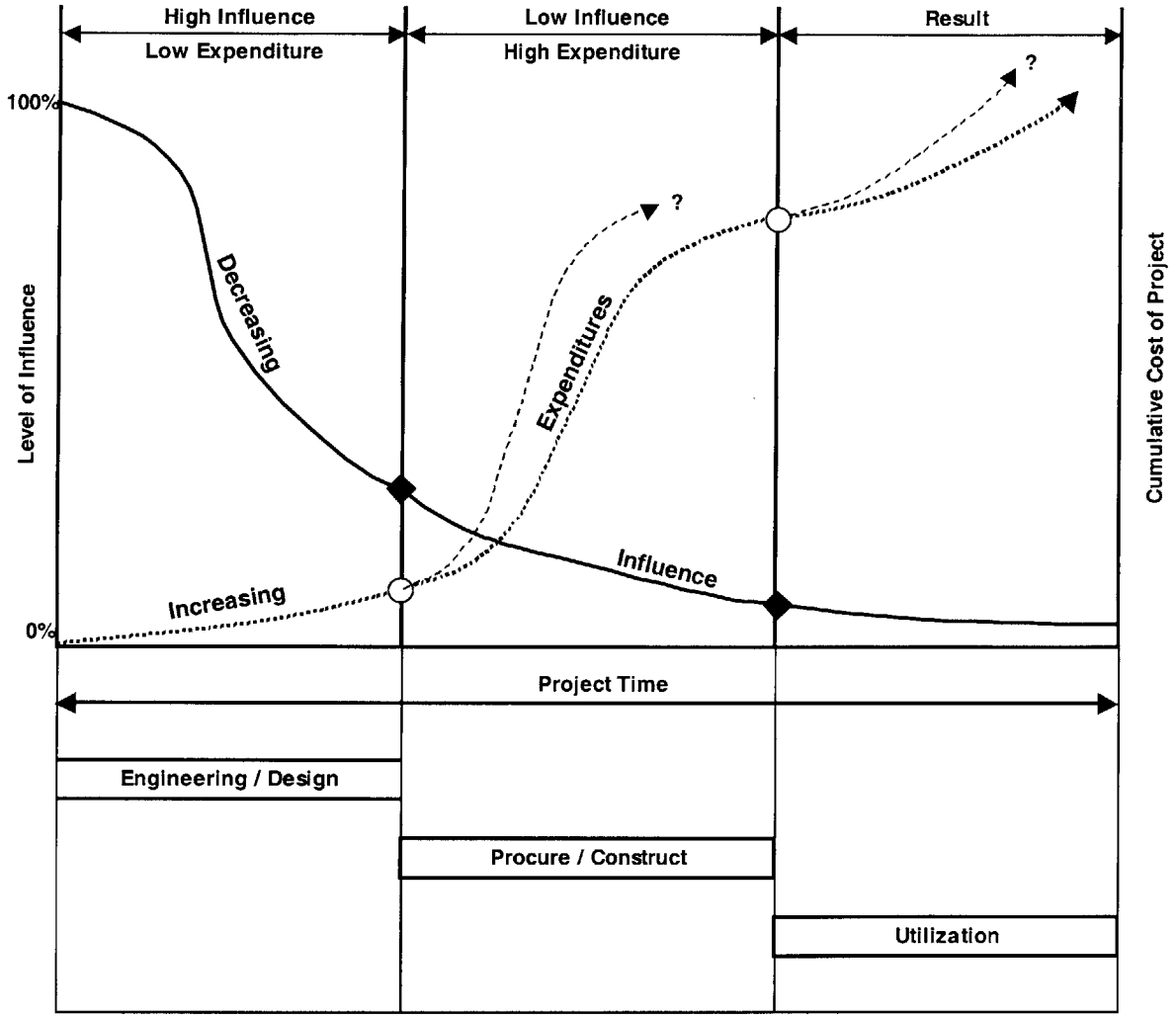


FIGURE 4-1: LEVEL OF INFLUENCE ON PROJECT COSTS[59]

4.4 CONSTRUCTION PROJECT COLLABORATION:

According to the US Bureau of Labor Statistics Productivity Index, productivity in non-farm industries has risen from a benchmark of 100 in 1964 to 180 in 1998. In that same time period, productivity (defined as the ratio of dollar size of contracts to work hours required for completion of the contract) in construction dropped from 100 to 85[60]. The

fragmented nature of the construction industry, along with its inability to adapt new technology has caused it to consistently lose ground on other industries.

4.4.1 Project Collaboration Overview

In the construction industry, one of the largest problems on any project is communication up and down the construction supply chain. Requests for information (RFI's), change orders, shop drawings, invoices, and other project communications are handled by paper copies that can be faxed, mailed or scanned for e-mail. These communications result in follow up phone calls to ensure that the receiver got the document, along with the need for large administrative staffs to keep the enormous paper flow moving. On large projects, hundreds of documents and verbal or written communications can be flowing up and down the construction supply chain on any given day. With no central repository for all of this communication and paperwork, it is easy for items to fall through the cracks, which could lead to delays, inappropriate build-outs, erroneous material orders, and other inefficiencies that cut into profits and timely completion of the project. In the construction industry, effective communication is crucial for completing projects on time and within budget. Therefore, project collaboration is a concept that is growing in popularity in the construction industry. Figure 4-2 provides an illustration of the project collaboration concept in the construction industry[61].

There are many companies that have developed or are developing project collaboration software. Some of the leaders in the software development are: Buzzsaw, Primavera, Cephren, Meridian, and Constructware. All of these companies provide applications that are intended to improve communications and reduce paperwork and inefficiencies in the construction supply chain. This paper will focus on Primavera PrimeContract, because the Navy has recently awarded a multi-million dollar contract with Primavera to use the software.

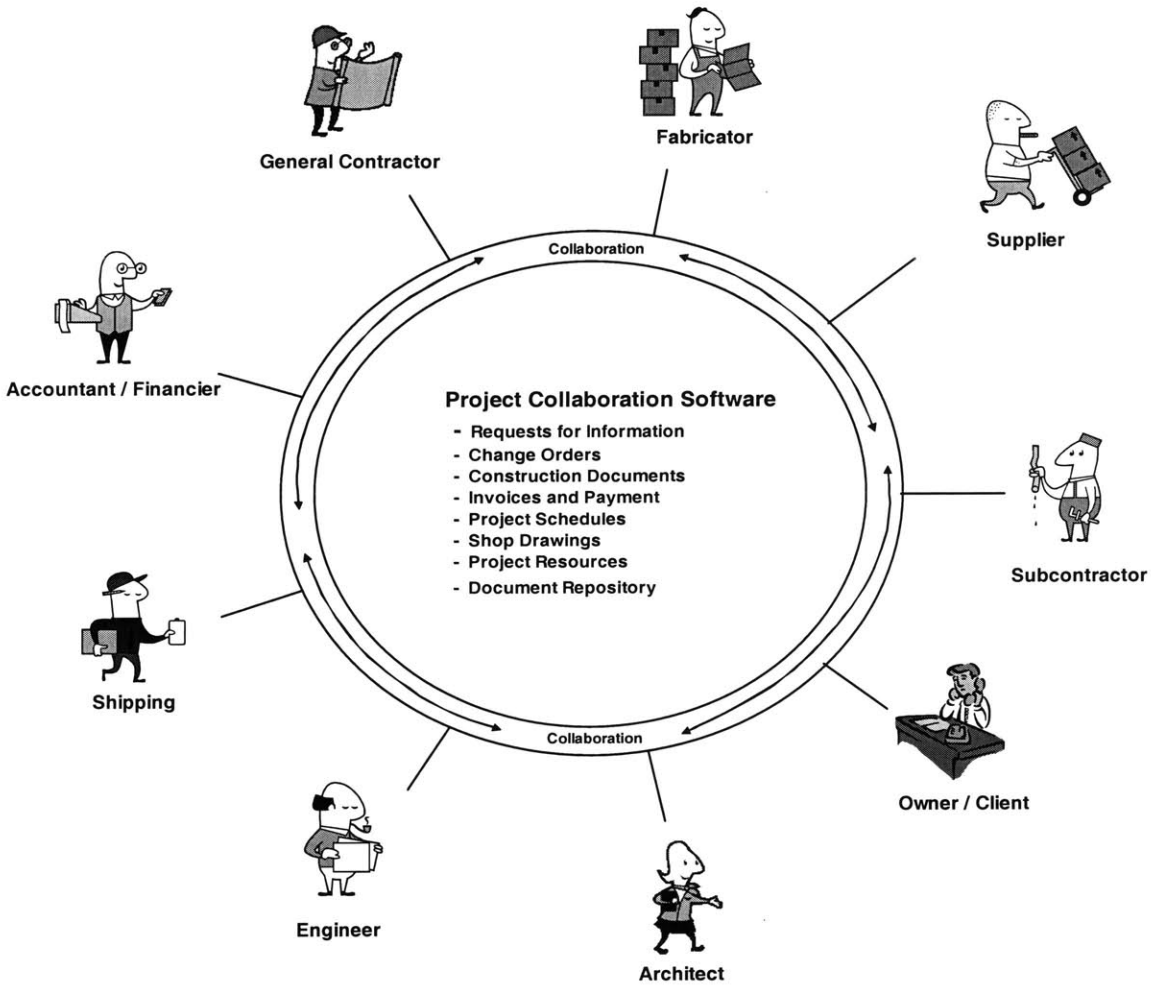


FIGURE 4-2: PROJECT COLLABORATION IN THE CONSTRUCTION INDUSTRY[61]

Project collaboration software applications in the construction industry focus on two standard concepts. The first concept is that the all members of the supply chain can access and share information efficiently by having everything located at one central area. The second is that the collaboration technology should be accessible with standard web browser software so that any member of the construction supply chain can access the data with standard software that is already on their computer.

4.4.2 Improved Communication

A central location for project information reduces the potential for errors and miscommunication by allowing all members of the supply chain to access project documents and exchange information electronically, which saves time as well as costs for document reproduction and distribution. The central repository allows members of the supply chain to view schedules and provide input on the schedules. Change orders and requests for information can be reviewed with comments and approvals being posted online, which allows real time information flow and reduced potential for documents to get lost or fall through the cracks. Required due dates can also be assigned to specific requests for information and change orders so that the software can notify members when items are coming due, which allows the project to remain on schedule.

Johnson and Johnson performed a construction project in 2002 and utilized project collaboration software in their supply chain. Based on comparisons with similar projects that it performed, the company estimates that it reduced the request for information process from seven days down to two days. The company also estimates that it saved approximately 9% in total costs by reducing the number of errors, administrative costs, and overall time for completion of the project[62].

4.4.3 Connectivity and Accessibility

The second major issue with collaboration software in the construction industry is that it should be accessible with standard web browser software. As stated previously, there are so many different players in every construction supply chain. For each of them to be required to purchase specific software in order to be compatible with the supply chain would not be cost effective, and would greatly reduce the marketability of the product. If one player in the supply chain decided not to get the special software, the communication chain would be broken, and would essentially be operating as it has in the past, with limited benefit to the members who purchased the software. Therefore, by making it easy for even the smallest of subcontractors to access the project collaboration with just a regular personal computer and a dial up modem improves the chances of success for the project and maximizes the effectiveness of the collaboration. This represents a major benefit for the Naval Construction Force because of their mobile nature in performing construction projects all over the world.

4.4.4 Concerns With Project Collaboration Software

There are two major areas of concern with the use of project collaboration software, and both are very important to the Naval Construction Force as well. If the collaboration software is easily accessible over the internet, it must have a means of being secure. It should be password protected, and have the ability to prevent hackers from accessing the project information, because much of it will be proprietary information. This is especially true for military construction projects that could potentially use this software. Also, the project collaboration software should have limited access capability so that some members of the supply chain will only have access to view certain portions of the project, and not have access to the entire project. This is especially necessary when dealing with cost estimates and invoices. These items should only be allowed to be viewed by the necessary parties, and not everyone in the supply chain. In Naval Construction Force applications, this limited access requirement is also necessary, especially when commercial contractors are sharing information with government employees.

Another area of concern is that the software should have a mechanism for backing up and archiving project information. Since all project information will be in one central location, and the goal is to reduce the amount of hard copy paperwork being passed, this information must be protected in case of software malfunction or accidental deletion. If personnel in the supply chain are concerned about information being lost, they will make hard copies of everything, and the reduced administrative burden that is an expected result of a cost savings will not be realized. Also, if the data were to be lost, and could not be retrieved, it would produce a major blow to the project. Therefore, the software must have an adequate system for backing up information so that all members of the chain have confidence in the system.

4.4.5 Fully Integrated and Automated Technology Consortium

In January 2002, the Fully Integrated and Automated Technology Consortium (FIATECH), which is a non-profit consortium focused on the development of technologies to improve the construction process from design through life cycle maintenance, provided results of a study that it performed on construction project collaboration. The study projected approximately 20% to 50% reduction in design time for architects and engineers, and an approximate 20% to 40% reduction in time and construction cost for construction supply chains that utilize collaboration software[63].

FIATECH does caution that much of the study was based on theoretical situations and that it will take time and further software development for these savings to materialize in the construction industry. However, they feel that through continued improvements with collaboration software, and through increased use of the software in the construction industry, the savings identified in the study are very realistic and can be expected in the near future.

4.5 PRIMAVERA PRIMECONTRACT

Primavera Systems, a worldwide provider of project management software applications and services, has recently developed a project collaboration software application called PrimeContract specifically designed for improving the efficiency of the construction supply chain. PrimeContract is a secure, web-based application that allows information sharing among members of the supply chain. This application seeks to improve the efficiency of the supply chain through improving communication among the various players. The software was designed to meet three objectives: accelerate project delivery, reduce overall project cost, and enable best practices[64].

PrimeContract is capable of centralizing all project related items, such as documents, forms, drawings, specifications, schedules, and reports in one location in which the entire project team is connect to. The application focuses on collaboration, and the ability of construction supply chain members to redline drawings, view project milestones, create task lists online and provide real time information to everyone as documents are updated. The application also allows the owner to view project milestones and provide his/her input on the project. One of the best features of the software is that PrimeContract also synchronizes

efforts by allowing construction supply chain members to create and exchange schedules online. This would provide a definite benefit to the Naval Construction Force.

PrimeContract also has the ability to manage the financial portion of the construction supply chain. The application allows contractors to submit their invoices for progress payments electronically. The requests can be viewed and negotiated electronically, and are tracked electronically to ensure that none are overlooked or misplaced. This speeds up the contractor payments, and reduces the amount of paperwork that must be passed back and forth, saving both time and money. PrimeContract also integrates with most standard business software applications to ensure compatibility for progress payments to be made electronically.

The Naval Facilities Engineering Command has recently awarded an $8.5 million contract to Primavera for consulting and subscription services of the PrimeContract application. The PrimeContract licenses that were purchased by the Naval Facilities Engineering Command are intended to be used in Public Works offices and Navy Construction Contract offices. This provides an outstanding opportunity for the Naval Construction Force to benefit from this application. Even though the applications were not purchased specifically for the Naval Construction Force, the Seabee construction supply chain that will be presented in the next chapter clearly illustrates that Public Works offices are in that chain, and act as the clients. Therefore, if the Public Works office sets up the Seabee project in their PrimeContract, and allows the Seabees, who are acting as the general contractor, internet password access, the Seabees can access the project online, and benefit from the online collaboration that PrimeContract allows. However, the desirable solution would be for the Naval Construction Force to obtain its own licensing of the software, and be the central manager of the collaboration. This will be covered in greater detail later in the paper.

4.6 CHAPTER SUMMARY

This chapter researched and presented three bold construction supply chain initiatives that are currently underway in the civilian construction industry. The purpose of this research was to try and gain an understanding of what civilian construction firms are doing to gain a competitive advantage through using supply chain management initiatives. Although the Naval Construction Force does not compete directly with these civilian organizations, it is a government organization that is expected to effectively manage taxpayer money, and therefore, has an obligation to operate as efficiently as possible. Learning from private industry and applying their successes to a government process is one way of being fiscally responsible with taxpayer dollars. Another responsible option may be to contract with a company presented here, or with one of their competitors who can offer a cost and time savings to the process, and is found to be the best and most effective choice. This outsourcing option will be discussed in greater detail in Chapter 6.

This and all previous chapters provided the background, and research information necessary to conduct a detailed analysis and complete understanding of the Seabee Class IV material process. The remaining chapters will now focus on the analysis of the Seabee construction supply chain and identify the potential areas of improvement based on the research obtained and outlined in these initial chapters.

CHAPTER 5 ANALYZING THE CURRENT SEABEE CLASS IV MATERIAL SUPPLY CHAIN PROCESS

"Gentleman, the officer who doesn't know his communications and supply as well as his tactics is totally useless"
-General George S. Patton

5.1 CHAPTER OVERVIEW

This chapter will take the tools of construction supply chain management, value chain, and value system analysis that were covered in previous chapters, and apply them to the current Naval Construction Force class IV material supply system. This chapter will present graphic representations of the Seabee construction supply chain, value chains, and value system, and provide a thorough written explanation of each analysis. The purpose of this chapter is to perform a detailed analysis of the current Seabee class IV material supply system, by breaking down the process into small parts, thereby allowing for the determination and identification of areas in which improvements can be made, and efficiencies can be realized. While this paper is focused on the construction material portion of the supply chain, the entire construction supply chain will be mapped and analyzed because there are many links throughout the chain that have a direct or indirect affect on the class IV material.

5.2 SEABEE BATTALION CONSTRUCTION MATERIAL SUPPLY CHAIN

A peacetime Naval Construction Force class IV supply chain was mapped and is provided as figure 5-1. The information for the chain was compiled through interviews with Navy personnel, a thorough review of Navy instructions, and research of project material metrics. This construction supply chain has not been mapped by the Naval Construction Force, and up to this point, has been operated like the traditional manufacturing industries identified in Chapter 3, in which the segmented organizations focused on improving their portion of the chain, but nobody really analyzed the chain as one complete entity. The peacetime supply chain will be the focus of this analysis because that is the most common and predominant situation that Seabees experience. Also, it is the situation where standard

procedures and techniques can be recommended, and where the greatest cost savings can be realized.

The supply chain and all identified procedures would also apply to wartime and humanitarian operations, with a few exceptions. In most cases, the priority shifts from cost being the driving factor to time being the driving factor in wartime. Therefore, in wartime, costs will most likely increase due to requests for more air shipments, and the necessity for requesting accelerated material orders from suppliers. Another difference would be that in wartime, the designs and construction are usually much simpler, and more than likely will come directly from a compilation of standard wartime designs for Navy and Marine Corps battlefield and camp construction facilities. This document is referred to as the Automated Building, Facilities, and Components (ABFC) Manual and contains drawings, specifications, and bills of material for most standard battlefield facilities. Therefore in wartime, the design and estimating steps that are identified on the Seabee supply chain map are greatly simplified and accelerated if ABFC manual designs are used.

As stated previously, the typical construction industry supply chain consists of many different organizations and players that come together to perform a project. The construction material supply chain for a deployed Construction Battalion is no exception. However, unlike the civilian construction industry, many of the team members in the Seabee supply chain remain the same from project to project. Therefore, an excellent opportunity exists to analyze the existing construction material supply chain and identify areas of improvement for increased efficiency.

The construction material supply chain for a deployed Construction Battalion consists of five major organizations, and these are: the US Base Public Works Department (client in a civilian context), $22^{nd}/30^{th}$ Regiments, material suppliers (Prime Vendor), shipping contractor, and the Construction Battalion (general contractor in civilian context). While the personnel in the Construction Battalions, US Base Public Works Departments, and shipping contractors will change for each project, Construction Regiment personnel, and Prime Vendor will remain the same. Figure 5-1 maps the complete Naval Construction Force supply chain. The inter-relationships among the various organizations and the entire chain will be broken down and discussed in this section.

Current Peacetime NCF Construction Supply Chain

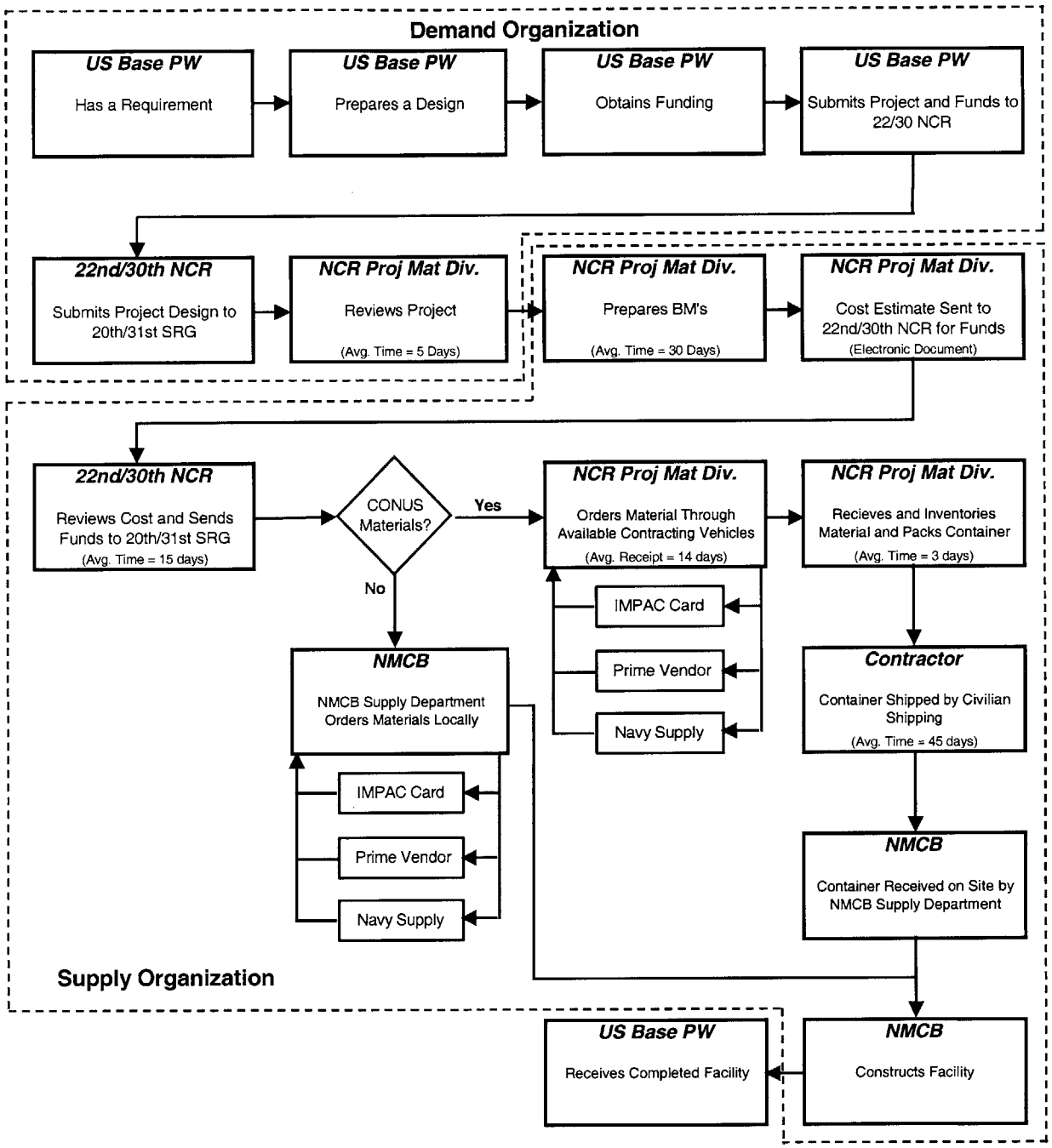


FIGURE 5-1: CURRENT CONSTRUCTION BATTALION SUPPLY CHAIN

5.2.1 Project Design and Funding

The first links in the Seabee construction material supply chain involve the Public Works Department planners of a US base who have the initial requirement for a facility. It could be any Navy or Marine Corps base, but usually it is an overseas base that requires Seabees to perform the work. Once the Public Works Department planners have their requirement identified, it is up to them to prepare a design. They can prepare the design with either their in-house staff design team or through an A&E contract. Once the design is complete, the planners perform their own independent cost estimate for the construction, and work through their appropriate funding source to obtain funds for construction.

Once the base receives funding for the project, it can then submit the project to the 22nd or 30th Naval Construction Regiment for review. There is a formal process that the base planners must go through for submission of their projects, and this is outlined in the NCF Call for Work Instruction. Timelines are not identified on Figure 5-1 for these initial steps because the base planning process is affected by factors such as scope and complexity of project, priority of project, and availability of funds. The times for the initial design and funding steps for a project can range from a few weeks for the entire process to many years to obtain designs and funding; every project is different.

In this Seabee construction material supply chain presented in figure 5-1, it is evident that the Public Works Department planners at the US base act as the client, and therefore have all of the same needs and requirements that their civilian counterpart would have on a civilian construction project. Another issue worth noting is that this construction material supply chain is laid out in the traditional design-bid-build format. The reason for this is because the Naval Construction Force currently does not have the capability to perform design-build construction.

5.2.2 Project Review and Scheduling

Once the construction project is submitted to the 22nd or 30th Naval Construction Regiment, their planning staff reviews the design, and schedules the project by assigning it to a specific Construction Battalion and a specific deployment cycle for that battalion. If the US Base that is requesting the construction project is in the Mediterranean or Atlantic area of responsibility, the project is submitted to the 22nd Regiment, which is located in Gulfport,

Mississippi. If the project is in the Pacific or Indian Ocean area of responsibility, it is submitted to the 30th Regiment, which is located in Pearl Harbor, Hawaii.

Once the Regiment receives the project and assigns it to a Construction Battalion, the Regiment will forward the design to the Construction Battalion for review as well as the Regimental Project Material Division. The 22nd NCR Project Material Division is located in Gulfport, Mississippi and works with all 22nd Regiment projects. The 30th NCR Project Material Division is located in Port Hueneme, California (approximately 60 miles north of Los Angeles) and works with all 30th NCR projects. The reason that the Project Material Division for the 30th NCR is geographically separated from its headquarters is because of the reorganization discussed in previous sections. The fact that the material personnel are at the same location as the homeported battalions which makes communication between the two parties easier, but makes communication between the Regimental Headquarters and Regimental project Division more difficult. See Figure 5-2 for the geographic locations of the various units discussed in this section.

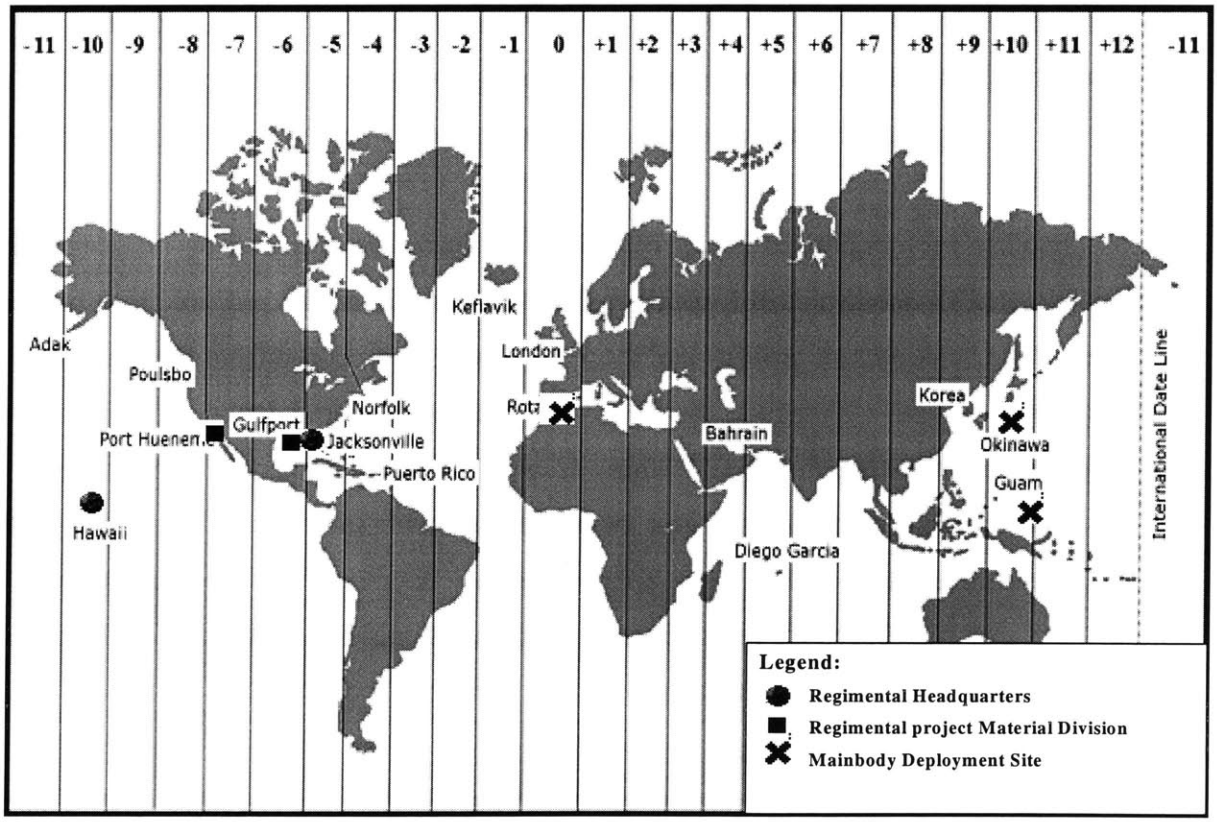


FIGURE 5-2: GEOGRAPHICAL LOCATIONS OF REGIMENTS

5.2.3 Planning and Estimating

The Regimental Project Material Divisions have a civilian staff of planners and estimators that are comprised of the major construction disciplines: civil, electrical, and mechanical experts. These planners and estimators perform a thorough review of the project design, and also prepare a complete bill of materials (BM). These bills of material are created with Timberline Construction Estimating Software, and a sample is provided in Appendix B.

At the same time, the Construction Battalion that will be performing the construction also assembles a team of personnel who will be working on the project, and they prepare a complete list of required materials, which is referred to as a material take off (MTO) because it only contains quantities of materials, and not costs. The reason for this duplication of effort is two fold. As stated in the Naval Construction Force overview, the level of experience for a Seabee is limited, and the Construction Battalion estimating process is used as a method of training for young personnel. Secondly, the material take off is compared to the bill of materials prepared by the Regimental Project Material Division, and therefore can be used as a check system. If there are major discrepancies, the Construction Battalion can work with the Regimental Project Material Division planners and estimators, and resolve the discrepancies.

Another very important aspect of the bill of materials prepared by the Regimental Project Material Divisions is that it specifies the materials that can be procured locally (at the location of the construction project) and those that must be procured from the United States and shipped overseas. Therefore, the Regimental Project Material Division estimators are responsible for reviewing the specifications as well as the local market for availability of local materials, and determining the best method of procuring the material. On average, this review and estimating process takes approximately one month to accomplish for each project, but can vary based on the size, geographic location, and complexity of the project. Once the bill of materials is considered to be reasonably accurate, it is forwarded to the appropriate Regiment for funding.

At any one time, the Regimental Projects Material Division can have approximately 80 projects that are at various phases of the process ranging from initial review to material procurement. In order to track all of the projects, the 30th Regimental Project Material

Division in Port Hueneme, California uses a Microsoft Access database that is referred to as the Project Coordinators Database. This database tracks the projects and assists the manager in balancing the workload of the planners and estimators. The 22nd Regimental Project Division uses a DOS based program called the Seabee Automated Management and Maintenance System (SAMMS), which was developed in the 80's to assist the Naval Construction Force with various stages of management, and is rapidly becoming obsolete for many applications.

5.2.4 Review and Approval of Funding

When the Regiment receives the bill of materials from the Regimental Project Material Division, The Regiment can then request and obtain the correct amount of funding from the US base Public Works Department that is requesting the work. Once the Regiment receives the funding, it sends the appropriate amount of funds to the Regimental Project Material Division and the Construction Battalion based on the costs identified in the bill of materials.

The Regimental Project Material Division receives the funding necessary for procurement of the construction materials that must be purchased in the United States. The Construction Battalion receives the funds necessary to procure all of the items that they can procure locally at their deployment site. The process of the Regiment receiving the bill of materials, and sending the correct funding to the appropriate units varies in time, but on average it takes approximately 15 days for this process to be completed in peacetime. During wartime, funding is more readily available, and this process is definitely accelerated and is usually completed within one or two days.

5.2.5 United States Material Procurement:

Once the Regimental Project Material Division receives funds for construction materials, it currently has three main contracting vehicles that it can use to procure the construction material.

The Regimental Project Material Division can go through the Base Supply Department for procurement of the construction materials. However, this is a time consuming option because most of the supply clerks are not familiar with construction

materials, and this results in extra time for communicating requirements. Also, with outsourcing and other procurement initiatives currently underway in the Department of Defense, the staffing of most Navy supply departments has been reduced, and they encourage Navy personnel to procure materials through the use of IMPAC cards and Prime Vendors, both of which will be discussed. However, the Base Supply Department is still a viable and cost effective option for certain material purchases, and should not be completely discounted or eliminated from the list of possible tools available for construction material procurement.

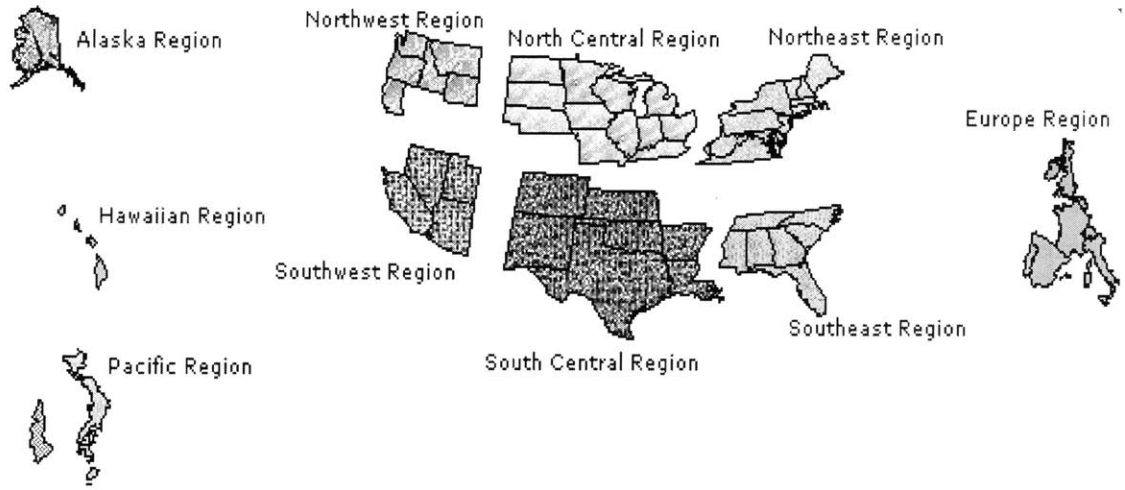
The second available option, if the procurement is small enough, is through use of a government credit card, also known as an IMPAC card. These cards work just like any other credit card, and after the appropriate training, any authorized government cardholder can make a purchase with the credit card. However, the card has limitations, which reduces its effectiveness with construction material procurement. The IMPAC card only allows a threshold of $2,000 per purchase for construction materials. The card also does not allow "incrementation" of purchases. Incrementation is defined as the breaking up of a large procurement requirement into smaller procurements in order to make the purchases under a restricted threshold[65]. Therefore, the Regimental Project Material Division cannot use the government credit cards for the procurement of large bills of material in excess of the threshold. The credit cards are, however, good for small emergency purchases for items that were overlooked or under-ordered in the original bill of materials because the purchase can be made fast and with limited required paperwork.

The third and most popular construction material procurement method that is currently available to the Regimental Project Material Divisions is through "Prime Vendor" contracts that are sponsored by Defense Industrial Supply Center (DISC). These are long-term, construction material supply contracts that are awarded through competitive bidding and are awarded to the vendor with the lowest proposed markup on construction material. The Regimental Project Material Division can forward the material requirements on the bill of materials (less the estimated cost information) to the Prime Vendor for a quote. Upon receipt of a quote, the Regimental Project Material Division can enter into negotiations with the Prime Vendor and award a task order (TO) on the contract.

The benefit of having a Prime Vendor contract for the government is that the initial award of the contract takes longer, but once the contract is awarded, the task orders can be

awarded much faster than entering into the competitive bidding process every time material is required. The Prime Vendor contract also enables the government to partner with the contractor and develop improved working relationships, which can result in efficiencies and cost savings to the government.

However, there are downsides to the current Prime Vendor contracts as well. Currently, the contracts are awarded by regions, and the Regimental Project Material Divisions can only work with the contractor in their region, and only have the material delivered to their region. Secondly, the Prime Vendor contracts do not allow for the direct shipping of material overseas. Therefore, the Regimental Project Material Division must receive the construction material in the United States and prepare it for shipping through the use of a separate Department of Defense transportation contract. Since the Prime Vendor contracts are regionalized, the Regimental Project Material Divisions each have a different contractor that they must use. The 30th Regimental Project Material Division uses Graybar, while the 22nd Regimental Project Material Division uses Procurenet[66]. Figure 5-3 provides a breakdown of the current Prime Vendor regions. The average amount of time for the Regimental Project Material Divisions to receive their construction materials is approximately 10 days from once the task order is approved. Of course, long lead items, such as transformers, or custom fabrication item requirements will take longer. However, common, off the shelf construction items are contractually required to be delivered in 14 days from the date of order.



Graybar Electric	Procurenet	SupplyCore	TWI
•Alaska	•Southeast	•North Central	•Europe
•Southwest	•Hawaii	•Pacific	
•Hawaii	•Northeast	•South East	
•Northeast	•South Central		
•South Central	•Northwest		
•Southeast			

FIGURE 5-3: DEFENSE INDUSTRIAL SUPPLY CENTER PRIME VENDOR REGIONS

5.2.6 Construction Material Receipt and Packaging

Once the Regimental Project Material Division receives the construction material from the Prime Vendor, or other procurement source, the material is dropped off at a warehouse, where Regimental Project Material Division personnel review the order. They check the order to ensure that the proper items were delivered, and that none of the items are damaged. If the personnel feel that the construction material is acceptable, they sign off on the shipment and accept the material. They then order an 8'x 8'x20' shipping container from a local shipping company through one of the Department of Defense transportation contracts in preparation for shipping the material overseas.

Once the container arrives, the Regimental Project Material Division has one day to pack it and have it prepared for the shipping contractor to pick up and ship to its overseas destination. When the construction material is packed in the container, it is inventoried, and a hard copy inventory is included in the container prior to it being sealed.

There are three main reasons why the Regimental Project Material Division receives the material and packs it in a shipping container. The first reason, and probably most critical, is because the current Prime Vendor contracts do not have a clause for shipping overseas. Therefore, in order to take advantage of the flexibility provided by using Prime Vendor contracts, they must have the material delivered to the base. A modification to the existing contracts to allow for shipping overseas would be questionable, because the scope of the existing contracts would be changing considerably by adding overseas shipping, and the proper method in that situation is for the contracts to be resolicited[67]. Since the Naval Construction Force is only one small user of the Department of Defense wide contracts, the justification to resolicit would not receive the necessary support required to justify that drastic action.

The second reason for the Regimental Project Material Division reviewing and packing the material is that the material takes approximately 30 to 45 days to arrive overseas when shipped by sea. The concern is that, if the supplier directly ships the wrong construction material to the overseas location, it will take that entire time to realize the material is wrong, and then another minimum of 30 to 45 days to have the proper material shipped. When a Construction Battalion has only six months to complete a project, a two-month delay of critical material would have a major impact on the completion of the project. This concern can be resolved through better communication and use of information technology, which will be discussed in Chapter 6.

The third reason is that the Construction Battalions receiving the construction materials overseas are in such a time crunch to complete their projects, they do not always take the time required to thoroughly dig through a container and properly inventory all construction material that arrives in the container. If construction material was shipped directly by the material supplier, the Construction Battalion would be required to perform a detailed inventory to ensure that everything the government paid for was received. This is similar to the concerns that the Army had during Desert Storm, which led to the creation of Total Asset Visibility covered in Chapter 2. This construction material receipt and packing stage takes the Regimental Project Material Division approximately three days to accomplish for CONUS materials.

5.2.7 Construction Material Shipping

The typical method of shipping the construction material overseas is by a Department of Defense commercial transportation, shipping contract. Due to cost constraints, shipping by sea is the method of choice for peacetime construction. Commercial air shipping is also an option, but due to the extreme difference in cost, commercial air shipping is only used in the case of emergencies.

Shipping on military air transport is also an option, but usually not a favorable one for peacetime situations. Although it is cheaper to ship the material by military air transport, the current policies for shipping on military transport are not favorable for shipping Seabee construction material. Unless the construction material is rated as urgent by the transport command, it is only considered space available. In most peacetime cases, construction material for a Seabee project does not meet the criteria required for a priority rating. Therefore, it must go as a "space available" shipment. Furthermore, since most construction material is heavy or bulky, it can sit for days or weeks waiting for a flight that has enough "space available" room to support the construction material. Another problem is that most flights lay over at various bases on a route, and the material runs the risk of getting bumped at any one of those stops if there is enough priority cargo waiting at that stop. The construction material currently does not have any way of being tracked, and once it is turned over to the transportation personnel, there is no method of knowing exactly when the material will arrive, and no efficient means to find out where the material is at. Therefore, by using military air transport, the Regimental Project Material Division cannot predict when their material will arrive at its overseas destination, and the Division has no control or influence over that process.

In wartime, military air transport is a viable option because there is a much higher probability that the construction material can be found to be mission essential, and receive a priority rating. Also, during wartime and in the buildup to war, there are many more military flights and government contracted flights headed into the area of operation, and that leads to greater opportunities for the construction material to be scheduled on those military flights. This issue is another justification for why the Naval Construction Force should ensure that it is focusing on the Joint Vision 2020 and ensuring that it is part of the Joint Total Asset Visibility Plan, because in a future joint operation, the Seabee construction material should

have the capability to be tracked by barcodes and the Global Combat Support System identified in Chapter 2, just like the other cargo on that plane.

5.2.8 Construction Battalion Receipt of Materials

Once the container arrives at its overseas destination, the Construction Battalion receives the container, reports to the Regimental Project Material Division that the construction material was received, and they unload the container. The division in the Construction Battalion that is responsible for the receipt and control of the construction material is the Material Liaison Office (MLO).

This step is not without its share of problems. As stated previously, the Seabees do not have an automated tracking system, and many times the Construction Battalion on site does not know the material has arrived because the shipper drops it off at the port, and from there it is the responsibility of Department of Defense personnel working with the pier to ensure that the Construction Battalion is notified that the shipment has arrived. This notification does not always happen in a timely or efficient fashion.

Currently, the commercial shipper provides an estimated time window for arrival, but the unit is not given a specific arrival date. Many times, the material will sit on the pier for a week or longer until the notification occurs. The communication gap between the Regimental Project Material Division in the United States and the Construction Battalion overseas also results in miscommunication on issues of shipping arrival times, and even the material that is packed in the containers. This is especially true when a Construction Battalion is on site, and requests additional construction material, or makes a change to construction material. These are known as add-ons bills of material, and will be discussed in greater detail in Chapter 6. The add-ons probably create the most confusion and problems in the chain.

5.2.9 Local Material Procurement

The locally procured construction material is handled by the Material Liaison Office of the Construction Battalion. Each overseas location is different, and the Material Liaison Officer relies on support from the public works personnel of the base where the Construction Battalion is working to assist with the various material procurement options available. In some overseas locations, the Base Supply Department is the best method of procurement. Other bases have contracts with local vendors that the Construction Battalion can utilize. Also, usually at least one member of the Material Liaison Office has a government credit card, which is the method of choice for small items that are needed quickly, as stated previously, the single purchase threshold for construction material is $2,000.

During wartime, and even some remote locations in peacetime, the government credit cards are not a viable option because many vendors overseas do not have capability to accept credit cards. This was a lesson learned from OPERATION IRAQI FREEDOM, in which many Construction Battalions experienced local suppliers that would not accept credit cards, only wanted to deal in cash[68]. This caused problems, because most Department of Defense contracting mechanisms involve paperwork and credit.

5.2.10 Seabee Construction Material Time Analysis

As stated in Chapter 3, when mapping a supply chain, the average times for each step are an important aspect of the mapping process. The peacetime average duration for each step are provided in Figure 5-1, and are based on data obtained from the 30th Regiment Project Material Division.

5.2.10.1 *Peacetime Construction Material Time Analysis*

Figure 5-4 provides a graphical representation of the time required for each step in the United States peacetime procurement scenario. It also provides a cumulative total time for the project material portion of the construction supply chain. From the graph, it shows that the average time from when drawings are received, until the project material arrives on site is approximately 120 days for material purchased in the United States and shipped overseas, which is the worse case scenario. For project material that is ordered locally by the

Construction Battalion, the total cumulative time for the process is approximately 64 days because the shipping and receipt steps identified in Figure 5-4 are not required.

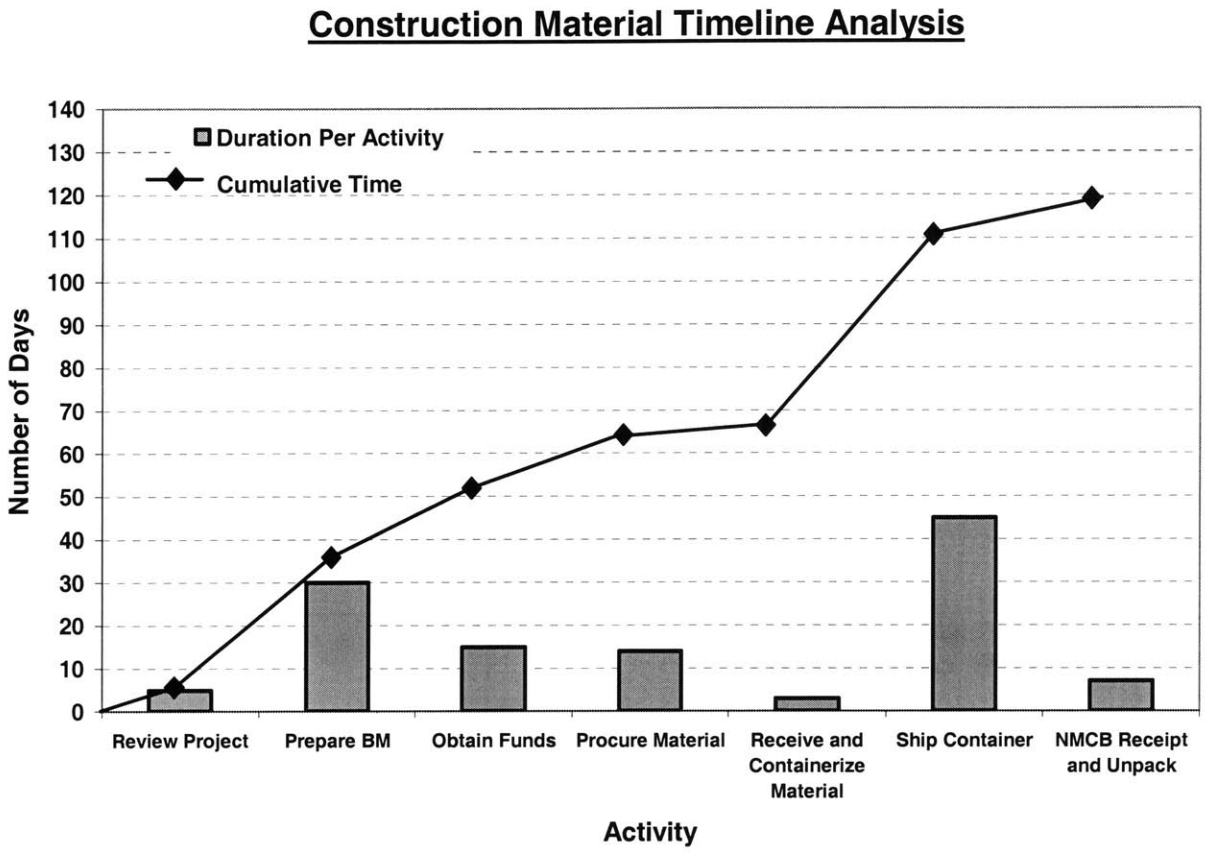


FIGURE 5-4: NCF PEACETIME CONSTRUCTION MATERIAL TIME ANALYSIS

The chart shows that the steps requiring the greatest amount of time in the project material supply chain are for the preparation of the bills of material, and the shipping of the material from the United States to its overseas destination. These two steps alone account for over 50% of the time required for the entire process. As long as materials are containerized and shipped on sea, the time for shipping will remain the longest duration item in the chain, because of the limitations on transit time. However, by improving efficiencies on the support functions of preparation and receipt of containers, a time savings can still be realized. Also, the planning and estimating function can become more efficient through use of information technology improvements. The recommendations for providing a time and cost savings to the process will be provided in Chapter 6.

5.2.10.2 *Contingency / Wartime Construction Material Time Analysis*

Figure 5-5 provides a graphic representation of the average time required for each step of the United States material ordering process for a contingency scenario. It also provides the cumulative time for the process. The graph shows that it could take approximately 30 days for material to be received in a contingency or wartime situation. This again represents the worse case scenario for wartime material, and takes into account preparation of bills of material and shipping of the material. If the material were ordered locally by the Construction Battalion, the material could be received as fast as a few days if the supplier has the material on hand, and the contracting vehicles are in place and acceptable to the local method of doing business.

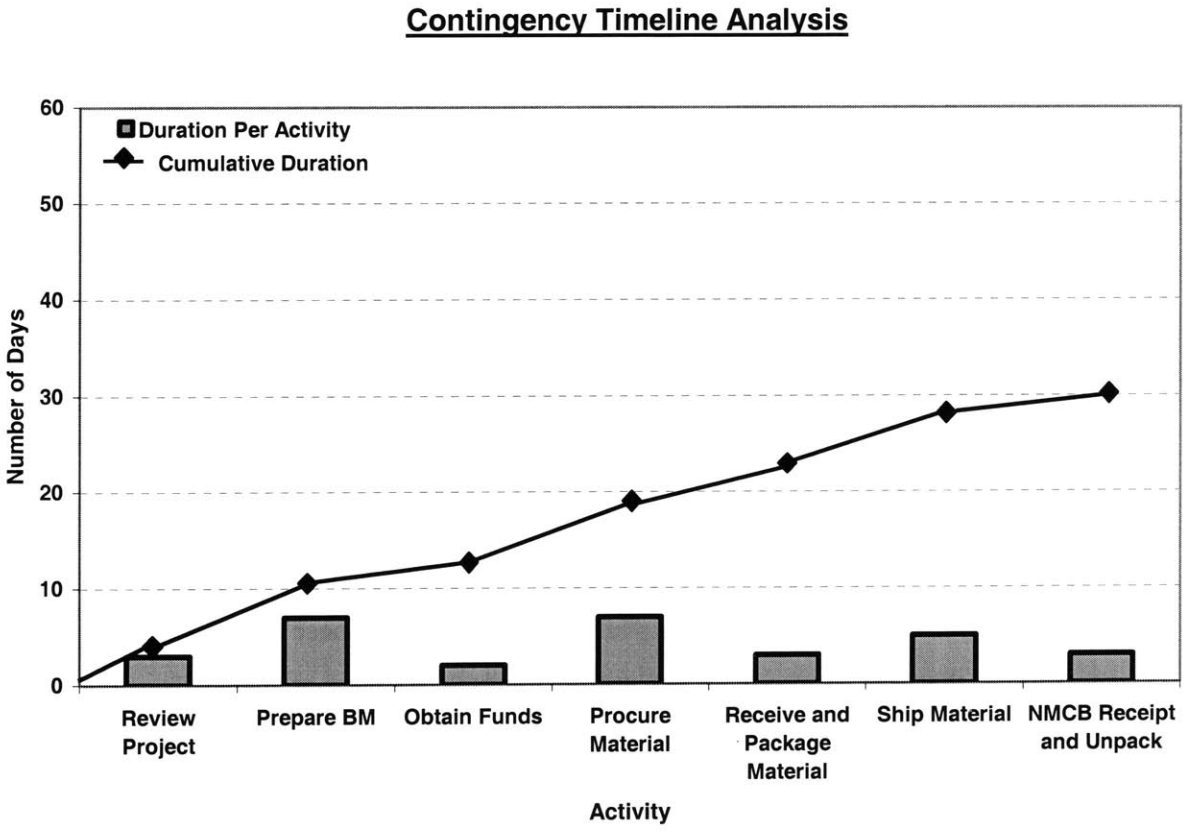


FIGURE 5-5: NCF CONTINGENCY CONSTRUCTION MATERIAL TIME ANALYSIS

Figure 5-5 takes into account time for a bill of material to be developed. As stated previously, in a contingency or war, the projects are much less technical. Also, if it is standard battlefield construction, the bills of material may already be on file in the Advanced Base Facilities Component Guide. However, since many of these standard bills of material are not yet electronically maintained, it takes time to transpose the bill of material into the proper format. The chart also shows approximately 7 days for material to be received by the Regimental Project Material Division from the material supplier. In many cases, standard materials can be received much faster, even if it may cost a little more. The shipping identified in the chart takes into account that much more air shipping is used during a war or contingency, so the shipping time is considerably less than the required time for sea shipping in the peacetime scenario.

5.3 SUPPLY AND DEMAND ORGANIZATIONS

As presented in Chapter 3, the construction supply chain consists of a supply organization and a demand organization. Figure 3-2 illustrated the relationships between the various players in the construction value chain, and how they are incorporated into a supply or demand organization. To put it simply, the supply organization consists of all the players who are involved with the construction portion of the project. The demand organization consists of all the players that provide funding and will be the end users of the facility. The relationship between the supply organization and the demand organization is important because of the flow of information in the chain.

The information flow in a construction supply chain is shown in Figure 5-6[69]. This figure illustrates how the general contractor forms a link between the supply organization and the demand organization. Therefore, the efficiency of the construction supply chain is greatly affected by the ability of the general contractor to successfully act as a communication liaison between the supply and demand organizations.

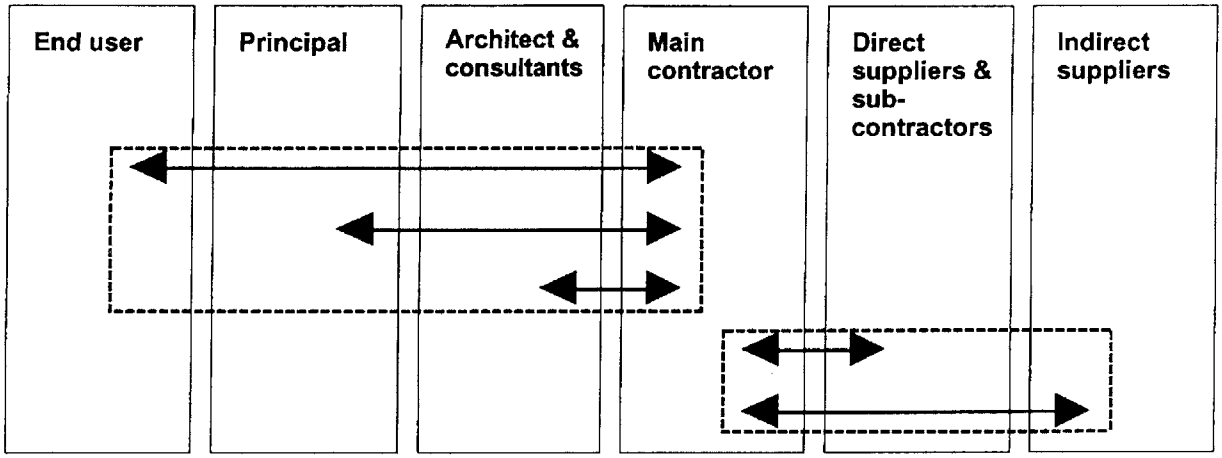


FIGURE 5-6: COMMUNICATION FLOW IN CONSTRUCTION SUPPLY CHAIN[69]

The Seabee construction supply chain that was mapped in Figure 5-1 illustrates the supply and demand organizations of that chain. In the Seabee construction supply chain, the link between the supply and demand organization is the Naval Construction Regiment Project Materials Division. Therefore, the communication and interactions that the project Material Division has with other members of the supply chain is critical for the efficiency of the Seabee construction supply chain.

Since the Regimental Project Materials Division is such a critical link in the chain, the next section will perform a value chain and value system analysis on the Project Materials Division in order to gain insight into the organization and those that are directly linked to it.

5.4 SEABEE VALUE CHAIN AND VALUE SYSTEM ANALYSIS

Chapter 3 provided an overview of the Michael Porter value chain and value system analysis. This section will apply those techniques to the current Naval Construction Force class IV material supply process. Although the techniques were developed for private firms to develop a competitive advantage in their industries, the techniques are also beneficial for analyzing the Seabee construction material supply processes to highlight areas of improvement and make the system more efficient, which is favorable to saving tax payer money.

In performing the analysis, three specific value chains were developed. The first was developed for the Regimental Headquarters. The second was developed for the Regiment Project Material Divisions, and the final was developed for the typical Construction Battalion. While these value chains present similar primary activity information as the construction supply chain map in the previous section, the value chains provide an opportunity to highlight relationships among the primary activities. It also highlights the specific items of personnel and technology (secondary activities), and the effect that these have on the Seabee construction supply chain process. The primary and support activities used by Michael Porter are applicable except for the "marketing and sales" primary activity because that does not apply to a government entity. Therefore "marketing and sales" will be identified as not applicable on the value chain diagrams. This section will present the three specific organizational value chains and also present the value system for the entire Seabee construction material process.

5.4.1 Regimental Headquarters Value Chain

The Regimental Headquarters value chain was developed based on research and interviews conducted with Naval Construction Force personnel. The value chain is provided as Figure 5-7. The primary activities that are identified on Figure 5-6 were explained in detail in sections 5.2.2 to 5.2.4. However, many of the support activities identify new issues and topics of discussion that were not identified by mapping the supply chain in the previous section.

On the Regimental Headquarters value chain, there are some specific items worth noting. The first item is that primary activities identified in the value chain are performed by all active duty military personnel. Therefore, these personnel rotate out every few years, and training is an important issue. On the other hand, there are no civil service employees associated with these tasks, which allows for more flexibility of shifting labor assets if changes are proposed.

The second major issue is the technology that is used to perform the tasks. Currently, the Regiment uses Excel to layout and schedule projects to the Construction Battalions. The spreadsheets are saved onto an intranet website that Construction Battalions and Regimental personnel can access. However, the schedules are usually updated daily, and not always

posted, and when they are posted, the other members of the supply chain are not notified of the changes. This may not sound like a major issues, but each Regimental Construction Material Division manager usually has approximately 60 to 80 projects, at any one time, in various phases of the supply chain from initial reviews, planning and estimating, to procurement and shipping. Therefore, it is not feasible for the manager of the Regimental Project Material Division to review the schedules daily to try and figure out what changes were made. Automatic notifications would benefit the members of the supply chain, and this will be discussed in the next chapter. The Regiments have also developed a database called the Project Information Tracking System (PITS) to assist them with scheduling and tracking projects.

If designs are submitted electronically by the Public Works Department, the designs are also posted on the website. However, these also change frequently, and many times the revised versions are not posted, and when they are, there is no electronic notification to alert all members of the construction supply chain. This results in rework for planners and estimators as well as erroneous material orders. Both of which negatively affect the efficiency of the Seabee construction supply chain.

5.4.2 Regimental Project Material Division Value Chain

In the traditional value chain analysis, normally only one value chain is drawn for each organization. However, in this case, it was decided that the Regimental Project Material Division would be drawn exclusive of the Regimental Headquarters value chain. The decision for doing this is twofold. First, since the Project Material Division was just recently reorganized to fall under the Regiment, their infrastructure and geographic locations still have them operating like separate organizations from the Regiments. Secondly, with the level of detail and amount of primary activities that the Regiment performs under the reorganization, it would have been difficult to include all activities on one value chain and still obtain a meaningful analysis on the support activities. For these two reasons, the Regimental Project Material Division value chain is drawn separately, and is provided as Figure 5-8.

FIGURE 5-7: REGIMENTAL HEADQUARTERS VALUE CHAIN

Naval Construction Regiment Construction Material Firm Value Chain

	Inbound Logistics	Operations	Outbound Logistics	Mkt and Sales	Service
Firm Infrastructure	One Division, Two Regiments (NCR), Two Seabee Readiness Groups (SRG's), 8 Construction Battalions (NMCB's)				
HRO	-Active duty mlitary -Training required	-Active duty mlitary -Training required	-Active duty mlitary -Training required		-Active duty mlitary -Training required
Technology	-Email	-PITS -E-mail -Website	-Excel -E-mail -Website		-Excel -E-mail -Website
Procurement	-Office supplies through Navy procurement	-Office supplies through Navy procurement	-Office supplies through Navy procurement		-Office supplies through Navy procurement
	-Receives request for work from Public Works offices -Receives drawings and funding from Public Works offices	- Reviews design -Schedules project to a specific NMCB	- Sends project drawings to NMCB and Reg. Proj. Material Division. -Coordinates and sends funding to NMCB and Reg. Proj. Mat. Division for material procurement	Not Applicable for government organization	- Schedules projects and reviews construction progress. - Provides support for dealing with design and funding issues.

The primary activities and procurement support activities presented in this value chain were explained in detail in sections 5.2.2 to 5.2.7. The items worth noting on this value chain, similar to the previous chain is the human resources and technology support activities. The human resources activity illustrates that both civilians and active duty military currently perform these functions. Since the civilians are permanent, and have construction expertise, their training involves refresher courses, new technology seminars, and new software classes. There is also great difficulty with moving or abolishing the civilian positions, which must be taken into consideration for any recommendations. Another item worth noting about the human resources support activities is that both Regimental staffs feel that they are undermanned, and are currently augmenting their planning and estimating staff with senior, active duty Seabees who have considerable construction experience and are capable of providing planning and estimating support. However, these Seabees generally are not as technically competent on software applications as the civilian workforce, and therefore require training on the Timberline software and possibly Excel also. The active duty Seabees do provide the planning and estimating staffs with flexibility during workload fluctuations.

The Regimental Project Material Divisions currently uses many software applications to perform their primary activities. As stated previously, Timberline estimating software is used by the planning and estimating staffs. Once a bill of materials is completed, it is converted to an Excel file that can be e-mailed to the material supplier, and the Construction Battalion that will be performing the work. This results in duplication of work, as well as the potential for errors because when revisions are made, they must be covered on both programs. The Project Coordinators Database and Seabee Automated Maintenance and Management System are management and scheduling tools for the Regimental Project Material Division that were discussed in the previous section.

The Regimental Project Material Divisions are currently finalizing a new software application that was specifically designed for the Seabees. This application is called the Project Material Planning and Tracking Program (PMPT), and was created as an answer to the confusion and miscommunication that existed between Regiments and the Construction Battalions overseas. It is specifically designed to improve communication between the Regimental Project Material Division and the Material Liaison Offices of the Construction Battalions. This program will be a web-based application that the Regiments and

Construction Battalions can both access. It can be characterized as a mini-collaboration software package that allows the Regiments and Construction Battalions to be more efficient. It will allow the Regiments to post the bills of material on the site and the Material Liaison Offices to get the real time data that they can use to update their inventory sheets. The software is in its final stages of development and will be fielded within the next year. The software was designed with an open architecture database, so that in the future, it can be altered to be compatible with other web based applications.

5.4.3 Naval Mobile Construction Battalion Project Material Value Chain

The value chain prepared for a Construction Battalion is provided as Figure 5-9. The primary activities and procurement support activities presented in this value chain were explained in detail in sections 5.2.3 to 5.2.9. This value chain covers the primary activities associated with project material from initial receipt of the material through turnover of the facility to the Public Works Department.

The Construction Battalion is comprised exclusively of military personnel, due to the fact that it deploys to war zones. However, there are no personnel in the unit that are trained exclusively for Material Liaison Office techniques. A group of Seabees are picked early in a Construction Battalion homeport to be a part of the Material Liaison Office for the upcoming deployment, and during that homeport, they receive the training necessary to perform the job. Therefore, training is instrumental for successful material liaison operations on deployment. Most Seabees perform this job for one deployment cycle, and then return to their trade. As a result, there is no continuity between deployments, and many deployment sites have developed their own Material Liaison Office procedures. The issue of training and the need for standardized procedures are important and will be discussed further in the next chapter.

Regimental Project Material Division Construction Material Firm Value Chain

	Inbound Logistics	Operations	Outbound Logistics	Mkt and Sales	Service
Firm Infrastructure	One Division, Two Regiments (NCR), Two Seabee Readiness Groups (SRG's), 8 Construction Battalions (NMCB's)				
HRO	-1 Civ. Warehouser -Active duty military -Training required	-6 Civilian P&E -Active duty military -Training required	-1 Civ. Warehouser -Active duty military -Training required		-Civilian Manager -Active duty military -Training required
Technology	-Excel and PMPT for mat. inventory -E-mail for drawings	-Excel and PMTP for mat. inventory -Timberline for P&E	-Excel and PMTP for mat. inventory -E-mail		-Excel and PMTP for mat. inventory -E-mail
Procurement	-P. Vendor, IMPAC, Supply Dept. for CONUS material	-Office supplies -Timberline upgrades	-Shipping contractor for CONUS material shipment		-Office supplies through Supply Dept.
	-Receive CONUS construction materials from contractor. - P&E Dept. Receive drawings from NCR.	- Perform P&E - CONUS materials reviewed and prepared for shipping - CONUS material inventory is updated in Excel.	- Completed BM's sent to battalion and NCR. - CONUS material shipped via shipping contractor (usually by sea)	Not Applicable for government organization	- Coordinate with Seabee unit for delivery of CONUS material -Coordinate with NCR for funding.

FIGURE 5-8: REGIMENTAL PROJECT MATERIAL DIVISION VALUE CHAIN

The Project Material Planning and Tracking Program that was explained previously will be implemented as a means to standardize procedures at the various deployment sites, as well as improve communication. However, many deployment sites are currently using Excel spreadsheets to assist in performing their material inventories. The Construction Battalions also use another Navy specific software called Construction Battalion Construction Management (CBCM) which is a scheduling software that develops a critical path schedule for a project and identifies all resources required. It is the Seabee equivalent of Microsoft Project with resources specifically setup for the Naval Construction Force. The CBCM schedules are reviewed by the Regiment Headquarters, but are not seen by the Regimental Project Material Divisions. It is the responsibility of the Material Liaison Officers and the crew leaders of the Construction Battalion to ensure that all construction material is received on time to maintain the critical path of the project. It would benefit the Construction Battalions and Regimental Project Material Divisions if the schedule could be shared by both organizations because the material procurement could be prioritized better. This will be discussed further in Chapter 6.

When a project is complete, the turnover between the Public Works Department and the Construction Battalion is still completed by hard copy documents. All users manuals for equipment and a warranty letter are provided to the Public Works Department after a final walk through and punch list are completed.

Naval Construction Battalion Project Material Firm Value Chain

	Inbound Logistics	Operations	Outbound Logistics	Mkt and Sales	Service
Firm Infrastructure	One Division, Two Regiments (NCR), Two Seabee Readiness Groups (SRG's), 8 Construction Battalions (NMCB's)				
HRO	-Active duty military -MLO Training required	-Active duty military - Construction Training required	-Active duty military		-Active duty military
Technology	-Email -Excel and PMTP for mat. inventory	-Scheduling Software (CBCM)	-E-mail - All else handled by hard copy		-E-mail -All else handled by hard copy
Procurement	-Local materials through local DOD procur. vehicles	-Local materials through local DOD procur. vehicles	-Office supplies through Navy procurement		-Office supplies through Navy procurement
	-Receives CONUS shipments of mat. -Procures local material through MLO organization. -Construction equipment is Navy assets or rented as required.	- Maintain material inventory -Construct project within budget	- Provide completed facility to Navy Public Works office.	Not Applicable for government organization	- Provide quality construction. -Provide on-time construction. -Provide cost effective construction. -Provide a one year warranty.

FIGURE 5-9: CONSTRUCTION BATTALION PROJECT MATERIAL VALUE CHAIN

5.4.4 Seabee Construction Material Value System

The Seabee construction material value system is provided as Figure 5-10 and illustrates the relationship between the value chains of all the key players in the Seabee construction material supply chain. The value system is similar to the construction material supply chain that was presented in Figure 5-1. However, the value chains of the three major players, the Regimental Headquarters, The Project Material Divisions, and the Construction Battalions have been presented in an exploded view to illustrate a very important relationship that exists and will be important for analysis presented in the following chapter.

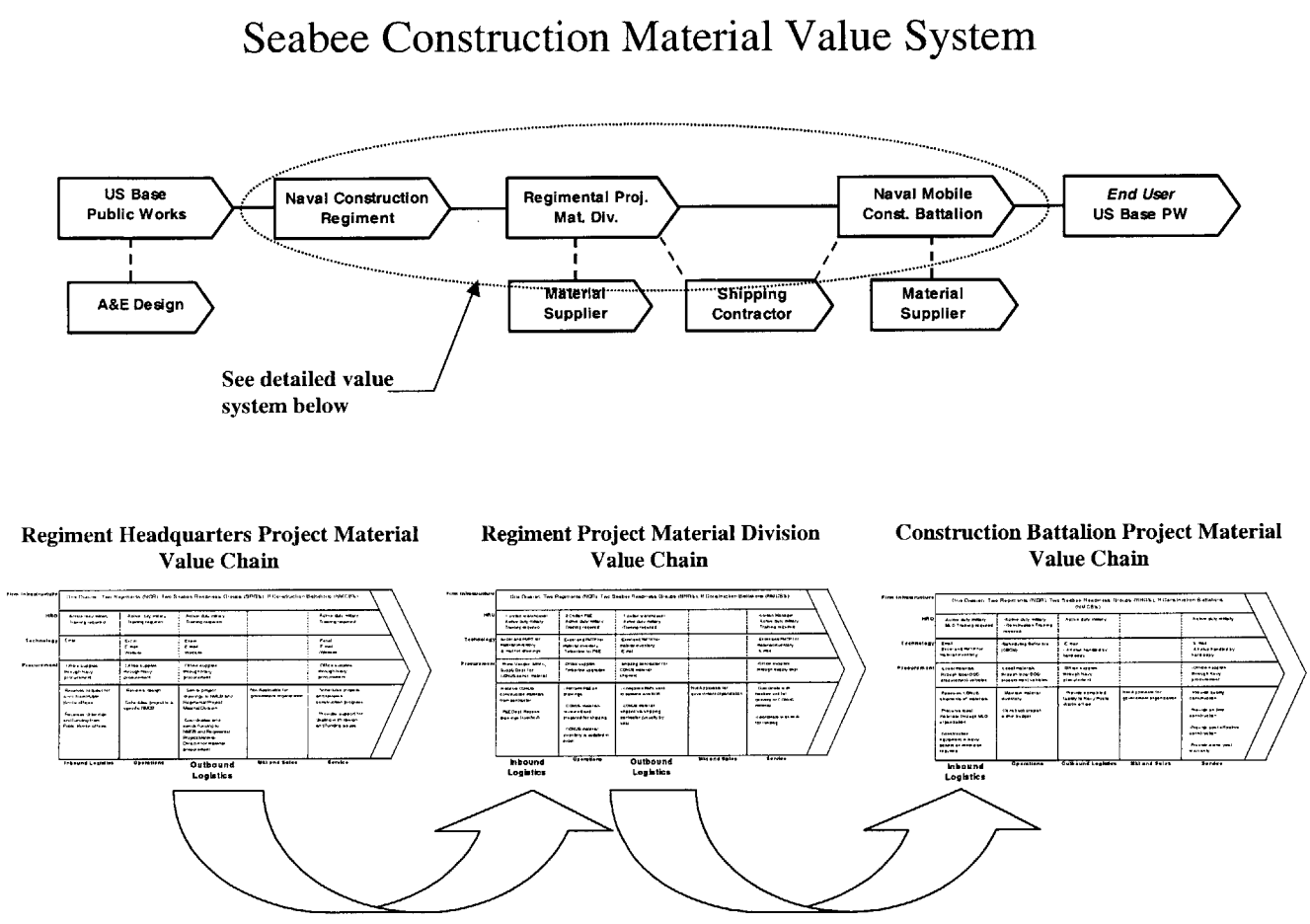


FIGURE 5-10: SEABEE CONSTRUCTION MATERIAL VALUE SYSTEM

The "outbound logistics" for the Regimental Headquarters value chain is directly affected by the "inbound logistics" for the Regimental Project Material Division value chain. Likewise, the "outbound logistics" for the Regimental Project Material Division value chain directly affects the "inbound logistics" of the Construction Battalion value chain. Therefore, these are crucial links in the value system, and represent areas where efficiencies can be realized by taking advantage of technology to improve procurement, communication, cost, and time, which will be discussed in Chapter 6.

5.5 CHAPTER SUMMARY

This chapter provided an in depth analysis of the Naval Construction Force project supply chain. The entire construction supply chain, from the base public works recognizing a requirement to the completed facility being turned over by a Construction Battalion, were mapped and explained. The current time requirements for each step of the project material process were also graphed to illustrate the average duration required from when the Naval Construction Force receives drawings to materials arriving in the hands of a Construction Battalion overseas. This chapter also analyzed the value chains for the Regimental Headquarters, Project Material Divisions, and Construction Battalion, as well as the value system. By performing these analyses, a thorough understanding of the inter-relationships of the various players involved in the Seabee construction supply chain was accomplished. The analysis also provided valuable insight into the processes currently in place in the supply chain to help identify inefficiencies in the current chain, and provides the foundation for Chapter 6.

While this paper is focused on Naval Construction Force class IV project material, an understanding of the entire supply chain is necessary, because all of the steps in the chain have an effect on the project material portion of the chain. Chapter 5 provided the analysis and information required to fully understand how the current Naval Construction Force project supply chain is organized. Chapter 6 will take the analysis from Chapter 5 and combine that with the research and information provided in Chapters 2 through 4 to explore potential future efficiencies in the Seabee construction supply chain and will provide recommendations for changes to the Seabee supply chain that can improve cost and time requirements in the chain.

CHAPTER 6: IMPROVING THE SEABEE PROJECT MATERIAL SUPPLY CHAIN

"Over the past decade, the American commercial sector has reorganized, restructured, and adopted revolutionary new business practices in order to ensure its competitive edge in the rapidly changing global marketplace. It has worked. Now the Department must adopt and adapt the lessons of the private sector if our Armed Forces are to maintain their competitive edge in a rapidly changing global arena."

-William S. Cohen
Secretary of Defense (1997)

6.1 CHAPTER OVERVIEW

Chapter 5 provided a detailed analysis of the current Naval Construction Force supply chain as well as the value chains for the Regiment and Construction Battalions. This chapter will use the results of that analysis, along with the research performed in chapters 3 and 4 to identify parts of the chain that can operate more efficiently through leveraging the management concepts and information technologies that were identified in the previous chapters.

Through interviews with personnel in the Seabee construction supply chain, personal experiences, and a review of lessons learned from previous Seabee deployments, Figure 6-1 provides a summary of the areas of concern throughout the entire Seabee construction supply chain. A few of the items in this illustration are beyond the control of the Naval Construction Force, and beyond the scope of this paper. However, they do have an effect on the Seabee construction supply chain and have been identified on the figure for completeness. For example, the funding issues identified under the Base Public Works portion of the chain are a result of the Department of Defense funding process, which is a macro level issues that would need to be solved by restructuring the entire Congressional budgeting process, and is beyond the scope of this paper. However, the effects that those funding issues have on the remainder of the chain will be discussed, and how the issues can be mitigated by improving the efficiency of the downstream, controllable end of the chain will be studied because it has a definite affect on the successful operation of the chain.

From reviewing the information provided in Figure 6-1, it becomes apparent that there are several areas in the Naval Construction Force supply chain that have the potential to operate more efficiently. The areas that will be discussed in this section are: standardization of processes, improved training, move to a paperless process, use of project collaboration software, and improved methods of shipping and procuring materials.

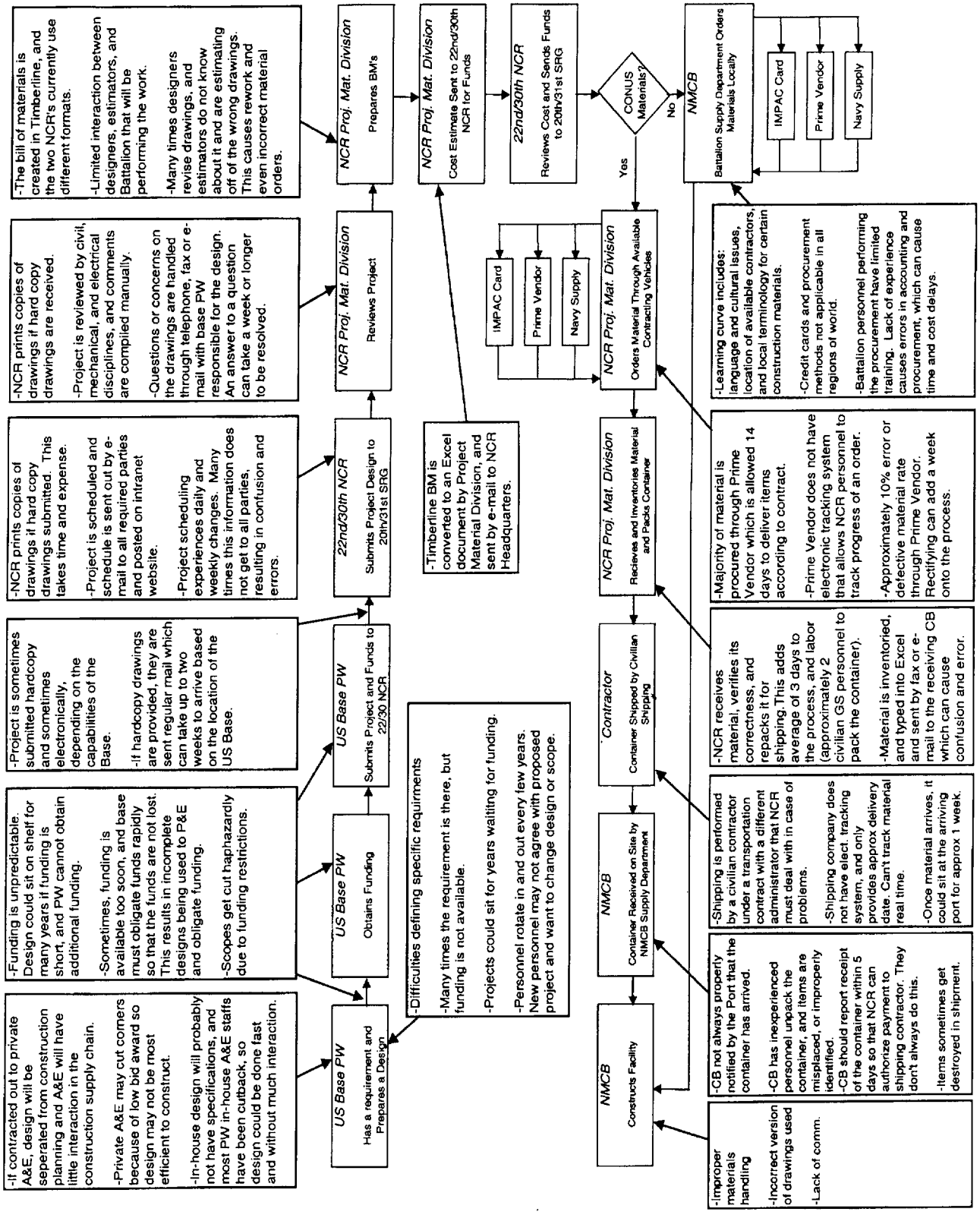


FIGURE 6-1: SEABEE CONSTRUCTION SUPPLY CHAIN PROBLEMS

6.2 STANDARDIZATION OF PROCESSES

In many parts of the supply chain analysis provided in Figure 6-1, there are examples of how the various players in the chain are currently utilizing different information technology applications for managing their processes. They also use different formats and processes for handling bills of material, which create confusion and inefficiencies in the system. This section will review the differences that exist between the Regiments and Construction Battalions and will explain how those differences cause inefficiencies in the supply chain.

6.2.1 Regimental Processes

The 30th Regimental Projects Division uses a database that was constructed locally (Project Coordinators Database) to manage the scheduling and workflow of projects. The 22nd Regimental Projects Division uses the Seabee Automated Management and Maintenance System to perform the same function. Both applications are unique, and have different restrictions that have influenced the divergence of standard formats and processes between the two Regiments.

Probably the largest issue that has been identified is that the Regiments do not use a standard format for their final bills of material. While both Regiments use the Construction Standards Institute (CSI) 16 section format, The 22nd Regimental Projects Division uses separate sections for local and United States procurement, while the 30th Regimental Projects Division uses one bill of material for each CSI section, and codes the line items as local or United States procurement.

There are two main reasons for the importance of standardizing the bills of material. First of all, the Construction Battalions rotate their deployments to both Regimental areas of responsibility. The different formats that are used by the Regiments causes confusion for personnel in the Construction Battalion and many times results in double orders or failures to place orders. The following example has been a common reason for double orders in the past. A Construction Battalion crew leader performed a deployment under the 22nd Regiment and was accustomed to reviewing a bill of materials for his project that was in a CSI section. He and the Material Liaison Office were responsible for ordering everything on that bill of material. That person now deploys as a material liaison expeditor to an area under the

responsibility of the 30th Regiment, and orders everything on the bill of material for a CSI section, not recognizing that there are codings to identify local and United States procurement on the bill of material. Meanwhile, the items coded as US procurement have been procured, containerized and are already on their way to the deployment site by the Regimental Project Material Division. While this situation can be rectified, it takes time and results in a possible restocking charge to the government by the vendor. This double ordering scenario has happened in the past, and is the direct result of inefficient communication and confusion with understanding the bill of material.

The second reason for standardizing the bill of materials is to make development and implementation of information technology easier. In order to use project collaboration software or the Project Material Planning and Tracking Program software that is currently being developed, standardized bills of material will enable a more efficient and standardized approach that can be incorporated into the software. As this paper is being written, the two Regiments are working on standardizing their bill of material so that they can implement the standard bill of material format into their Project Material Planning and Tracking Program, and rectify the problems that were identified above.

6.2.2 Construction Battalion Processes

Another area that requires standardization is the project material inventory processes at each deployment site. As stated previously, each deployment site has developed their own home grown excel spreadsheets or access databases to track material inventory. The main reason that this has happened is because the last project material inventory program that the Seabees had was a DOS program that was not Y2K compliant. Therefore, each deployment site created simple spreadsheets and databases to ensure that their inventory was not lost at the turn of the century. Since then, no standard application to replace the DOS program was developed, so a home grown spreadsheet or database at every site has evolved over the last few years, with no standard format being followed, and the level of sophistication being based on the computer skills knowledge level of the personnel at that site. While every site has an application that is effectively used to help them inventory and organize construction project material at that site, it is not an overall efficient method of managing the entire macro level process.

The good news is that these applications are simple to use, and allow the Battalion to maintain a fairly accurate inventory. However, the bad news is that since each location has a different application with different formatting, there is no uniformity. Therefore, when new material arrives from the United States, the material must be manually entered into the spreadsheet at the site. This results in inefficiencies and creates an increased chance for keystroke errors. If one standard method was used, the shipped material inventory could easily be sent electronically for the Regimental Project Material Division, and directly downloaded into the battalion tracking system, saving time and the potential for errors. The new Project Material Planning and Tracking Program under development is being created specifically for this purpose. However, the new program is designed to be a tool exclusively for the Regiments and Construction Battalions, and will require the Regiments to manually input the inventory information into the database.

6.3 IMPROVED TRAINING CURRICULUM

The Navy currently has a training curriculum for personnel who will be assigned to the Material Liaison Office while on deployment. This training curriculum covers standard items such as warehouse procedures for maintaining inventory, and also covers general procurement issues that can be experienced during a deployment. The curriculum that is currently being used is out dated, and many of the applications that are covered in it no longer apply. For example, the curriculum still has a section on the obsolete DOS project material inventory system that was discussed in the previous section. As stated previously, the Seabee Readiness Groups are the units responsible for providing the training to the Construction Battalion personnel, and currently provide the training from the old curriculum. Use of this old curriculum results in inefficient material liaison operations when the Construction Battalion deploys because the personnel require more on the job training to gain proficiency.

The training that is provided by the outdated curriculum results in personnel who deploy without all the knowledge that they should possess on the current methods of project material supply and inventory. This lack of knowledge results in a greater learning curve at the deployment site, as well as an increased chance of errors, which will result in time and money being wasted. This is a cause of inefficiencies in the system.

By rewriting the Material Liaison curriculum and incorporating the new concepts that are currently being applied, the personnel will receive pertinent training that they will benefit from when they deploy, and will result in a more efficient Material Liaison operation on deployment. However, due to the cost and time associated with rewriting a curriculum, this should be one of the last items that will be addressed, so that the latest concepts and information technology initiatives can be included in the new curriculum. If new information technology is employed, it should become part of the curriculum. For example, the Project Material Planning and Tracking Program will definitely need to be a part of the new curriculum when development is complete because a thorough understanding and proper use of it will provide superb benefit to the efficiency of the supply chain.

As stated in Chapter 5, the planners and estimators should also receive training on the software applications as well as the latest technologies in the construction industry. Currently, all of the training that is provided to the planners and estimators is very sporadic and does not follow an organized plan. Many of the planners and estimators have learned Timberline and Excel through on the job use of it, but have not received any formal training. By developing a training plan that includes the latest information technology that the planners and estimators use, as well as the applications that they will be using in the future, can result in a more efficient and productive workforce.

6.4 MOVE TO A PAPERLESS PROCESS

Figure 6-1 illustrates that there are many areas in the Seabee construction supply chain where hardcopy correspondence is still being used. While it may not be possible to totally eliminate hardcopy transfer of information, this practice should be reduced as much as possible. As stated in Chapter 4, Johnson and Johnson was able to save 9% of total project costs by using collaboration software, and they credit a large portion of that savings to reducing the paperwork and its associated costs. The reduction of hardcopy paperwork can result in both a time and cost savings in the Seabee construction supply chain.

For example, some of the construction drawings provided by Public Works Departments are still in hardcopy format, which causes added time and expense in the process. To illustrate this with a real life example, consider that an overseas Public Works Department in the 30th NCR area of operations has a hardcopy set of plans for a project they

want the Seabees to do. They prepare and mail the plans to the 30th NCR headquarters in Hawaii. Depending on the time of year, and volume of mail, the drawings could take up to two weeks to arrive at the 30th NCR. Once received, the Regiment will have an administrative person log them in as received, and then make at least three copies of the drawings; this adds approximately two days onto the process. Once the Regiment reviews the drawings, a copy must be sent to the Regimental Materials Division in California, so a copy of the drawings are packed up and shipped to California, which adds approximately another week of time to the process. When the Regimental Materials Division receives the drawings, another administrative person must log them in and make five more copies for the planning and estimating phase, which adds another two days to the process. As you can see, the hard copy process alone can add approximately three weeks and considerable shipping and reproduction costs to the supply chain, and no estimating or material procurement has even begun yet. Since most Public Works Departments civilian designers use computer aided drafting, it would not be a difficult transition if the Regiments required Public Works Departments to submit electronic copies of the construction documents, and this should be added to the Seabee Call for Work process.

Another concern when dealing with hard copy paperwork is that the possibility of errors and miscommunication increases. This is especially true at the Regimental Project Material Division where they are dealing with approximately 80 projects at any one time. The faxing and mailing of correspondence between Prime Vendors, Construction Battalions, and Regimental Headquarters produces a large administrative burden, and requires adequate administrative personnel support to keep everything moving. It is easy for correspondence to be misplaced or forgotten. Lessons learned from previous deployments identify the issue of add-ons or change orders as causing the largest problem. These are usually one-page sheets prepared by a deployed Construction Battalion identifying a few line items of material that they need to procure from the United States. The problem arises when there are multiple (three or more) add-ons for the same project, and multiple single sheet bills of material being processed at the same time. Miscommunication between the Regimental Project Material Division and the Construction Battalion or supplier occurs frequently. These miscommunications and mistakes ultimately lead to time delays in the project.

Defense Industrial Supply Center (DISC) manages the Prime Vendor contracts, and was discussed in Chapter 5. One of their main goals is to move to a paperless process for procurement. Since the procurement process is a major part of the Seabee construction supply chain, and the Naval Construction Force will need to implement the policies of the Defense Industrial Supply Center, it would make sense for the Naval Construction Force to take that process one step further, and implement a paperless process for the entire construction supply chain. Figure 6-2 illustrates the current contracting process, and shows that approximately 13 paper copies are produced in an average contract[70]. Considering that each contract can produce hundreds of pages of documentation, this large amount of hardcopy documentation results in an extraordinary administrative effort, and high reproduction and mailing costs.

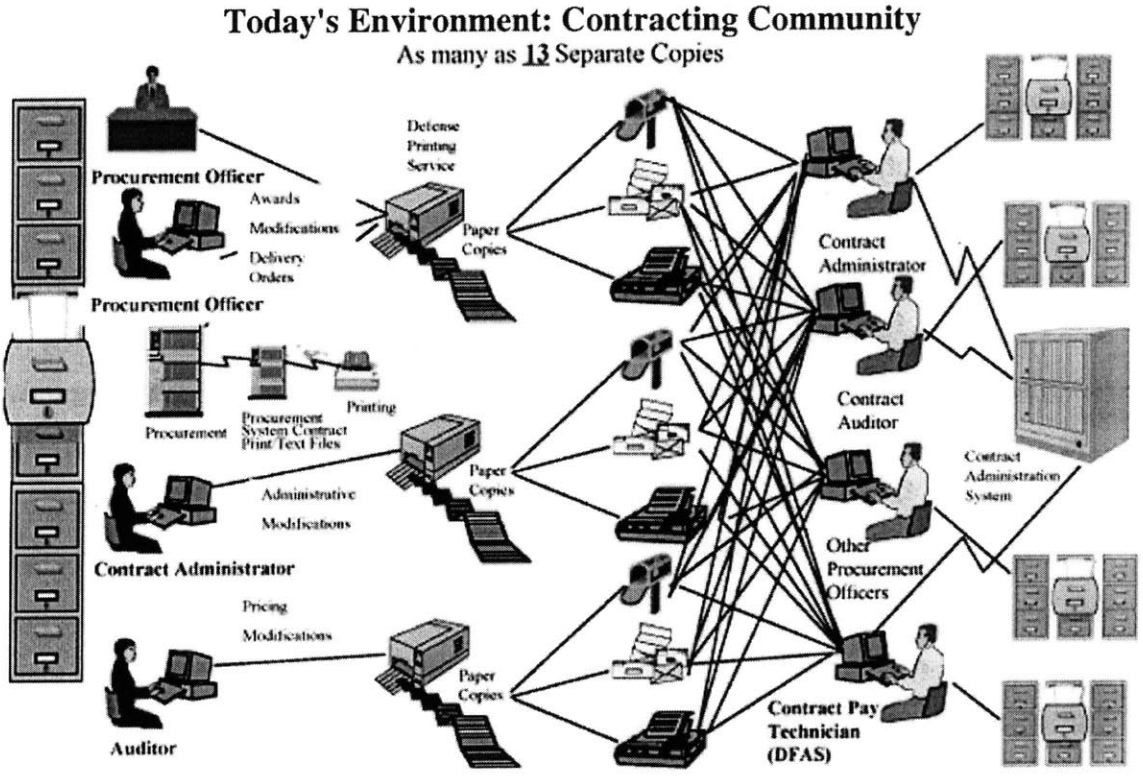


FIGURE 6-2: DoD PAPERLESS CONTRACTING INITIATIVE[70]

There are various methods that can be used to develop a paperless process. However, the obvious condition for implementation of a paperless process is that information technology will be required. It could be as simple as e-mail and pdf files. However, that does not provide much added benefit, and still results in a large amount of miscommunication and misplacements. The way in which many civilian construction industries have moved to a paperless process is by implementing project collaboration software. This leads to the next recommendation, which is to use project collaboration software in the Seabee construction supply chain.

6.5 PROJECT COLLABORATION SOFTWARE:

Of the many concerns and problems that are identified in figure 6-1, a majority of them can be attributed to insufficient communication among members of the construction supply chain. These problems are similar to what has been experienced in the civilian sector construction supply chains, and is the reason why project collaboration software has been growing in popularity. The Naval Construction Force construction supply chain has some players and processes that are unique to what is common in the civilian sector, and these differences must be taken into consideration. However, the collaboration software will produce many benefits.

In many other Department of Defense information technology initiatives, off the shelf software was found not to be acceptable due to the uniqueness of the military processes. Therefore, the Department of Defense contracted for specific software to be designed, and used. Both options will be considered in this section. Regardless of the method that is decided upon, the Naval Construction Force can still experience much benefit and efficiency from the use of project collaboration software and it should therefore be pursued as a future initiative.

6.5.1 Benefits:

Chapter 4 provided information on project collaboration software and its use in the civilian construction industry. Many of those same benefits can also be realized in the Seabee project value chain. Figure 6-3 provides an illustration of the Naval Construction Force project collaboration concept. In this model, the project collaboration is among the

five major players in the Seabee construction supply chain. This is important because as illustrated in Figure 6-1, many of the concerns and problems surrounding the construction material portion of the supply chain are caused by the communication and flow of information between the players in the supply chain.

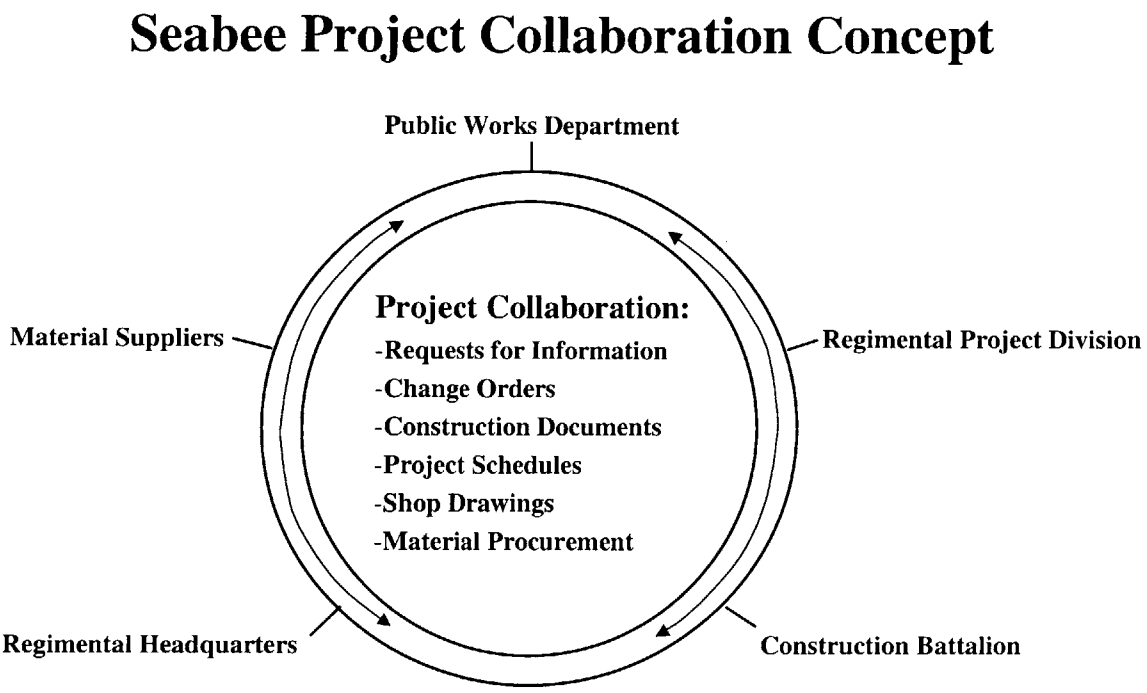


FIGURE 6-3: SEABEE PROEJCT COLLABORATION CONCEPT

6.5.2 Information Technology Compatibility Concerns:

From Figure 6-1 and the value chains that were analyzed in Chapter 5, it is evident that there are many software applications that are currently in use throughout the Naval Construction Force project material supply chain. These applications should be compatible with construction project collaboration software. Table 6-1 provides a summary of the applications that are currently in use or under development. It also provides information on the program architecture and the ability of the software to be compatible with other applications.

Software Application	Used By	Compatibility
Project Material Planning and Tracking Program (PMTP)	Regimental Project Divisions and Construction Battalions	Web-Enabled, Microsoft Access Based
Timberline Estimating Software	Regimental Project Divisions	Web-Enabled, Open Architecture Database
Project Coordinator Database	30th Regiment Project Material Division	Access Database
Seabee Automated Management and Maintenance System (SAMMS)	22nd Regiment Project Material Division	DOS Based Application
Construction Battalion Construction Management (CBCM)	Construction Battalions	Web-Enabled, Compatible With Microsoft Project
Project Information Tracking System (PITS)	Regimental Headquarters	Access Based Application
Call for Work	Regimental Headquarters	Web-Based Application

TABLE 6-1: OVERVIEW OF SOFTWARE APPLICATIONS IN THE NCF SUPPLY CHAIN

While not all of the current Naval Construction Force applications are required to be compatible with project collaboration software, it would be beneficial if a majority of the applications were, because this would increase the efficiency of the supply chain, and effectiveness of the collaboration. After reviewing the software applications in Table 6-1, all except the Seabee Automated Management and Maintenance System (SAMMS) appear to be compatible. The SAMMS is a DOS based program and would not be compatible with any web-based applications. The others are web-enabled, open architecture applications that should allow them to be compatible with a web-based collaboration software application. Modifications to the programs may be required, but these modifications should be relatively minor.

Figure 6-4 illustrates the proposed relationships among the various software applications. From the illustration, it is clear that all programs should interact with the collaboration software, and many applications should also interact with one another. The SAMMS software is outdated and not compatible with any of the new applications. Therefore, it should be discarded by the 22nd Naval Construction Regiment, and replaced with the Project Coordinator Database and Project Material Planning and Tracking Program.

Software Interactions and Compatibility

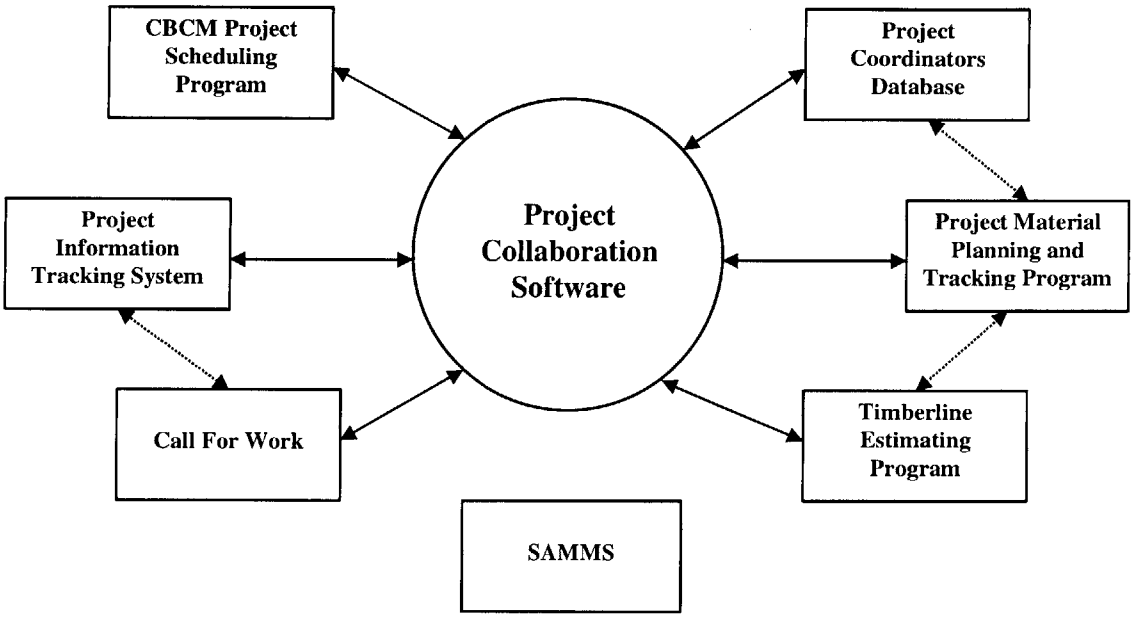


FIGURE 6-4: NCF SOFTWARE INTERACTIONS AND COMPATIBILITY DIAGRAM

6.5.3 Off the Shelf Software:

One of the major concerns in any Department of Defense information technology initiative is whether an off the shelf application could be used, or if a new application will need to be developed. If an off the shelf item can be used, in most cases it is more cost effective to pursue that option. However, many applications in the Department of Defense are unique, and off the shelf software does not meet the requirements. A good example of this situation in the Naval Construction Force was the development of Construction Battalion Construction Management. After reviewing the capabilities of Microsoft Project, and Primavera scheduling software, it was decided that development of a unique application was the most effective option due to the uniqueness of the Naval Construction Force resources and scheduling methods. The application, however, is comprised of an architecture that is compatible with Microsoft Project. This feature makes Construction Battalion Construction Management software flexible and compatible with most project collaboration software.

In reviewing the Seabee construction supply chain, it appears that off the shelf software could potentially be used by the Naval Construction Force. As stated in Chapter 4, most of the collaboration software designers know that their software must be compatible with standard web applications so that all members of the construction supply chain are not forced to buy specific software in order to be connected with the rest of the supply chain. Since, most of the current software applications in use by the Naval Construction Force supply chain are web enabled, open architecture applications, they should be compatible with standard, off the shelf, project collaboration software.

One area of concern will be the compatibility that can be achieved with suppliers and their information technology systems. Currently, none of the Prime Vendor contracts in place outline specific information technology requirements that a contractor must conform to. Therefore, none of the current suppliers are contractually obligated to utilize project collaboration software. However, this requirement can be written into future contracts, and will be covered in greater detail in the outsourcing and privatization section.

Another situation that makes off the shelf software an attractive option is the fact that the Naval Facilities Engineering Command has already procured $8.5 million of Primavera PrimeContract software rights for its Public Works Departments. If the Naval Construction Force supply chain can utilize that software, many of the Public Works Departments that Seabees will be doing projects with already have the software. While the option of acting as a general contractor, and utilizing the public works software would be beneficial, it would be much more beneficial for the Naval Construction Force to obtain its own licenses and be the central manager of the software for a Seabee project. This would enable the Naval Construction Force to develop standard procedures and have overall control over the software. By acting as a general contractor with the public works having overall management of the software will result in all public works using various procedures, and the Naval Construction Force being at the mercy of the public works to decide when to put the project into the collaboration software, and who gets access rights. The Naval Construction Force could also obtain additional licenses through a modification of the existing Naval Facilities Engineering Command contract if required.

Based on the yearly volume of work that the Naval Construction Force performs, they could potentially justify the need to develop unique software. However, this probably should

be considered as the second choice and least attractive option. Even though the Naval Construction Force project supply chain is somewhat unique in its setup and organization, it still has the same requirements as most civilian construction supply chains, and should, therefore, have the ability to adapt to the capabilities and restrictions that any off the shelf project collaboration software would have.

6.6 SHIPPING SYSTEM:

As identified in Chapter 5, the shipping time required for Seabee construction material to be sent over the sea is the activity with the longest duration with an average of 45 days. While the actual in transit time cannot be changed, unless faster ships are designed, which is definitely beyond the scope of this thesis, there are many supporting steps of the shipping process that can realize efficiencies through information technology and better processes. This section will explore some of the methods that can be used to improve the project material shipping process. These methods include the use of bar code technology and eliminating steps in the project material supply chain that do not produce sufficient value to the system.

Many industries have utilized bar code technology to greatly improve the efficiency of their supply chains. Chapter 3 provided an example of how Wal-Mart uses bar coding to provide real time stocking data to its suppliers. Additionally, Chapter 2 explained how the Department of Defense's vision of the future is Total Asset Visibility for all supplies. Therefore, the implementation of bar code technology would not only improve the ability of the Naval Construction Force to track material, but will also provide efficiencies in the project material process, and allow the Naval Construction Force to be poised for meeting the future requirements of Department of Defense logistics.

Additionally, the use of bar code technology can help reduce the number of errors that occur from entering the inventory and shipping data multiple times into spreadsheets, which is the current practice in the Naval Construction Force project material supply chain. Department of Defense studies have shown that the error rate in recording data through the use of bar code technology is 1 in 3,000,000 compared to an error rate of 1 in 300 for manual data entries[71]. This reduction in errors will result in a savings of cost and time in the construction material supply chain.

To have an efficient barcoding process, the civilian material suppliers should also possess the barcoding technology and have software compatible with the Naval Construction Force and Department of Defense. Many construction material suppliers already utilize bar code technology for their inventory and material tracking, for others who want to do work with the United States government, it would probably be considered a good investment. Therefore, the suppliers have or can be required to get the infrastructure in place to support a Naval Construction Force initiative with bar coding.

Furthermore, the Defense Logistics Agency and Department of Defense are focusing on "just in time" logistics and the electronic linkage of global data between suppliers and various Department of Defense components[72]. In the current Prime Vendor contracts, there are no requirements on contractors to use barcode technology, or to even provide a method of electronically tracking a material order. However, on many future Department of Defense contracts, electronic linkage will become part of the contract requirements. Also, if the Naval Construction Force decides to outsource the class IV material process, barcoding should definitely be written into that contract. These contractual issues will be covered in greater detail under the outsourcing and privatization section.

By working with the Defense Logistics Agency and developing or using scanner technology combined with web-enabled software that is compatible with the Total Asset Visibility software. The Naval Construction Force will improve its ability to operate in a joint force environment, and provide a valuable electronic link for project material throughout the entire Seabee construction supply chain.

Since the Naval Construction Force currently does not have any bar code scanners or software to support them for construction material, the initiation of barcode technology will be an added cost that the Naval Construction Force will be required to budget for in future years. Additionally, this will not be a cheap initiative for the Naval Construction Force. Therefore, implementation of bar code technology will probably take a few years to accomplish because of the funding issues. However, this is a very important initiative and one that should be pursued, because of its importance in supporting Total Asset Visibility and the efficiencies that will be gained by improving the ability to track project materials.

One important aspect of supply chain mapping is to evaluate the value of each step in the process, which was discussed in Chapter 2. In reviewing the Seabee construction supply

chain, there is one step that produces limited value to the process, but adds time and considerable cost to it. This is the process of receiving construction materials at the Regimental Project Material Divisions and preparing the materials for shipment overseas. From Figure 5-4, you can see that this process takes an average of three days. This time is not value added time, and the process is labor intensive. This is where a cost savings can be realized. The process also creates another point where handling of material and data input is being performed, which results in an increased chance of error, miscommunication, or material breakage.

In Chapter 5, a complete explanation was provided for why the process is setup in the way that it is. The first reason is because of the restrictions associated with the current construction material contracts that the Department of Defense has in place. The second reason is because the Regimental Project Material Divisions want to inventory the material prior to shipping it overseas and ensure that the correct construction material was provided.

Currently, when the material is received from the Prime Vendor, it is inventoried by an employee of the Regimental Project Material Division. Depending on the amount of construction material, this can take almost an entire day. Upon completion of the physical inventory, the employee updates an Excel spreadsheet containing the material inventory, and sends it to the Construction Battalion who will be receiving the material. Also, at this time, a government warehouse employee must unload the material from the Prime Vendor shipment, organizing the material, and preparing it for shipment by loading it into a shipping container. The inventory and unloading of the container is again repeated by the receiving Construction Battalion overseas. From the description provided above, it becomes apparent that there is duplication of effort by government employees that results in unnecessary labor and time in this step.

Although the step must remain until the current Prime Vendor contracts expire, or until a new contract is prepared and awarded, this step should be eliminated in the future. By using bar code technology, an instant electronic inventory list can be provided by the contractor eliminating the need for a government employee to reinventory the material and put the information into Excel. Additionally, when a new contract is awarded, it should include the capability to have the contractor pack and ship a container directly to the overseas site. By the contractor performing this function, the construction material will only be

inventoried and unloaded once by the government. By the contractor providing an electronic inventory that the Regimental Project Division or Construction Battalion can electronically review the contents of the container anytime, and the concern of what material has been sent by the supplier is resolved.

The contract should also include a clause that makes the contractor provide real time data on the location of the shipment so that the Regiments and Construction Battalions can find out the status of their material at anytime online. This will enable the Regiment to more efficiently track the flow of all Seabee project materials, and the Construction Battalion to manage its construction schedule better.

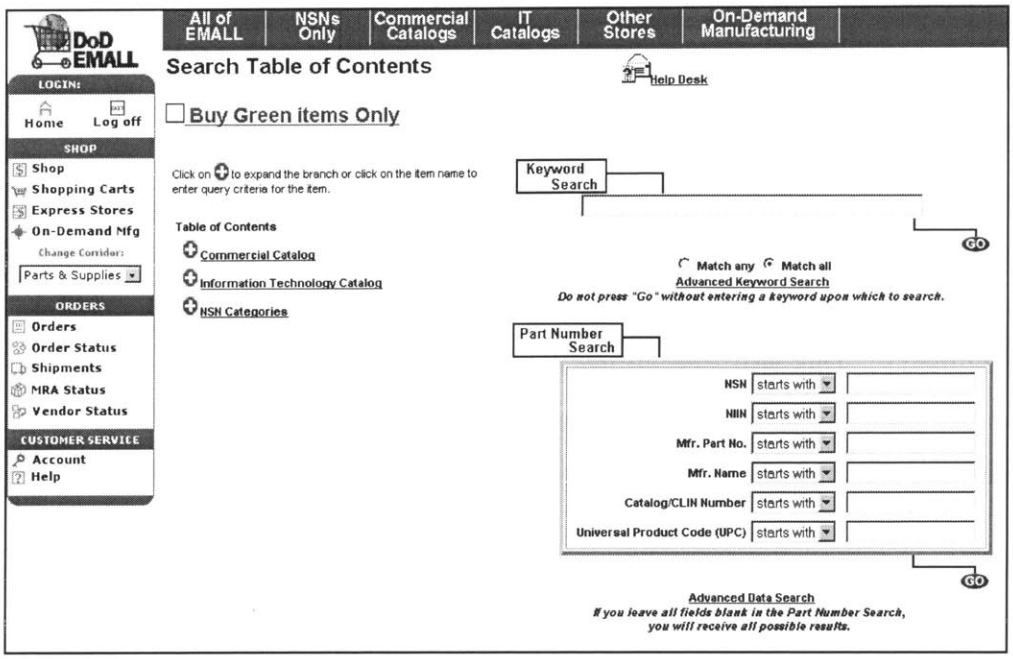
6.7 LEVERAGING LATEST DOD INITIATIVES FOR PROCUREMENT:

As stated in Chapter 5, the Naval Construction Force uses three main sources for its procurement of construction material, and these are The Naval Supply System, Prime Vendor Contracts through Defense Industrial Supply Center, and government credit cards. Through initiatives by the Department of Defense to reduce government resources and inventory by leveraging the commercial sector for providing material support, the Navy Supply System has greatly reduced its resources, and various contracting options have been put in place. This led to the Prime Vendor contracts and government credit cards being the main procurement vehicles for Department of Defense personnel. Prime Vendor contracts were discussed in detail in Chapter 5 and will be addressed again in the section on privatization and outsourcing. The government credit cards, also known as IMPAC cards, were developed because the small orders that went through the traditional Navy Supply Departments created such a large volume of work, that it required a large pool of resources to process all of the small orders. By developing the IMPAC card, the government put the administrative responsibility back on the person requiring the item of procurement, thus enabling the Supply Departments to reduce their labor pool, and only focus on the large procurements. This also saves time, because the buyer knows exactly what he/she wants, and time is saved because the effort of communicating their requirements to procurement specialists is gone.

The IMPAC cards are a valuable tool for the Naval Construction Force, however, they also provide limitations. As stated in Chapter 5, the cards have a limit of $2,000 for a purchase, and the purchase cannot be split up into a group of smaller purchases for the same

purpose. Therefore, the IMPAC cards cannot be used for a procurement of all construction materials on a large project's bill of materials. However, the cards provide flexibility for procuring items that were either forgotten on the original bill of material, or more importantly, they can be used for add on bills of material, when additional materials are required. Currently, the number of IMPAC cards are limited, with only a few personnel per Construction Battalion having them. The reason for this small amount of cards is that training is required prior to an individual being issued a government credit card. There is also an administrative burden to the unit, and the more cards that a unit has, the greater the administrative burden. More importantly, in many parts of the world, the credit card is not as readily accepted as it is in the United States, so at many deployment sites, the cards only provide limited benefit. However, the Defense Logistics Agency has developed a website called EMALL which can be a valuable tool for Seabees.

EMALL is the Department of Defense version of Amazon.com. It is a website that any government employee can access. The website contains over 12 million off-the-shelf consumer items, and has many standard construction materials, with more on the way. The website was developed by the Defense Logistics Agency with the support of over 350 commercial vendors, and allows government employees to search for items by part number, product description, catalog number or UPC. The payment process is either government credit card, or a unit line of accounting can be setup initially. The EMALL also provides the capability to ship to any government address in the world.



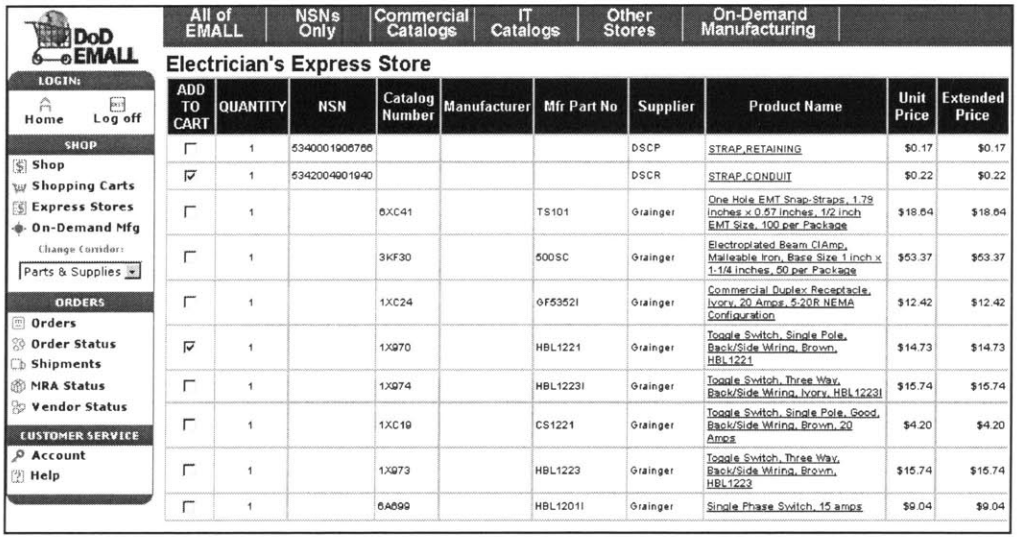


FIGURE 6-5: EMALL SAMPLE SCREENS[73]

Since EMALL is still in its early stages of development, and the construction materials are still fairly limited, it is currently not an effective tool for large-scale purchases. By performing some spot tests by randomly taking a bill of material and searching for the items in EMALL, only approximately 25% of the materials were found on each bill of material. However, EMALL will be a good tool in the future when more construction material suppliers are added to the database. This will enable deployed units to purchase add on bills of material that must be purchased in the United States directly from the website,

without being required to go through the Regimental Project Divisions. Currently, as identified in Figure 6-1, the add-on bills of materials are the ones that bog down the Regimental Project Material Divisions the most, and create the largest amount of miscommunication and error with back and forth communication to verify the correct items on the bill of materials. By the Construction Battalion accessing the EMALL site, they can search and identify the items that they need without back and forth communication with the Regiments. This will free up the Regimental Project Material Division manpower to focus on the planning and estimating, and procurement of the large bills of material. Figure 6-5 provides illustrations of the search screens that are a part of the EMALL website[73].

6.8 OUTSOURCING AND PRIVATIZATION:

In 1995, The Commission on Roles and Missions of the Armed Forces encouraged the Department of Defense to pursue outsourcing and privatization because their studies showed that it could provide approximately a 31% cost savings to the government[74]. The focus for outsourcing and privatization were functions that were being performed by the government, but could just as easily be performed by the commercial sector without having a negative impact on force readiness. The goal of the Department of Defense is to greatly reduce internal government resources and only maintain those core functions that cannot be passed along to the commercial sector due to force readiness or national security issues. The following is the Department of Defense definitions for privatization and outsourcing:

> "Outsourcing is the transfer of a support function previously performed by a government activity to a private sector provider...Privatization is a type of outsourcing involving the transfer of government assets to the private sector as the government sheds the capability to perform the function[75]."

The Department of Defense does not consider outsourcing and privatization to be an initiative where the government simply passes the entire responsibility to the commercial sector, and forgets about it. Instead, the Department of Defense views outsourcing and privatization as an important part of comprehensive strategy that will enable the Department of Defense to gain efficiencies by leveraging the private sector and fitting it into governmental functions where efficiencies can be realized. The Department of Defense

outlined some of the major benefits of privatization and outsourcing, and they are as follows[76]:

- Introduce greater competition into logistics business areas
- Eliminate inefficient duplications of effort between the Department of Defense and private industry
- Take maximum advantage of commercial business practices
- Create unrivaled support structures that will improve performance and generate savings

6.8.1 Guidelines for Outsourcing:

The Secretary of Defense provided three specific guidelines that all Department of Defense services and agencies would follow in determining whether an activity should be outsourced or remain a governmental function. These three guidelines are as follows[77]:

1. "The Department will not consider outsourcing activities that generally constitute Department of Defense's core capabilities; the activities the Department of Defense and military leaders consider to be essential to being prepared to carry out the Departments warfighting mission."

2. "A competitive commercial market must exist for the activity being considered for outsourcing that must still meet the warfighting mission needs. Competition is the best way to ensure that the Department of Defense benefits. It drives organizations to improve quality, reduce costs, and better focus the customers needs."

3. "Outsourcing the activity must result in the best value for the government, and therefore, the US taxpayer"

Based on the information provided in Chapter 5 on the current Seabee construction supply chain, there is not much government infrastructure in place to support the supply chain. Therefore, privatization is not a viable option, and outsourcing will be analyzed as an option. In reviewing whether outsourcing is an acceptable option, many things must be considered. The three guidelines provided by the Secretary of Defense must be met. Additionally, the activities that will be outsourced in the supply chain must be defined, and consideration must be given as to what percentage of the process will be given to a single contractor so that competition and fair pricing can still exist.

In order to determine if the Naval Construction Force class IV material process can be outsourced, the three guidelines provided by the Secretary of Defense must be met. In

considering the first guideline, while Seabee Class IV material is important, it is something that could be performed by a civilian contractor. As a matter of fact, through the Prime Vendor contracts and transportation contracts that are currently in place, much of the process is already performed by the commercial sector, therefore the first guideline has been met. The second guideline brings up the subject that was covered in Chapter 3. Figure 3-2 illustrates that the construction industry is a fragmented industry, and competition does exist between construction material suppliers. Therefore, in a competitively bid contract, the government would probably receive competitive prices. Therefore, the second guideline for outsourcing has also been met. The third guideline is the most difficult to analyze, and would require a detailed analysis once a contract was prepared, and bids were received. Based on the competition that exists in the construction industry, it is probable that outsourcing of the construction material procurement could result in the best value to the government. In order to better answer whether the third guideline is met, the entire Seabee construction supply chain must be analyzed to determine what activities should be privatized and which should remain with the government.

6.8.2 Outsourcing Scenarios:

In reviewing the Seabee construction supply chain process, there are several scenarios that can exist and these will be reviewed:

1. Completely outsource everything from the development of bills of material to complete supply of all construction materials to all overseas locations.

2. Completely outsource material procurement and shipping of materials, and maintain Regimental Project Material Division planning and estimating capability.

3. Outsource a combination of the activities identified in options 1 and 2, but maintain a governmental capability to also perform the functions.

If the first scenario was used, the main reason would be because the Naval Construction Force could reduce its Regimental Project Material Division in-house staff and the contractor could produce the bills of material faster. However, this scenario would also cause problems and is not the recommended choice.

There are two potential major problems with this scenario. First of all, there is a concern with the potential for a conflict of interest to develop. If the same contractor is doing the bill of materials and ordering materials, the contractor can potentially specify the construction material brand that produces the largest profit margin, and not necessarily the materials that are best for the construction project. Of course the government will review the bill of materials and approve it prior to ordering the material. However, this will require governmental manpower and expertise to perform these reviews. Therefore, the planning and estimating personnel would still be required for reviews, and the time that was saved by the contractor doing the bill of materials would be lost by the review, and negotiations that would follow. This scenario would result in little to no cost or time savings. The second problem with this scenario is that the contractor would not be familiar with the Seabees and how their processes work. This problem can be overcome with successful partnering, but there would still be a large learning curve involved.

The second scenario is a better option than the first. In this scenario, there would be a cost and time savings created by eliminating the Regimental Project Material Division receiving, inventory, and container packing step that was identified previously. This process would also allow for partnering with the contractor, and would enable the Naval Construction Force to leverage the commercial sector information technology and practices. However, the downside would be that once the contract was awarded to one contractor, the level of competition is somewhat reduced, which could potentially lead to the contractor charging higher prices for material. However, that downside can be controlled by effective governmental supervision over the contract. Another downside is that if only one contractor is chosen to provide material throughout the entire world, competition could be reduced because only a few large companies could meet the contractual requirements of providing material all over the world in the timelines provided by the contract. Although not the ideal scenario, this scenario is one that could potentially be utilized by the Naval Construction Force.

The third scenario is the one that is most attractive and is highly recommended in my opinion. In this scenario, the contractor provides construction material, and can also have the capability to perform planning and estimating. In this scenario, the contractor would receive a majority of the construction material procurement. However, the Regimental Project

Material Division and Construction Battalions would still have the capability to use other Prime Vendor contractors as well as EMALL. This would create a greater level of competition and would result in better prices. Additionally, the bill of materials portion of the contract could be exercised in times of surge, when the in-house planners and estimators are backlogged. This will enable the Regimental Project Material Divisions to manage the workload to most efficiently produce bills of material. This scenario appears to produce the best value for the government, and would therefore meet the third outsourcing objective of the Secretary of Defense.

In summary, scenario 2 and 3 appear to be acceptable options that would result in a cost or time savings for the Naval Construction Force. However, of the two scenarios, the third option appears to be the most favorable because it will result in a greater level of competition as well as provide more options for Regimental Project Material Division management to control the surges and dips that it will experience in the planning and estimating workload.

6.8.3 Outsourcing Analysis:

An outsourcing analysis was also performed and is provided as Table 6-2. This table summarizes the pros and cons of outsourcing the Naval Construction Force class IV material process.

Analysis For Outsourcing Seabee Class IV Material Process

Pros	Cons
Leverage commercial sector for IT and infrastructure	Contractor must be capable of providing construction material anywhere in the world
Long-Term contract will allow for partnering between contractor and NCF	Regimental Material Divisions lose some control on the process
Utilize barcode technology and Total Asset Visibility for material tracking	Overhead and markup costs must be studied prior to award to ensure that contractor is more cost effective option
Receive competitive pricing on materials	Contract will have a guaranteed minimum order amount that the NCF must meet
Contractor can pack container and ship directly overseas	Government must develop metrics or a way to determine how well the contractor is doing.
Can setup contract for contractor to also have capability of preparing bills of materials in time of surges.	A new contract like this one will require large contract administration costs for development of the contract, and administration of it after award

TABLE 6-2: PROS AND CONS OF OUTSOURCING SEABEE CLASS IV MATERIAL

Based on the information provided in this section, and the direction that the Department of Defense is focused on for future logistics, the procurement and shipping process for Class IV material should be outsourced. However, my recommendation would be to structure the contract around scenario three. Based on information obtained from the Regimental Project Materials Divisions, during OPERATION IRAQI FREEDOM, approximately one military flight departed from Gulfport and Port Hueneme per day, on their way to the area of operation. This provided much flexibility and allowed the Regimental Project Material Divisions to ship materials on these flights. Therefore, the Regimental Project Material Divisions should maintain a capability to procure items through IMPAC card and have the ability to receive project materials in time of war.

6.9 CHAPTER SUMMARY

This chapter took the research and analysis that was performed in the previous chapters, and used it to identify areas of improvement and increased efficiency in the current Seabee construction supply chain and the class IV material supply process. Standardizing business practices between the two Regiments and Construction Battalions was identified as an area of concern. Also, the standardization of processes leads to a larger recommendation for using project collaboration software to improve communication among members of the supply chain. Developing a paperless process is related to the project collaboration software, and will result in a cost savings on administrative and reproduction costs. Leveraging new procurement initiatives that are currently underway by the Department of Defense is an area that can result in cost and time savings, and provide greater competition among contractors. Finally, the potential for outsourcing the Seabee construction material process was analyzed, and recommendations were made.

CHAPTER 7: CONCLUSION

7.1 SUMMARY

The following provides a summary of the major topics that were covered in this research paper:

- The Joint Chiefs of Staff for the Department of Defense have developed the *Joint Vision 2020* document, which creates the Department of Defense vision for the future. Included in this document are many logistics initiatives that will have an impact on the future of Seabee class IV construction material. These initiatives include: Joint Total Asset Visibility, Outsourcing and Privatization, Contingency Contracting, and Reduced Inventory. The initiatives were taken into consideration when providing recommendations for improving the Seabee class IV material supply chain.
- The concept of supply chain management was discussed. In the manufacturing, production, and distribution sectors, supply chain management has become a popular method for gaining a competitive advantage and developed as a result of globalization and increased competition. The construction industry has not been as successful as the other sectors in utilizing supply chain management concepts to improve efficiency, and there are many reasons for that. The construction industry is a fragmented industry in which there is a high level of competition, with constantly changing players in the supply chain. Also, the construction industry produces a one-of-a-kind product. After the product is complete, all of the players of that supply chain go their separate ways, and there is no consistency or development of strategic alliances. This lack of consistency makes it difficult to develop a knowledge base and track metrics for improvement.
- Although the implementation is much slower than in other industries, the construction industry is taking steps to incorporate supply chain management techniques. There have been many organizations, such as the Construction Best Practice Programme in the United Kingdom that are studying and promoting the use of supply chain management techniques in construction. Two main objectives that have been identified for successful implementation of supply chain in the construction industry

is partnering and communication. This, however, requires the construction industry to overcome its traditional mistrust and adversarial relationships with one another to develop a new mindset of working together as a team.

- There are some bold construction supply chain initiatives that are being undertaken in the construction industry.
    - Turner Logistics is a company that has developed its business plan around construction supply chain management concepts. Turner Logistics has a goal of providing the customer with a wider range of products that can be supplied cheaper and faster than traditional methods. Turner Logistics attempts to do this by using its large, world-wide, parent company, Turner Construction, to develop strategic alliances with suppliers that will result in cheaper and faster products. Turner Logistics also utilizes information technology to improve communication and reduce the time and administrative costs associated with shop drawings and correspondence.
    - DESTINI is an initiative by the Beck Group, and also focuses its business plan around construction supply chain management. However, the Beck Plan focuses on the design step as a means of providing efficiency for the rest of the chain. They have invested a large amount of money on a 3D computer modeling program that is designed to produce an efficient design and improve collaboration among the players in the construction supply chain.
    - Project collaboration software is also gaining popularity in the construction industry. This software allows all members of the supply chain to have access to the construction project documents online. This improves communication and leads to efficiencies in time and administrative requirements on the project.
- The complete Naval Construction Force project supply chain was mapped and presented in Chapter 5. This mapping illustrated the entire construction project material class IV material process for United States procurement as well as local overseas procurement by a Construction Battalion. There are three main methods of procurement that are currently used by the Naval Construction Force, and these are: government credit card, Prime Vendor contracts, and Base Supply Departments. The

average time for class IV material procurement was also determined. Currently, it takes on an average of four months from when the Naval Construction Force receives a set of drawings for a project, until material arrives at the overseas project site for a peacetime scenario, which includes United States procurement as well as shipment on the sea. For locally procured material, this process takes approximately two months.

- The Value Chain concepts of Michael Porter were also applied to the Naval Construction Force construction supply chain, and they illustrated the need for effective communication and training throughout the chain. This analysis also helped to identify the many software applications that are currently in use by the various members of the supply chain, and identified the problem of the non-standardized processes that are currently in place in the Seabee construction supply chain.
- The lessons learned for OPERATION IRAQI FREEDOM and OPERATION ENDURING FREEDOM reflect that there were some areas of concern with the Seabee class IV material process. One key problem identified was that when Construction Battalions were dependant on Marine logisticians in the field, the class IV material was not given a high priority. This resulted in over ordering and stocking materials. Another area of concern was that when Construction Battalions tried to purchase local construction materials with government credit cards, many vendors in the war torn region would only accept cash, and trusted no other means of payment, which caused problems for governmental personnel trying to operate under the traditional procurement methods.
- By taking the research information provided in Chapters 3 and 4, and combining it with the supply chain analysis that was provided in Chapter 5, a complete analysis was made on the supply chain, and recommendations were made for improving the efficiency and responsiveness of the supply chain.
    - One recommendation was to standardize the processes that the Regiments and Construction Battalions are using for class IV material. Over the years, several different methods have developed at various deployment sites and between the two Regiments. These differences result in increased errors and inefficiencies.

- The training curriculum is outdated, and should be updated to reduce the large learning curves that are currently present for Construction Battalions.
- Moving to a paperless process is also a key initiative that is designed to save both time and money by reducing the administrative burden and reproduction costs that are currently experienced in the process.
- Using project collaboration software is an important recommendation because it will support the recommendation of moving to a paperless process, and will greatly improve the communication among the various players in the supply chain, which will definitely result in a more efficient supply chain.

- The current shipping system for Seabee construction material has many inefficiencies that have developed as a result of restrictions caused by the current Prime Vendor contracts that are in place. This paper provided recommendations for the future, when the contracts expire and will need to be resolicited. The recommendations include:
  - Writing overseas direct shipping into the new contract or contracts.
  - Ensure that the contractor utilizes bar code technology and provides real time tracking capability for the project materials. Through the use of barcode technology, the Seabees can be in compliance with the Total Joint Asset Visibility concepts of the *Joint Vision 2020*. The real time tracking will also provide the Construction Battalions with better information on their material, and will reduce the stockpiling that currently occurs, which will result in a lean construction process.
- Outsourcing or privatization of the Seabee class IV material process was also analyzed for feasibility. The three major Secretary of Defense guidelines for outsourcing were reviewed and several outsourcing scenarios were considered. As a result of the analysis, it was determined that privatization was not feasible, but that outsourcing was a feasible option. Of all the scenarios that were analyzed, the concept of outsourcing the process, but maintaining a governmental ability to perform the function appeared to be the best option. This option provided greater competition to the contractor, and also provides the greatest flexibility to the Naval Construction Force.

7.2 FUTURE RESEARCH

This paper focused on the overall construction supply chain for the Naval Construction Force, and identified numerous recommendations for improving the efficiency of the chain. The research in this paper was focused on providing a macro level analysis on the entire process. There are many specific areas that can be studied in greater detail to identify further efficiencies and in depth analysis. Future areas of research can include: a detailed information technology analysis of the chain, a detailed study of outsourcing the class IV material process, and a detailed implementation plan of the recommendations provided in this paper.

7.2.1 Information Technology Research

Future research on the subject could be a detailed analysis on all of the information technology software that is currently in use by the Naval Construction Force, and was identified in this paper. A majority of the applications were developed specifically for the Naval Construction Force, and require system maintenance and updates. Also, most of the applications were developed independently of one another. Therefore, an in depth analysis of each software application could be performed, and a determination of whether applications could be combined, or if off-the-shelf software could be used instead would present an opportunity to uncover further efficiencies and cost savings in the process. The analysis could also include a detailed study of the requirements necessary to make each application compatible with project collaboration software. A comparative analysis of the various project collaboration software applications can be performed to determine which is the best option for the Naval Construction Force.

7.2.2 Market Analysis and Outsourcing Study

While this paper analyzed the possibility of outsourcing the Seabee class IV material process, and studied various scenarios, it did not perform a detailed market analysis to determine the number of contractors capable of providing the service. Therefore, an area of further research would be to perform a complete market study and determine the level of competition that would be present in a competitively bid contract. The research could also include the development of contract clauses that would be required in the contract, as well as

a cost study to determine if outsourcing would provide the best value to the Department of Defense.

7.2.3 Implementation Plan and Metrics Development

This paper provided a detailed analysis of the supply chain, and offered detailed recommendations for implementation. An area of further research could be to focus on the next three stages of the five step cycle for construction best practice, and develop a detailed implementation plan for the recommendations provided in this paper. The research can also include the development of certain performance metrics that can be used to measure the effectiveness of the implemented recommendations, and allow for future reanalysis and improvements of the process. With the constantly developing technology, and the increased implementation of construction supply chain analysis in the commercial sector, the recommendations in this paper could be revisited to ensure that they are still in line with the latest technology.

7.3 CONCLUSIONS

Upon completion of the detailed analysis that was performed in this paper, it can be concluded that there are some inefficiencies that are present in the current Naval Construction Force project material supply chain. This was hypothesized in Chapter 1. While some of the inefficiencies are a result of government contracting regulations that cannot be ignored, many were caused by the slow evolution and divergence of processes and information technology over the years. These inefficiencies were identified and recommendations were made that would allow the Seabee class IV material supply chain to operate more efficiently.

While some of these recommendations could be started immediately, many will require governmental funding, and must be identified in the future Naval Construction Force budgets. In the traditional Department of Defense budgeting process, it may take several years for some of the more costly initiatives to be started. This is especially true of the information technology applications that were identified in this paper, because they also must be approved through a separate Department of the Navy information technology review process.

ACRONYMS

ABFC	Automated Building, Facilities, and Components
CBCM	Construction Battalion Construction Management
CBPP	Construction Best Practice Programme
CBU	Construction Battalion Unit
CEC	Civil Engineer Corps
CSI	Construction Specifications Institute
DISC	Defense Industrial Supply Center
DLA	Defense Logistics Agency
DoD	Department of Defense
FAR	Federal Acquisition Regulations
FIATECH	Fully Integrated and Automated Technology Consortium
GCSS	Global Combat Support System
MLO	Material Liaison Officer
NATO	North Atlantic Treaty Organization
NAVFAC	Naval Facilities Engineering Command
NCD	Naval Construction Division
NCF	Naval Construction Force
NCR	Naval Construction Regiment
NCTC	Naval Construction Training Center
NMCB	Naval Mobile Construction Battalion
PITS	Project Information Tracking System
PMPT	Project Material Planning and Tracking Program
SAMMS	Seabee Automated Material and Management System
SRG	Seabee Readiness Group
TO	Task Order
TOA	Table of Allowance
UCT	Underwater Construction Team

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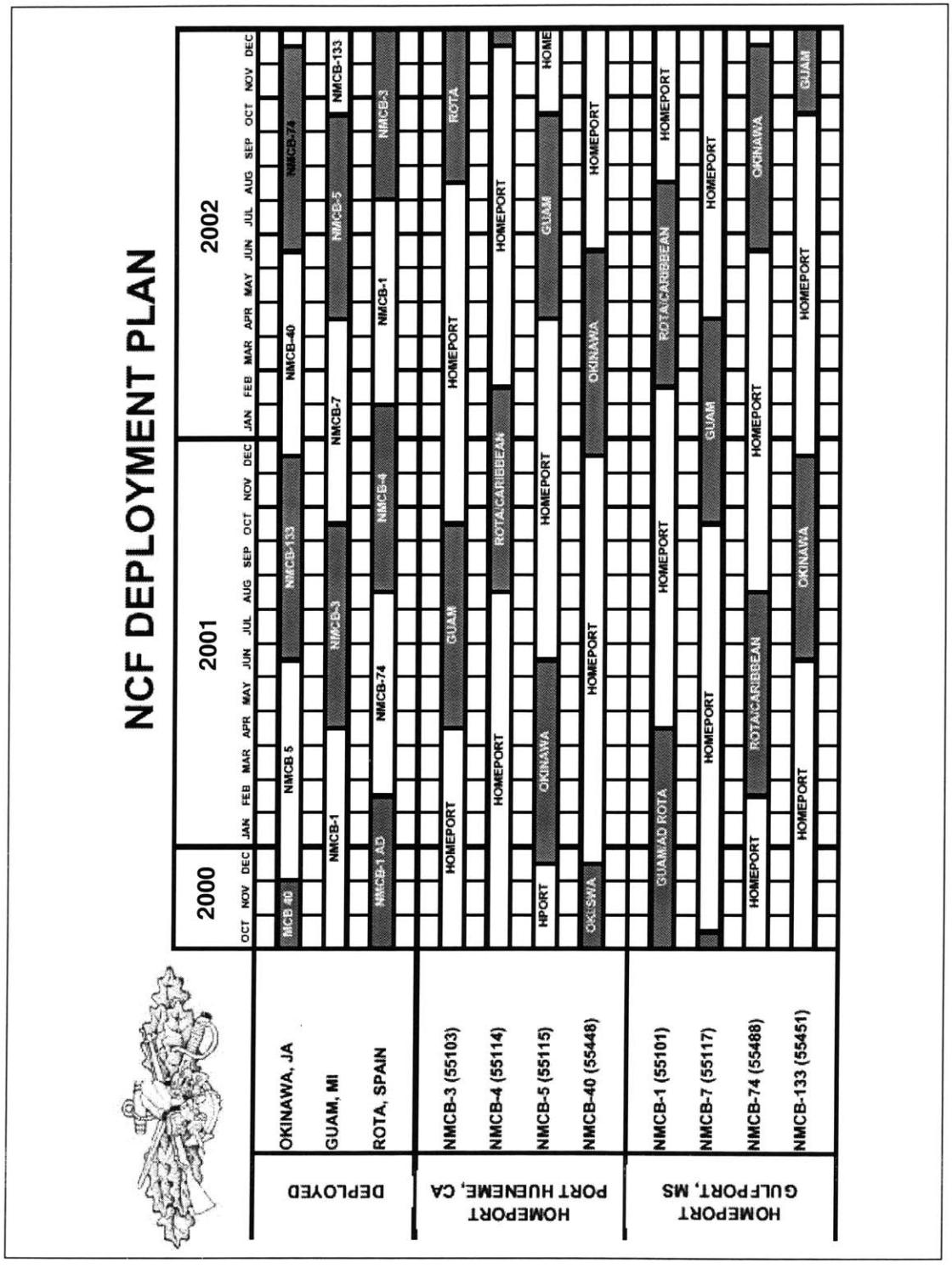
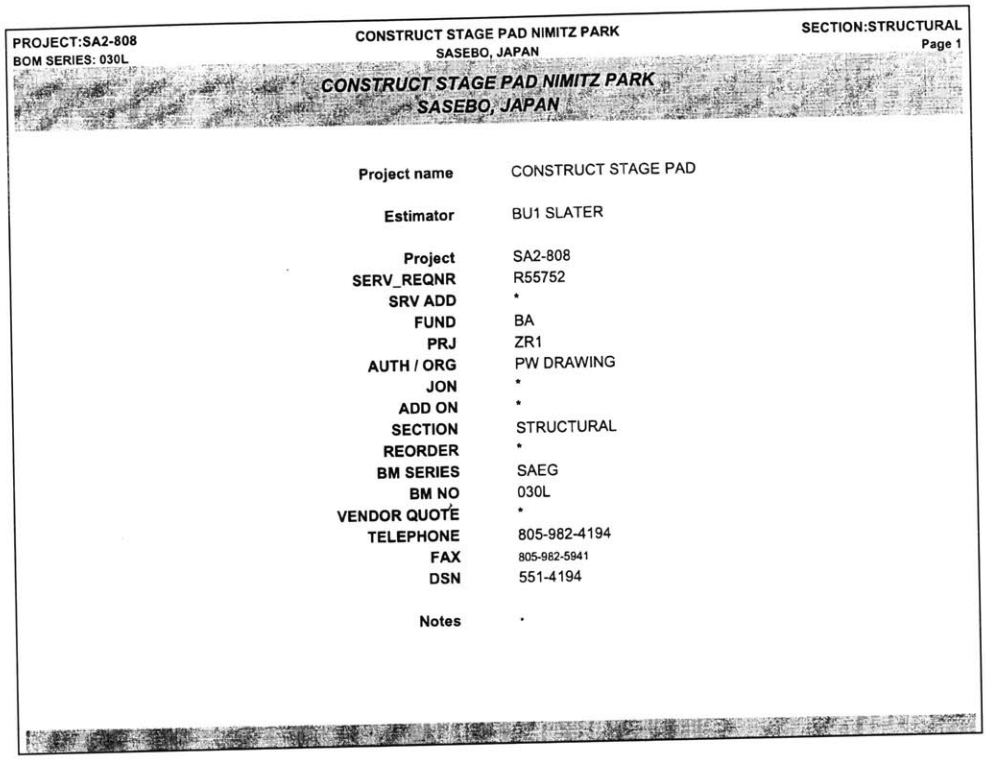
APPENDIX A



APPENDIX A-1: SAMPLE SEABEE DEPLOYMENT ROTATION PLAN[78]

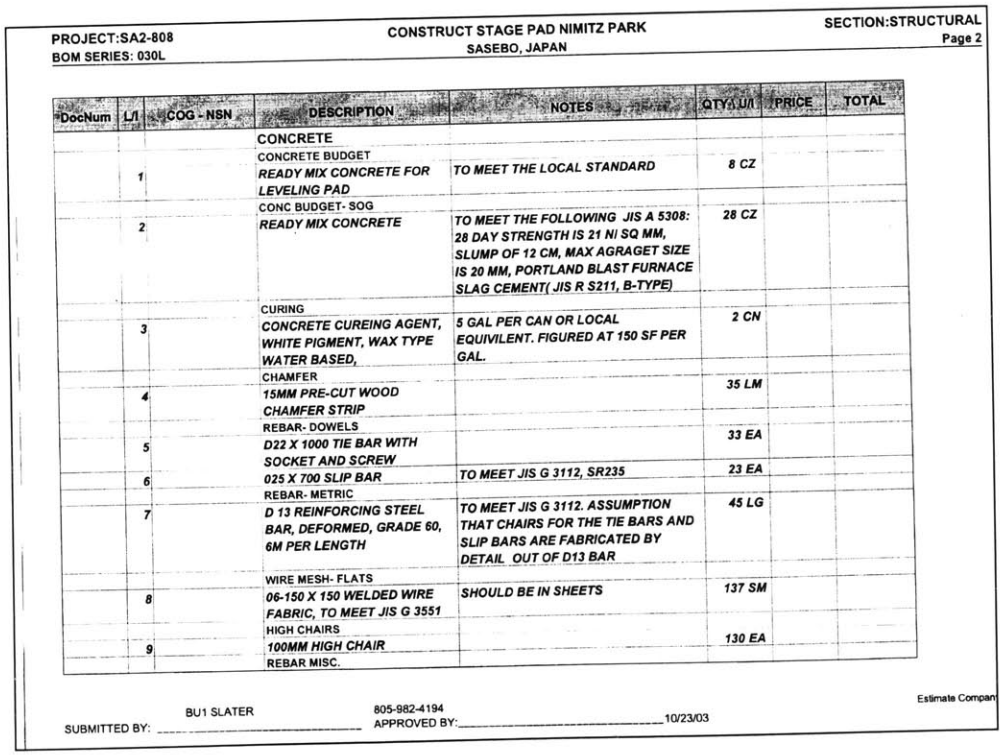
APPENDIX B



PROJECT:SA2-808 | CONSTRUCT STAGE PAD NIMITZ PARK | SECTION:STRUCTURAL
BOM SERIES: 030L | SASEBO, JAPAN | Page 1

CONSTRUCT STAGE PAD NIMITZ PARK
SASEBO, JAPAN

Project name	CONSTRUCT STAGE PAD
Estimator	BU1 SLATER
Project	SA2-808
SERV_REQNR	R55752
SRV ADD	*
FUND	BA
PRJ	ZR1
AUTH / ORG	PW DRAWING
JON	*
ADD ON	*
SECTION	STRUCTURAL
REORDER	*
BM SERIES	SAEG
BM NO	030L
VENDOR QUOTE	*
TELEPHONE	805-982-4194
FAX	805-982-5941
DSN	551-4194
Notes	.



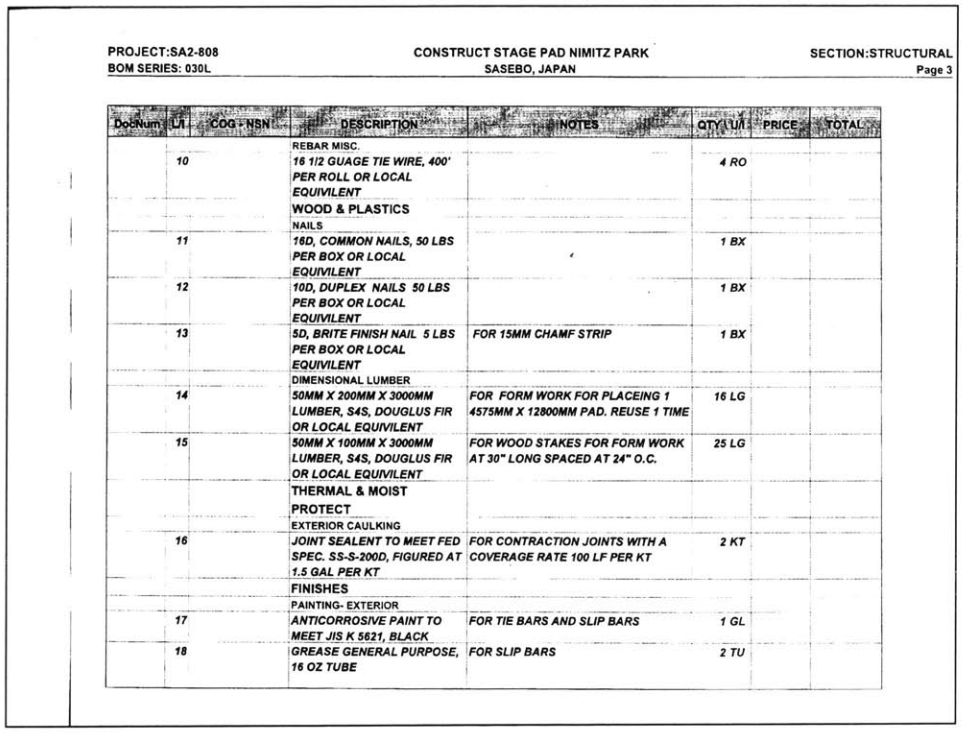
PROJECT:SA2-808 | CONSTRUCT STAGE PAD NIMITZ PARK | SECTION:STRUCTURAL
BOM SERIES: 030L | SASEBO, JAPAN | Page 2

#DocNum	L/I	COG - NSN	DESCRIPTION	NOTES	QTY	U/I	PRICE	TOTAL
			CONCRETE					
	1		CONCRETE BUDGET READY MIX CONCRETE FOR LEVELING PAD	TO MEET THE LOCAL STANDARD	8	CZ		
	2		CONC BUDGET- SOG READY MIX CONCRETE	TO MEET THE FOLLOWING JIS A 5308: 28 DAY STRENGTH IS 21 N/ SQ MM, SLUMP OF 12 CM, MAX AGRAGET SIZE IS 20 MM, PORTLAND BLAST FURNACE SLAG CEMENT(JIS R S211, B-TYPE)	28	CZ		
	3		CURING CONCRETE CUREING AGENT, WHITE PIGMENT, WAX TYPE WATER BASED,	5 GAL PER CAN OR LOCAL EQUIVILENT. FIGURED AT 150 SF PER GAL.	2	CN		
	4		CHAMFER 15MM PRE-CUT WOOD CHAMFER STRIP		35	LM		
	5		REBAR- DOWELS D22 X 1000 TIE BAR WITH SOCKET AND SCREW		33	EA		
	6		025 X 700 SLIP BAR	TO MEET JIS G 3112, SR235	23	EA		
	7		REBAR- METRIC D 13 REINFORCING STEEL BAR, DEFORMED, GRADE 60, 6M PER LENGTH	TO MEET JIS G 3112. ASSUMPTION THAT CHAIRS FOR THE TIE BARS AND SLIP BARS ARE FABRICATED BY DETAIL OUT OF D13 BAR	45	LG		
	8		WIRE MESH- FLATS 06-150 X 150 WELDED WIRE FABRIC, TO MEET JIS G 3551	SHOULD BE IN SHEETS	137	SM		
	9		HIGH CHAIRS 100MM HIGH CHAIR		130	EA		
			REBAR MISC.					

Estimate Compan

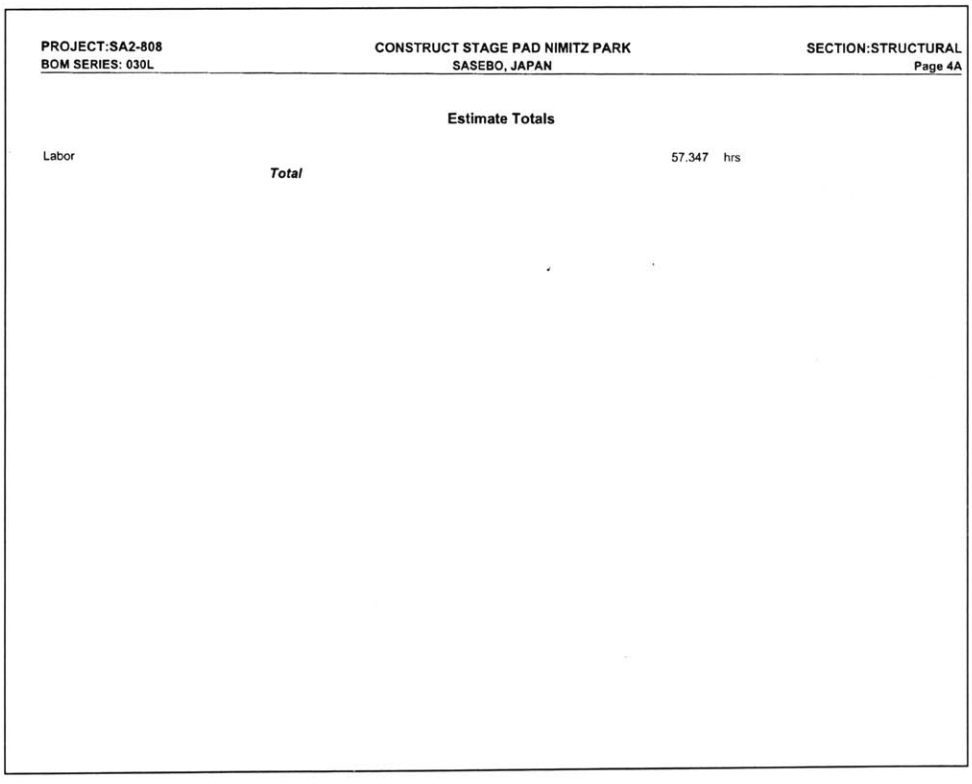
SUBMITTED BY: BU1 SLATER 805-982-4194 APPROVED BY: _____ 10/23/03

APPENDIX B-1: SAMPLE BILL OF MATERIALS FROM 30TH NCR PROJECT MATERIAL DIVISION[79]



PROJECT:SA2-808 | CONSTRUCT STAGE PAD NIMITZ PARK | SECTION:STRUCTURAL
BOM SERIES: 030L | SASEBO, JAPAN | Page 3

DocNum	Lit	COG - NSN	DESCRIPTION	NOTES	QTY	U/I	PRICE	TOTAL
			REBAR MISC.					
	10		16 1/2 GUAGE TIE WIRE, 400' PER ROLL OR LOCAL EQUIVILENT		4	RO		
			WOOD & PLASTICS					
			NAILS					
	11		16D, COMMON NAILS, 50 LBS PER BOX OR LOCAL EQUIVILENT		1	BX		
	12		10D, DUPLEX NAILS 50 LBS PER BOX OR LOCAL EQUIVILENT		1	BX		
	13		5D, BRITE FINISH NAIL 5 LBS PER BOX OR LOCAL EQUIVILENT	FOR 15MM CHAMF STRIP	1	BX		
			DIMENSIONAL LUMBER					
	14		50MM X 200MM X 3000MM LUMBER, S4S, DOUGLUS FIR OR LOCAL EQUIVILENT	FOR FORM WORK FOR PLACEING 1 4575MM X 12800MM PAD. REUSE 1 TIME	16	LG		
	15		50MM X 100MM X 3000MM LUMBER, S4S, DOUGLUS FIR OR LOCAL EQUIVILENT	FOR WOOD STAKES FOR FORM WORK AT 30" LONG SPACED AT 24" O.C.	25	LG		
			THERMAL & MOIST PROTECT					
			EXTERIOR CAULKING					
	16		JOINT SEALENT TO MEET FED SPEC. SS-S-200D, FIGURED AT 1.5 GAL PER KT	FOR CONTRACTION JOINTS WITH A COVERAGE RATE 100 LF PER KT	2	KT		
			FINISHES					
			PAINTING- EXTERIOR					
	17		ANTICORROSIVE PAINT TO MEET JIS K 5621, BLACK	FOR TIE BARS AND SLIP BARS	1	GL		
	18		GREASE GENERAL PURPOSE, 16 OZ TUBE	FOR SLIP BARS	2	TU		



PROJECT:SA2-808 | CONSTRUCT STAGE PAD NIMITZ PARK | SECTION:STRUCTURAL
BOM SERIES: 030L | SASEBO, JAPAN | Page 4A

Estimate Totals

Labor		57.347	hrs
	Total		

APPENDIX B-1: SAMPLE BILL OF MATERIALS FROM 30TH NCR PROJECT MATERIAL DIVISION (CONTINUED)[79]