FACTORS AFFECTING PRODUCTIVITY IN THE UNITED STATES NAVAL CONSTRUCTION FORCE

by

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ABSTRACT

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By using a craftsman questionnaire, this thesis identifies and ranks the most important factors impairing Petty Officer productivity and morale in the United States Naval Construction Force (Seabees). In addition, the author provides recommendations to eliminate or reduce the management constraints which cause unfavorable productivity and lower morale. Data for this study came from 61 surveys completed by active duty Seabee Petty Officers assigned to U.S. Naval Mobile Construction Battalion ONE, Construction Battalion Unit FOUR ONE EIGHT, and Construction Battalion Unit FOUR TWO SEVEN, and by reserve Seabee Petty Officers assigned to Construction Battalion Maintenance Unit THREE ZERO THREE.

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Chapter 1

Introduction

1.1 Purpose

The purpose of this thesis is to:

- Identify and rank the most important factors impairing productivity and morale of U.S. Naval Construction Force (Seabee) Petty Officers;
- Provide recommendations to eliminate or reduce the constraints which are adversely affecting Seabee productivity and morale.

1.2 Scope

Only United States Navy Occupational Field 13 (OF-13) direct labor Petty Officers are analyzed in this thesis. This includes the following traditional direct labor ratings: Builder, Steelworker, Equipment Operator, Construction Electrician, and Utilitiesman. It does not include indirect labor or other support personnel such as Construction Mechanics, Engineering Aides or any supply rates commonly assigned to Naval Construction Force units. Out of 100 surveys distributed, 61 surveys were properly completed, returned, and analyzed. Three types of Seabee units, a Naval Mobile Construction Battalion (NMCB), two Construction Battalion Units (CBU), and one Construction Battalion Maintenance Unit (CBMU) participated in the survey.

1.3 History of Construction Industry Performance and Productivity

Construction is among the largest industries in the United States. In 1986 the construction industry employed 4.4 million people and had expenditures of $389 billion dollars, nearly 9 percent of the gross domestic product. However, research conducted by the American Productivity Center shows that construction productivity has been declining since the mid 1960's despite the importance of construction to the economy. Buyers of construction have become increasingly concerned with high costs, increasing accidents, late completion, and poor quality during a period when high technology equipment, tools and materials have been deployed.

The Business Roundtable, an organization of the presidents of some of the largest corporations in the United States, began to look at ways to improve construction industry performance in the late 1970's. The rising cost of capital facilities was becoming a major problem and the Construction Industry Cost Effectiveness Project (CICE) was established by the Business Roundtable to determine the causes. The CICE project defined 23 key issues facing the industry including construction productivity. CICE Report A-1, "Measuring Productivity in Construction," found that there was no standard definition of productivity in the industry. Approaches to measuring input and output varied greatly, making comparisons between projects and the establishment of trends difficult. The next step was to undertake research to develop and disseminate methods to improve the performance factors identified by CICE. This need led to the establishment of the Construction Industry Institute (CII), based at the University of Texas at Austin in 1983. CII has been at the forefront in developing measurements of productivity and devising means to improve productivity since its inception.

Despite these efforts, little information exists regarding factors affecting productivity and to what extent. Even though worker productivity directly affects project cost and schedule, few organizations have endeavored to systematically improve their methods. Some experts blame the decline in productivity on poor employee work ethic. However, unwillingness or laziness of the work force is rarely the cause of poor construction productivity. Productivity improvement is clearly a function of effective management. This thesis will show that construction is an inherently motivating activity and that the factors negatively affecting this motivation can be identified, quantified, and eliminated. The Naval Construction Force (NCF) chain of command must get involved in implementing solutions to productivity problems if the NCF is to remain a successful and viable construction organization.

Chapter 2 of this thesis will provide the reader with an overall view of the Naval Construction Force, its mission and operation. A literature review in Chapter 3 presents several motivation theories and presents the findings of two independent productivity studies. Research methodology for this thesis is described in Chapter 4 including the craftsman questionnaire used to obtain data, problems in data collection, and the organization and analysis of the data. Questionnaire results are presented in detail in Chapter 5. Chapter 6 presents the author's conclusions and recommendations.

Chapter 2

The United States Naval Construction Force

2.1 History, Organization and Mission

The Naval Construction Force, popularly known as Seabees, is the United States Navy's internal construction company. The first Naval Construction Battalions were established at the outset of World War II by Admiral Ben Moreell, the Chief of the Navy's Bureau of Yards and Docks, now known as the Naval Facilities Engineering Command (NAVFAC). They quickly lived up to their motto, "We build, We fight." More than 325,000 men served with the Seabees in World War II fighting and building on six continents and more than 300 islands. In the Pacific, where most of the construction work was needed, the Seabees landed soon after the United States Marine Corps and built major airstrips, bridges, roads, warehouses, hospitals, fuel storage facilities, and housing. Seabees have fought and built in every major military conflict since World War II, including Korea, Vietnam, and Operations Desert Shield and Desert Storm. In addition, they have responded to natural disasters around the world assisting with recovery operations and have provided construction services and training to many of the world's underdeveloped nations. Today there are almost 10,000 active duty men and women serving in the Seabees. They continue to live up to and further their reputation for flexibility, responsiveness, and the ability to accomplish the impossible that over 50 years of service to the country has brought to the Seabees.

The NCF consists of a group of rapidly deployable naval units that can construct, maintain, and operate shore facilities. This work is primarily in support of the Navy and United States Marine Corps, but Seabees also work with other Armed Forces and governmental agencies. The most generalist of the NCF units is the

Naval Mobile Construction Battalion (NMCB). NMCBs are made up of approximately 750 men and women possessing every major construction skill and the means to fully support construction operations. Their mission is to provide a responsive engineering and construction capability to the Navy and Marine Corps in military operations, construct and maintain base facilities, repair battle damaged facilities, and conduct defensive operations as required to protect themselves and the facilities they have built. NMCBs are also trained to conduct disaster relief and recovery operations.

Construction Battalion Units (CBU), though much smaller on the order of 50 Seabees, mirror most of the construction skills found in the NMCBs. These units are permanently assigned to naval shore activities throughout the United States and provide base commanders with responsive construction support. These units are not self supporting but augment NMCBs during war and other contingencies. Their training is similar to that received by NMCBs. Construction Battalion Maintenance Units (CBMU) are a military public works force. These reserve units of about 300 Seabees are mobilized during wartime to maintain bases that the NMCBs build. Their mission is to provide minor construction, maintenance, repair, and operation of public works and utilities at advanced bases. They also maintain a self defense capability and are trained in disaster relief operations. These three units, the NMCB, the CBU, and the CBMU, are the subject of this thesis due to the similarity of their mission and skill.

Other specialized NCF units include Amphibious Construction Battalions (ACB), responsible for engineering and construction support of Marine amphibious landings; Underwater Construction Teams (UCT), responsible for construction, inspection, and maintenance of underwater facilities; and Naval Construction Force Support Units (NCFSU), another reserve unit mobilized to support NMCBs with material management, production of concrete and asphalt, long haul transportation, and major equipment maintenance. Due to their specialized missions, these units are not covered by this thesis. All of these units fall under a chain of command, or management structure, consisting of Naval Construction Regiments (NCR) and Naval Construction Brigades (NCB).

Naval Construction Regiments exercise administrative and operational control over units assigned to a specific geographic area and coordinate with the military customer during military operations. In peacetime, NCRs are responsible for the training and readiness of assigned units. At the top of the management structure, two Naval Construction Brigades, one Atlantic and one Pacific, exist to exercise administrative and operational control over assigned NCF units. The Brigades provide policy guidance, planning, employment plans and schedules, and distribute materials and equipment. Because of their authority, Naval Construction Brigades have the ability to add to or remove many of the constraints placed on Seabee productivity.

2.2 Objectives and Types of Work

The primary objective of the NCF is to be ready to successfully perform their assigned mission of expedient construction in hostile environments in support of the Marines. In order to do this, peacetime operations focus on training, both military and construction. In order to develop and maintain construction skills the Seabees work on actual construction projects at Navy and Marine Corps bases throughout the world. The objective of these construction operations is much like any for profit construction company: to safely build a quality facility within production schedules and cost estimates.

Seabees possess and train in basic construction skills that enable them to quickly construct solid facilities during war or other contingency. Basic carpentry and framing, steel erection and welding, site work and earth moving, rough electrical and rough plumbing are the Seabee's forte. Because of military training and other requirements, it is difficult to take the time to develop and hone more advanced skills. Efforts are made at the Brigade level to procure construction projects from customers that capitalize on and continue to develop basic construction knowledge. A pre-engineered building is a good example of a project that the NCF can successfully complete while training toward wartime requirements. Seabees, in general, do not do well working on projects requiring elaborate craftsmanlike finish work because these skills have very little value in a hostile construction environment.

2.3 Peacetime Project Life Cycle and Support

The NCF is required to be in a constant state of readiness to respond rapidly to any call for construction support. In order to maintain this ready posture while allowing for training and rest, NMCBs rotate through a standard 14 month cycle split into a 7 month "deployment" and a 7 month "homeport." During the deployment phase, the NMCB will move to an overseas naval base in order to be forward and closer to any region where their services will be needed. The NMCB will spend this period performing meaningful construction projects at the base. This period is the main focus of effort for any NMCB. They are at the height of their readiness by continuing to develop construction skills, and providing great value to their customers in the form of new construction. The NMCB sends several Details, from 10 to 150 personnel, to other bases in the region to work on construction projects. In recent years these Details have been established at several bases in the United States. The seven month homeport period allows the NMCB to concentrate on military training and allows Seabees to rest and spend time with their families. There are some limited construction projects at the home base mainly to develop project management skills for the upcoming deployment. Project information in the forms of plans and specifications are theoretically transmitted to the battalion several months before the end of homeport in order to allow planning and procurement time. In recent years this requirement has not been strictly forced upon the customer, causing many problems in the process. Figure 2.1 shows the typical NMCB project cycle.

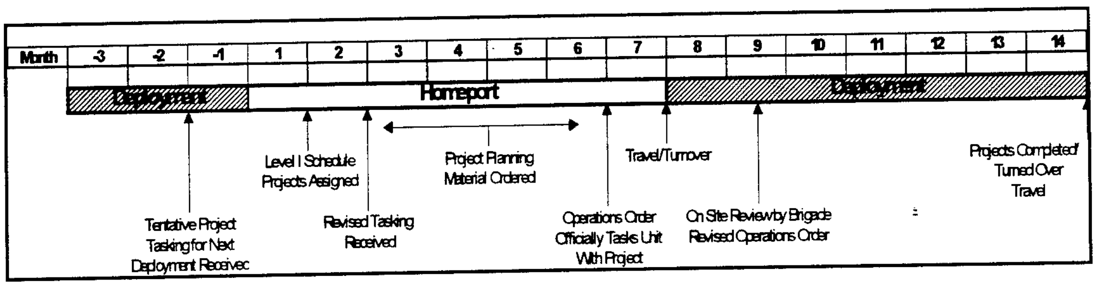


Figure 2.1: NMCB Project Cycle

Because war or another contingency cannot be easily predicted, completion of deployment construction projects becomes an auxiliary mission and objective. Much management attention at all levels is devoted to achieving success in this area. These projects and improving Seabee productivity on these projects is the focus of this thesis. Though the NMCB can be self sufficient, during peacetime they rely on the host base and customer for much of their support. The customer will generally provide design and engineering services and in some cases material enabling the Seabees to complete work. Where Details are deployed, the base will also provide housing, food and other necessities. The NCF is a great bargain to every base commander. Seabee labor, tools, and equipment procured for the wartime mission are put to use on projects free of charge to the base. The base pays only for material.

2.4 Impact of Budget Cuts on the Seabees

Reductions in the Department of Defense budget are forcing changes in the way Naval shore and afloat organizations operate. There is not enough money to meet operational expenses and to adequately maintain the shore infrastructure.

These resource constraints are squeezing the NCF from two sides. First, because of limited funds, base commanders are finding that the Seabee bargain (free labor, tools, and equipment) is an increasingly logical way to meet their maintenance, repair and construction needs. Commanders are demanding more Seabees and in fact, recent force reductions have not significantly affected the Seabees because of this demand. Seabees are providing a needed service to their customers with great success. They have more requests for work than they can take on. Their value to the operational commanders has caused the commanders to use their clout to keep budget cutters at bay. Although this is an enviable position in which to be, the NCF continues to be pressured to provide more and more to the customer in order to keep their support. This pressure to succeed and meet commitments at all costs is beginning to filter to the work force level and could soon cause problems.

Secondly, the resource cuts and limitations are directly affecting the Seabees. Insufficient funds slowed the acquisition of necessary tools, equipment, and technology to modernize the force. The NCF is having difficulty meeting all of its commitments with an inadequate amount of tools and with an aging equipment fleet needing constant maintenance attention. Again, this pressure to do more with less is beginning to affect the morale and the productivity of the average Seabee.

Chapter 3

Literature Review

3.1 Background

In this chapter, the basic theory behind improving construction productivity will be discussed. It will be demonstrated that productivity and job satisfaction relate to one another while increasing the success of any project. First, several classic motivational theories will be explored. Next, Dr. John Borcherding's initial exploration of construction worker job satisfaction and motivation will be discussed. Lastly, two reference documents describing programs developed to determine productivity problems and programs to improve productivity will be discussed and summarized. The first document is a thesis completed in August 1979 titled "Factors Influencing the Motivation and Productivity of Craftsmen and Foremen on Large Construction Projects," written by Douglas Garner, graduate student, John Borcherding, Associate Professor, and Nancy Morse Samuelson, Research Associate. The second document, entitled the "Super Bee Project" is a formal report prepared by consultants Richard Tucker, John Borcherding, Mike Casten, and Greg Howell for the Motivation and Productivity Committee of Conoco/Monsanto Joint Venture and Brown and Root, Inc. in 1980. Dr. Tucker, Dr. Borcherding, and Gregory Howell are all registered professional engineers and independent consultants who are nationally recognized as experts in the field of Construction Project Management and Construction Productivity.

3.2 Motivation Theories

No discussion of motivation would be complete without discussing the theories of Abraham Maslow, which are perhaps the most widely recognized and accepted theories in the field of behavioral science. In 1943 Maslow presented his theory of motivation which classifies the needs of human beings. These needs were arranged in a hierarchy of importance with definite steps. These needs in order are physiological, safety, belonging, ego and self actualization. Maslow concluded that in order to satisfy a need, each preceding lower level need must be satisfied. Once a need is satisfied it no longer is a motivator of behavior. Thus a need is a motivator only if a person is deprived of that need. Physiological needs are those pertaining to food, shelter, sleep, and other human basics. Safety includes a chance for an ordered existence and a secure future. Belonging applies to peer acceptance and affection from loved ones. Ego needs refer to the desire for recognition and self respect and esteem. The final step in the hierarchy, self actualization pertains to an individual's sense of achievement and an increasing influence or power. Applied to workers, Maslow's theory basically states that if workers are adequately paid and have some sense of job security, then they will be motivated by a sense of belonging and then by recognition.

Frederick Herzberg's satisfiers-dissatisfiers theory of motivation states that there are two key factors in the motivational process. Satisfiers, which he labels motivators, relate to job content and concern high order factors of responsibility, growth, and recognition. These are positive factors which motivate workers to produce. Dissatisfiers, called hygiene factors, do not cause dissatisfaction or satisfaction but rather are items that would cause dissatisfaction if they did not exist. Hygiene factors are low level needs including pay, company policy, supervision, and working conditions. These factors avert dissatisfaction but do not generate satisfaction or motivation. Herzberg states that jobs must be enriched by responsibility and opportunity for growth in order to increase motivation and productivity.

Douglas McGregor's Theory X and Theory Y represent a change in motivational theory over the last half century. McGregor originally proposed Theory X, which represents the old style authoritarian approach and was successfully utilized prior to the human relations movement. Theory X is based upon the elementary assumptions that the average human dislikes work, can be controlled and directed to accomplish a task, and in fact prefers to be directed. After World War II a more humanistic approach to management came into vogue and managers found that Theory X no longer held true. McGregor restructured his thinking and proposed Theory Y, which incorporated the human relations movement. The assumptions of Theory Y are that the average human enjoys physical and mental effort, possesses self control and self direction, and accepts and seeks responsibility. The majority of today's businesses utilize the concepts of Theory Y and it forms the basis of construction worker motivation theories. The military has continued to rely on Theory X but during the recent prolonged peaceful period, Theory Y has become more and more prevalent.

3.3 Motivation of Construction Workers

Construction workers have a great deal of intrinsic motivation. Intrinsic motivation is that which is developed within the individual and is not affected by external stimulus. Construction workers derive their greatest satisfaction from being productive on the job. Performing a task well or completing a well-built final product are very important to them. Dr. John Borcherding's research on this subject is important to understanding how motivation and productivity interrelate. He states in his article "Motivating for Productivity" that there are five motivational factors which can have significant influence on productivity:

1. Management must ensure the elements of work are available to allow craftsmen to complete assigned tasks.
2. Greater work force participation in problem-solving and decision making.
3. A work environment which recognizes employees for outstanding job performance.
4. Goal setting at the project and crew level.
5. A fair financial incentive program which rewards craftsmen and foremen for productivity improvement.

Dr. Borcherding concluded that well organized tasks, permitting workers to be more productive, leads to job satisfaction. This idea contrasts Herzberg's theory that job satisfaction leads to production. It is clear that in construction, satisfaction is inherent in the work itself. Smooth work flow, rather than job enrichment, will improve job satisfaction and productivity.

Essentially, construction workers are happiest when the work is well planned and on schedule. Dissatisfaction occurs when errors in planning, scheduling, materials procurement and other factors outside the workers control become common on the project. If supervisors practice the principles of good management, which ensures the elements of work are provided to their employees, the highest level of motivation is realized. The reader is encouraged to read Chapters 5, 6, and 7 of the Department of Energy (DOE) study discussed in the following paragraph as well as several articles co-authored by Dr. Borcherding referenced in the bibliography, to learn more about construction worker motivation.

3.4 Thesis (1979): "Factors Influencing the Motivation and Productivity of Craftsmen and Foremen on Large Construction Projects"

"Factors Influencing the Motivation and Productivity of Craftsmen and Foremen on Large Construction Projects" was a formal research study and thesis prepared and paid for by the DOE. The study was conducted to analyze the most frequent and prevalent factors adversely affecting the motivation and productivity of craftsmen and foremen on large energy construction projects. Twelve projects within the United States were studied. They included ten nuclear power plants, one large non-nuclear plant, and one smaller nuclear related facility. The primary data collection tool was a craftsman questionnaire supplemented by craftsman and foreman interviews and general foremen questionnaires. The NCF questionnaire is a modified version of the one used in the DOE study.

Areas affecting productivity that were studied were:

- material availability
- tool availability
- rework
- craft turnover
- foremen changes
- crew interfacing
- overcrowded work areas
- inspection delays
- craft absenteeism
- foreman incompetence

The biggest problem encountered in the study was material availability. Sixty-two percent of the craftsmen questioned indicated that material was a significant deterrent to productivity. Tool availability and rework tied for the second biggest problem area followed by overcrowded work areas. The author's relative rating system is another means of ranking problem areas with the largest score as the most severe. A third method for ranking problems is the lost man-hours analysis. Table 3.1 is a statistical summary of the craftsmen questionnaire.

Overall Statistical Summary of DOE Craftsman Questionnaire			
Problem Area	**Hrs/Week Lost**	**% Craftsmen Indicating Problem**	**Relative Index Score**
Material availability	6.27	62.0	.41
Rework	5.70	59.0	.28
Tool availability	3.80	52.0	.28
Overcrowded work areas	5.00	49.0	.15
Inspection delays	2.66	41.0	.11
Crew interfacing	3.29	36.0	.07
Instructions time	2.12	Not Computed	Not Computed

Table 3.1: Overall Statistical Summary of DOE Craftsman Questionnaire

The DOE study also correlated the amount of unproductive time and rework time with project completion. This research proved that unproductive time increased substantially during the first half of construction and leveled off later. Similarly, rework time was greatest during the first third of construction and leveled off during the last two-thirds of construction. Other trends and correlations that were developed were:

- lost time vs. size of the work force,
- lost time vs. craft turnover,
- lost time vs. number of QA/QC personnel,
- lost time vs. craft absenteeism, and
- lost time vs. engineering design lead time.

For the results of these correlations as well as additional information on trend identification, the reader is encouraged to refer to Chapter 4 of the DOE study.

3.5 The "Super Bee" Program

The "Super Bee" Program was a Productivity Improvement Program implemented on the cost plus Chocolate Bayou Project with the assistance of consultants (Tucker, Borcherding, Howell, Casten, and Ulkus) for the owner, Conoco/Monsanto Joint Venture and the contractor, Brown and Root, Inc. Construction started in early 1978 and at its peak the project employed over 2700 craftsmen. At the time of implementation of the Super Bee program in December 1979, the project was 50% complete, over budget, behind schedule, and craftsmen morale was low. Employee turnover and absenteeism were high.

The consultants were responsible for formulating and initiating the program by training on site personnel in its management and implementation. This included collecting productivity data, time-lapse photography and reviewing the progress of the program. A program manager was selected from Brown and Root's staff to implement the decisions of the committee. The program was continued under the direction of this individual after the consultants left the project. The major consulting effort occurred in early 1980 and involved the following activities: worker motivation, training, work methods improvement, data collection and feedback.

The consultants used questionnaires, interviews, foreman delay surveys, absenteeism data, and time-lapse film to identify and solve specific project problems. The majority of the improvement effort centered around the project foremen since they represent the key focal areas for productivity improvement. Hence, most program features were constructed to assist foremen in guiding their crews. Intense training sessions were developed to teach foremen and general foremen how to plan, organize, staff, direct, control, and monitor their work. The foreman delay survey, an evaluation tool used periodically by foremen to identify factors affecting their crew's productivity, was used extensively. For detailed information on the survey, formal pre-planning for construction and data gathering for onsite productivity improvement studies, the reader is encourage to refer to Oglesby, Parker and Howell's book, "Productivity Improvement in Construction."

The program name ("Super Bee") and emblem, job site posters, biweekly project newsletters, and an awards program (Crew of the Month), were direct motivational tools implemented to help cultivate a strong sense of project identification, ownership, and commitment. Indirect motivators were increased training programs, work methods improvements, questionnaires, and interviews. Low absenteeism, safety, and productivity were the tenets on which the awards program was based. Lectures, group problem solving, and case studies were the management training tools used to improve and develop foremen and general foremen management techniques. In addition, a training reference manual and a comprehensive introduction on work methods improvement was provided to management.

Time lapse film was used to identify areas where crew level work methods improvement techniques would benefit. Films and the consultant's analysis of the films were presented to supervisors and craftsmen who were also asked to provide improvement suggestions. This aspect of the program was critical to productivity improvement because it illustrated that direct communication between the worker in the field and the manager in the office could occur. In the beginning, the biggest hurdle was convincing workers that change was possible and that management wanted and supported change to make their job easier and thus, more productive.

One significant work improvement method occurring early in the program was the drastic improvement of tool room procedures. A survey revealed that approximately 150 persons per hour were failing to obtain their desired tools and expendables. This was equating to approximately 300 lost man hours per day. Therefore, the following steps were taken:

- a tool room problem solving committee was chartered
- an additional tool clerk was assigned to each tool room

- cut off saws were added to various sites
- an indefinite sign out period was established for safety belts
- purchase procedures were revised
- posters were added to tool rooms to remind the work force to report damaged tools and return tools that were checked out.

The results of the tool room study and its corrective action program were impressive. Tool room turndowns were reduced from 47% to less than 10% in an eight week period. Most importantly, since this occurred early in the program implementation and was widespread and highly visible, a sense of credibility for the entire program was firmly established. Similar positive results were achieved in material distribution, project level planning, and work methods improvement.

Although the use of questionnaires and interviews is a different approach to determine craftsmen's perception of productivity, it was a very important element in the participative decision making philosophy of the Super Bee program. As mentioned earlier in this chapter, craftsmen want to be productive and become frustrated by circumstances which reduce their effectiveness. Their frustrations and perceptions are best captured by the use of questionnaires and interviews designed to obtain both quantitative and qualitative impressions of job progress. Although they are based upon opinions, hence subjective in nature, they reflect perceptions of the work force and their working conditions. The questionnaires usually reflect the craftsmen's attitude as well as specific job problems.

Feedback was continuously shared with workers at all levels via project newsletters and management consultant meetings. Communication among workers, consultants, and management was the single most important item responsible for program success. Participative decision making was continuously reinforced and practiced at all decision points. The productivity improvement program implementation costs were $250,000 and the estimated cost savings were $4,000,000. Significant quantitative improvements, such as craftsmen delays, were reduced by one half in a two month period and absenteeism was reduced from 13% to 6%. Non quantitative improvements between the contractor and owner were increased cooperation and morale at all organizational levels.

By giving the craftsmen the opportunity to be heard, the interview and questionnaire process motivates them and strengthens their identification and commitment to the project. It is on this premise that the author selected the questionnaire process to determine the productivity constraints on the Seabees.

Chapter 4

Research Methodology

4.1 Research Methodology Introduction

The data for this study was obtained through a construction craftsman questionnaire. The questionnaire is a modified version of Dr. John Borcherding's survey developed in 1979 for the DOE's nuclear power plant construction program. It was developed to identify, qualify, and statistically quantify the type and severity of problems which adversely affect and constrain the production and motivation of NCF Petty Officers. The survey consists of fifty questions categorized into eight common inherent problem areas known to decrease construction productivity and adversely affect morale.

Table 4.1 gives a description of the eight categories.

Problem Area	**Description**
Rework	The time and effort expended performing work for the second time due to workmanship, design error, or changes.
Materials	Problems which result from material availability, lack of availability, or difficulty in obtaining or scheduling them.
Tools	Problems which result from tool availability, lack of availability, or difficulty in obtaining or scheduling them.
Equipment & Trucks (Civil Engineer Support Equipment (CESE))	Problems which result from CESE availability, lack of availability, or difficulty in obtaining or scheduling it.
Crew Interference	Relates to delays caused by lack of coordination and scheduling of trades.

Problem Area	Description
Overcrowded Work Areas	Refers to interference caused by other crews or the physical layout of the jobsite such as renovating a customer occupied building.
Instructions	Refers to time spent waiting for and/or receiving direction from supervisors.
Design Interpretation and Engineering Information	Refers to the time spent waiting for design clarification or additional engineering effort required to satisfactorily complete construction.

Table 4.1: Productivity Constraining Categories

Each category of the questionnaire survey is comprised of four to six questions. The first question asked in each category resulted in a "yes" or "no" response to whether or not each particular problem occurs "often" (defined as every day or every other day). The second question asks the respondent to approximate how many hours per week were spent unproductively due to a specific problem area. The next question asks the respondent to chose from a list of potential causes of the problem. The last question in the group is an open-ended question, asking the respondent how to improve or eliminate the problem. Responses to this question often illustrate the respondent's frustration or motivation. Appendix A is a copy of the questionnaire used. All unanswered questions, or answers indicating more than one choice were not used in the final analysis. All remaining responses were compiled and converted to percentages with applicable standard deviations calculated.

4.2 Collection of Data

One hundred surveys were personally distributed by the author to the Officers in Charge of four NCF units in December 1996. The largest unit, NMCB ONE, Detail San Diego received 40 questionnaires and 20 each were given CBU FOUR ONE EIGHT, Bangor, Washington, CBU FOUR TWO SEVEN, San Diego, California, and CBMU THREE ZERO THREE, San Diego, California. The Officers were asked to personally monitor the surveys and ensure a representative sample of each direct labor rating (Builders, Steelworkers, Equipment Operators, Construction Electricians, and Utilitiesmen) was surveyed. One hour was allotted to complete the survey.

Not one unit completed all of the surveys distributed, but each unit did provide a representative cross section of their direct labor work force. The following number of surveys were received: NMCB ONE - 24, CBU 418 - 18, CBU 427 - 16, and CBMU 303 - 5. Before being surveyed, respondents were informed that the survey was completely anonymous. It was further explained that the survey's purpose was to indicate key areas where management needed to improve their support of the work force.

4.3 Difficulties Encountered in Data Collection

Sixty-three surveys were returned by February of 1997 with two of the original sixty-three surveys discarded due to inconclusive or erroneous data. An example of erroneous data is when the cumulative hours of lost time exceeded the number of hours in the work week. Due to project constraints, the surveys were not personally administered by each Officer and in most cases were not given in groups or during normal working hours. Although difficult to determine, the respondents may have viewed this as a lack of concern by management. The Officers were the only individuals briefed in detail about the survey. Therefore, if the Officer did not proctor the survey, respondents questions would have gone unanswered or would have been answered by an unqualified peer or supervisor.

4.4 Organization and Analysis of Data

Table 4.2 shows, by rate and unit, the number of Seabees surveyed. All data from the questionnaires was entered into a Microsoft Excel spreadsheet and analyzed. Eight different sorts were performed on the data with summary reports generated for each sort. The eight sort categories were:

1) All units
2) NMCB ONE
3) CBU 418
4) CBU 427
5) CBMU 303
6) Builders and Steelworkers
7) Equipment Operators
8) Construction Electricians and Utilitiesmen

The sorts were developed in order to compare and analyze problematic areas for each unit and rate. Builders and Steelworkers were combined as well as Construction Electricians and Utilitiesmen because they are commonly assigned together in Companies or Platoons and their work is similar. Analysis indicated that there were no significant differences in results for each unit or rate. Some issues received higher percentages for certain rates; for example, Equipment Operators felt that CESE was the biggest problem, but the differences were not significant. In short the productivity and morale problems indicated by the results are common to all Seabees. A definite trend appeared regardless of rate or unit and this indicates that the problems are inherent with the NCF system and business practices as a whole. Appendix B is the management summary report for all units. The other nine summary reports are not included as appendices, but can be obtained from the author.

Rate	Total Rate per Unit				Total	% of Each Rate
	NMCB 1	CBU 418	CBU 427	CBMU 303		
BU	9	7	4	1	21	33.33
SW	3	3	2	0	8	12.70
EO	6	3	5	1	15	23.81
CE	4	2	4	1	11	17.46
UT	2	3	1	2	8	12.70
TOTAL	24	18	16	5	63	100.00

Table 4.2: Breakdown of Units and Rates Surveyed

4.5 Validity of Data

The results of the survey questionnaire are subjective and represent the Seabees' perceptions of job activities. However, due to the built-in redundancies of the survey and the end summary section, a fairly high level of consistency was achieved. Therefore, the results are believed to be highly representative of the day to day organizational constraints detracting from every Seabees' productive time. Even though the surveys are subjective, it is important to rectify problems perceived to be significant. The precision of the survey is inconsequential. The work force perception that there is a 2 hour loss due to tool problems, if carefully measured, may prove to be in fact 1.75 hours. However, the important point is not the precise delay but that tools have been identified as a problem by the Seabees and that the chain of command (management) must make an effort to improve the tool availability. A second survey would show any perceived improvement with the same level of accuracy.

Chapter 5

Quantitative Results

5.1 Questionnaire Results Introduction

This chapter presents the quantitative results of the eight problem constraints on productivity for all Seabees surveyed. As discussed previously, several sorts on the data were run with no significant differences in results. The most likely cause of this is that Seabees typically work in small crews and complete entire projects as a crew. They tend to work across trades, i.e. Construction Electricians assisting with formwork or Steelworkers laying out pipe, and thus see problems from a broad perspective that are not trade specific. After broadly summarizing the results in the eight areas, focus will be placed on discussing the causes of the five most significant constraints, as indicated by the questionnaire results.

The sample distribution included twenty Builders, eight Steelworkers, fifteen Equipment Operators, eleven Construction Electricians and seven Utilitiesmen. Figure 5.1 illustrates the percentage of each craft surveyed. The average trade experience of all Seabees surveyed was 10.2 years and, on average, 9.6 of these years were spent in the Navy. All results for lost time are based on the average work week for all Seabees surveyed of 45 hours. Typical work weeks for Seabees range from 40 hours to 60 hours depending on what point of the deployment cycle their unit is in. The average Seabee crew size was 6.8 people.

Figure 5.2 summarizes the magnitude of the perceived problems for all eight productivity constraints for all Seabees surveyed. The percent of lost time was calculated by dividing the average number of lost hours per Seabee per week for the sample distribution by the average forty-five hour work week. The percent greatest effect was determined by the responses to questions 44, 45, and 46 of the survey which asked the respondents to rank the top three problems listed in question 43.

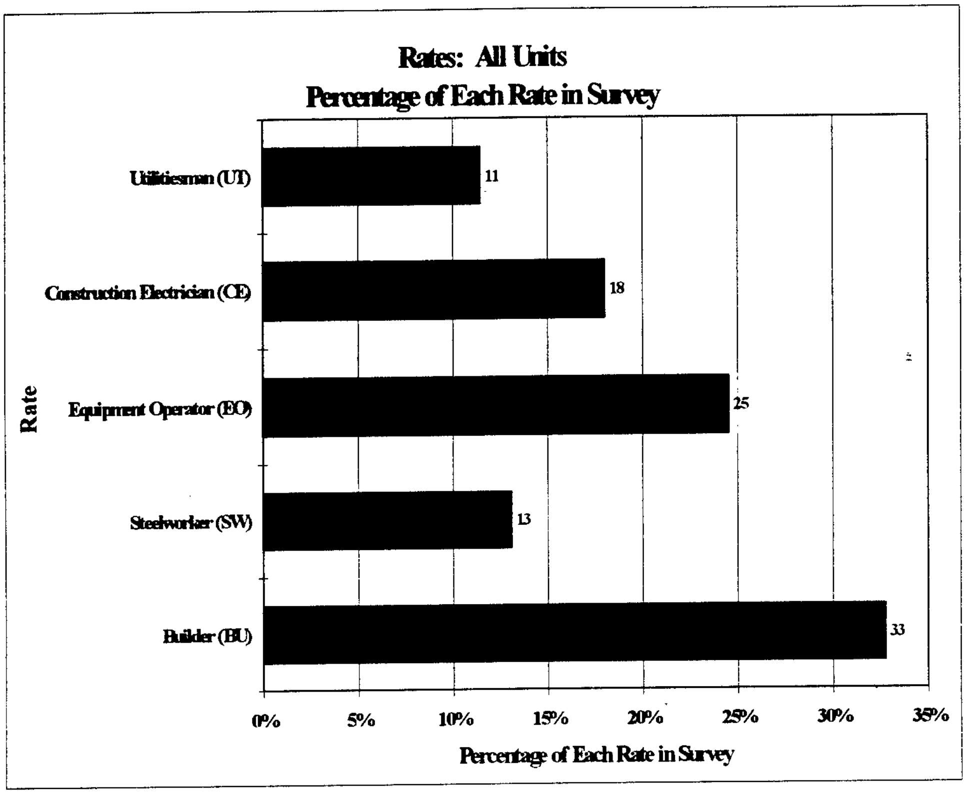


Figure 5.1: Rates: All Surveyed

Improvement of these problems would have the first, second, and third greatest positive effect on their job. A score of three, two, and one was then respectively assigned. The spreadsheet then totaled the scores for all sixteen problem areas listed and calculated their percentage relative to the other categories. The overall average lost time per Seabee per week was 22.3 hours or approximately one half of the work week. According to research by Dr. John Borcherding, projects of this type and size could expect 10 to 12 hours of lost time per week. In essence, Seabee lost time is twice what would be expected on similar work. Over 70% of the respondents viewed design and engineering as a major problem. Sixty percent viewed CESE, as well as material operations, a problem. and over 50% felt that tool availability was a problem. The other constraint categories, rework, crew interference, crowding, and instructions, do not seem to pose significant problems. However, rework will be looked at in depth due to the high amount of average lost time (3.26 hours). Table 5.1 lists the average time losses per constraint in hours per Seabee per week as well as shows the perception of a problem.

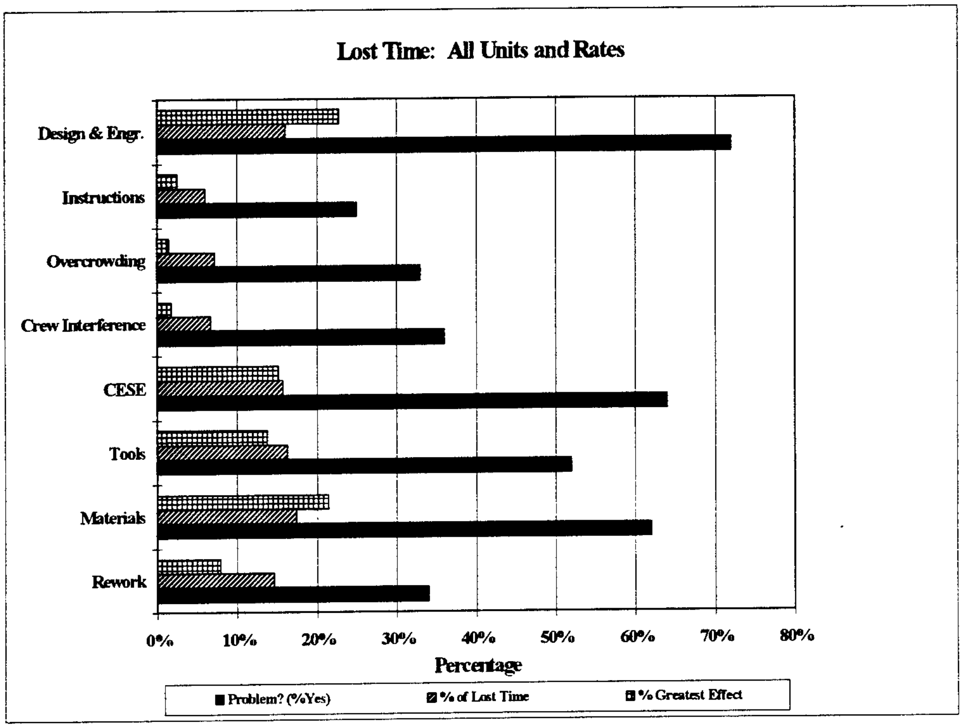


Figure 5.2: Lost Time: All Units and Rates

Productivity Constraints	Average Lost Time (Hrs/Week)	% Perception of Problem
Rework	3.26	34.42 %
Material	3.89	62.30 %
Tools	3.64	52.46 %
Equipment (CESE)	3.51	63.93 %
Crew Interference	1.49	36.07 %
Crowded work areas	1.61	32.79 %
Instructions	1.34	24.59 %
Design and Engineering	3.59	72.13 %

Table 5.1: Summary of Lost Time and Problem Perception for All Constraints

5.2 Design/Rework/Changes

As previously noted, design, engineering and planning were considered to be major problems by over three-fourths of those surveyed. Although design did not cause the highest amount of lost time, it was singled out as having the greatest effect on job outcome. The results of the survey also show that rework relates closely to the design problem. Most of the respondents singled out the designer and coordination with the designer as the main cause of the problem. Seventy percent stated that the problems were poor drawings, fifty-six percent cited poor specifications while approximately forty percent said that coordination with and obtaining information from the engineer was the cause of the difficulty. The direct comments about the design process ran along similar lines. Frustration that the engineer did not investigate the site, did not provide adequate plans, did not understand the Seabees' capability and did not understand the construction process were common responses. These comments are listed in Appendix B.

The responses to the rework section are important to understanding the full scope of the design problem. Due to rework 3.26 hours per week are lost, and when added to the design losses these two categories account for over one-third of the lost time. The majority of the comments in the rework section again cited the designer as being the cause of the problem. Fifty-two percent felt that design error was the major cause of rework. The most significant finding of the rework area, however, is that seventy percent blame customer changes for rework. Frustration and anger are evident in the comments about the customer and the author sees this to be the most disturbing finding of the survey. As the NCF senior leadership strives to be the constructor of choice for its customers, they have not communicated this vision to the work force very well. This needs to be addressed with communication and education.

The design/rework problem is a symptom of the budget environment and the pressure that the NCF feels to perform successfully regardless of obstacles. For many years of peacetime deployment cycles designs and specifications were completed and transmitted to NMCBs three to four months in advance of project start dates. This gave the Seabee crews sufficient time to review the job, plan its execution properly, and to make inquiries of the designers. As the NCF has moved into new bases and has pursued strong customer service, the requirement for plans up front has become less and less stringent. Designs are usually provided by the customer's in house public works engineering force and they have taken advantage of the NCF's leniency thus affecting the Seabee in the field. As stated previously, the customer is under budget pressure as well and he focuses his limited resources on what he perceives to be the biggest problem. In this case the designers must concentrate on providing good plans and specifications for contracted jobs. Basically, the contractor can claim or otherwise monetarily hurt the customer if his design is inadequate. The NCF does not have that ability and thus gets significantly less attention.

5.3 Materials

Material problems received the second highest score for greatest effect and was the biggest problem in terms of lost time. The material process is also a victim of continuing to operate under the old system and assumptions in a new era where responsiveness is absolutely necessary. Fifty-two percent of respondents stated that material was not ordered with adequate lead time, forty-six percent stated that paperwork was a problem and thirty-nine percent blamed the vendor for not delivering on time. The Seabees have operated under a very centralized material supply system for many years, with a stateside NCR ordering material and shipping it to the overseas project site. Many of the comments suggested decentralizing this system and putting more ability to procure material in the field. Today, almost all of the material used in a typical Seabee project can be bought "off the shelf" from local vendors. In some successful recent projects crewleaders have coordinated directly with the customer who supplied material on a just in time basis. Seabees are frustrated by what they feel is a lack of trust from the chain of command to run their projects. The author feels that a long-term objective of the NCF should be to completely re-engineer the material process to match its desire for flexibility and responsiveness.

5.4 Equipment

Civil Engineer Support Equipment (CESE) was cited as being the second biggest problem and had a similar amount of lost time as materials, tools and design. The main reason for problems with CESE stem from availability. Sixty-seven percent of the respondents stated that there was not enough CESE on site to do the work properly. Approximately forty-five percent said that CESE was in the shop or deadlined and forty-two percent said someone else was using the CESE they needed. All of these responses arise from an aging and inadequate equipment fleet. Comments ranged from "replace ancient CESE" to "need more mechanics" to "don't take on new projects when CESE is already committed." This is a difficult problem to solve because of lack of funding to quickly upgrade the fleet and also because the Navy is experiencing a lack of qualified mechanics. The most logical solution to this problem in the short run is to ensure that CESE is scheduled and that new projects that would exceed resource limits not be accepted. Some respondents suggested that improving the system to order parts would go a long way to keeping the equipment available to work. The current system is slow and bureaucratic and, like materials, most of the parts can be purchased "off the shelf" from local suppliers.

5.5 Tools

Tool availability ranked as the second highest factor in terms of lost time with the average Seabee spending 3.6 hours per week delayed waiting for the proper tools. Approximately fifty percent of the respondents felt that tool availability was a problem. The two causes which received the highest scores (approximately 50% of respondents) for tool problems were not enough tools for the size of the work force and tools were broken during work. Many of the comments referred to "outdated tools" and "cheap tools" that broke easily. This is a purely internal problem for the NCF brought upon by lack of funding available to quickly upgrade the tool inventory.

5.6 Morale and Communication

The vast majority of the respondents seem to be very satisfied with their jobs despite the problems mentioned above. One respondent stated, "It's not a problem. We'll find a way to get the job done regardless." This is the famous Seabee "Can Do" attitude in action. Over ninety percent of those commenting on what they like about their job responded with comments like "satisfaction in seeing a quality job completed," "feeling like I'm part of accomplishing something," and "doing the work." All of these comments correspond to the theory that construction workers derive satisfaction from being productive and participating in the construction of a physical structure. Seabees are generally above and beyond your typical construction worker in that they are also motivated by serving their country, advancing in rank, and doing things others may think impossible. The NCF has good people and morale is high as evidenced by the completion of many tough projects despite the barriers to productivity discussed above. If these constraints were removed or reduced even by 25%, a typical crew could do work as if they had an extra Seabee.

The main problem that was noted from the comments regarding what Seabees dislike, and also in some of the perceived constraints, seemed to be a lack of communication. The senior leadership appears to have some positive endeavors in the works but the crewleaders and Petty Officers are not getting the word. They are trained to expect input from a system (materials, plans, etc.) at certain times and in certain forms but they are not getting it. This is extremely frustrating. The Petty Officers need to be brought on board to the new way of operating. Flexibility, responsiveness and customer satisfaction can be achieved in peacetime construction only if the leaders at the work face get the word from and the support of senior leadership.

Chapter 6

Recommendations and Conclusions

6.1 General Problems and Solutions

The NCF continues to be able to do more with less, but they are not going to be able to sustain this pace. Due to budgetary constraints the NCF has given up on some old standards in order to make their organization more user friendly for customers. While customer satisfaction is important, lack of adequate lead time for planning will mean some failures eventually. The pressure to succeed at all costs is felt at the work face and the author feels that morale and safety will eventually suffer. In fact the author has observed a senior Seabee leader work his people 16 hours a day for 7 days a week in order to meet an arbitrary deadline. While maintaining the NCF as a "going concern" is important, the leadership needs to remember their internal customer, the troops, and provide them with the support they need to get the job done. It is important to educate the customer and the designer as to what can be done and what is needed to do it. Seabees must demand proper project documents and only accept work that is within Seabee capabilities. Officially, it is necessary to revise the project life cycle so that expectations are the same at all levels.

Leadership is the key to improving productivity for the Seabees. Almost every Seabee in the force wants to perform quality construction on schedule. They take pride in seeing what they have helped build put to good use by their fellow Sailors. Every Officer and Chief Petty Officer must work constantly to make sure that the people at the job site have the necessary materials, tools, equipment, plans, and training to get the job done. That is, "Give them the basics and they will amaze you." But remember, "No materials (or tools, or equipment, or plans), No Seabee magic." The author learned this profound idiom from a great Chief Petty Officer and it holds true. The late Admiral Mike Boorda recounted a story of one of his visits to a ship of the line. While visiting one of the ship's Departments he asked the Department Head, a Lieutenant, how many people he had working for him. When the Lieutenant replied "none," the Admiral looked confused until the Lieutenant said "I work for them." Every person in the NCF should remember this simple lesson and live by it.

6.2 Design/Rework/Changes

Although the budgetary situation is beyond the control of the NCF, there are several things that can be done to reduce the effect of the design problem on the work force. First, although this is what the customer wants, the NCF should try to avoid working on "fast-track" projects. Commitments to projects should not be made without adequate upfront engineering and project planning. There is sufficient demand for Seabee services that refusing projects with no plans will not affect the force. Secondly, designs should be submitted to the local Resident Officer in Charge of Construction (ROICC), the Navy's construction management organization, for a thorough constructability review. Next, the customers and designers should be educated as to how to get the most out of the Seabee workforce. It is necessary for the Brigade operations staff to explain capabilities and look for simple, basic projects. Brigade should show the customer that although the Seabees are a inexpensive construction force, that much more could be done if design and construction methods are well thought out. Establish a solid system to obtain information from the designers and to provide feedback to the designers. The senior officer in the field, either the Operations Officer or the Officer-In-Charge, should institute a weekly on site project meeting to include the design engineer, the ROICC, and the customer. Lastly, if the NCF is seeking to position itself as a "fast-track" capable, flexible, and responsive construction organization this must be communicated to the work force. It could be used as a motivator if put in the light that "we're better than you're typical contractor. We can give the customer what they can't." Additional training must be provided to give the crewleaders the tools to plan and manage a project in a short time frame. The current NCF planning system is quite thorough and well thought out but it suffers from a lack of computer technology that could speed the system and make it more effective. Successful project crewleaders consistently use short term two week schedules to ensure that all aspects of the project go smoothly. Using the short term schedules, problems can be solved before they cause lost time for the crew.

6.3 Materials

Material is the second biggest problem for the work force. Historically this has always been a problem for the Seabees due to their mobility and ability to work in distant lands. NCF leadership must take immediate steps to simplify and modernize the process of obtaining material. Pressure has always been put on the crewleader to make sure he tracks and follows up on the materials for his job, but more often than not the problems are beyond his control and above his level because of the centralized supply system. Two things must happen to fix the process. First, authority to procure material should be placed in the hands of the people who are being held accountable for completion of the project. The crewleader or project supervisor should have the ability to purchase standard off the shelf items to keep the job moving. This would definitely speed up the system. In most cases basic materials are available from local vendors and long shipments are not necessary. Secondly, the NCF should implement the latest federal procurement regulations adopted to streamline government contracting. Doing things smarter and using common sense should eliminate overhead and reduce time. As previously stated, the majority of the material needed for NCF projects is available off the shelf from several competing sources. Shopping for the best price is necessary but the low bid process for most construction material is outdated. One solution, within the procurement regulations, is to pre-qualify specific vendors to provide material at the lowest cost, allowing crewleaders to obtain material quickly.

6.4 Tools

Improving the availability of proper tools could provide large benefits. Even though budgets to purchase new tools are limited, purchasing the right tools and getting them into the hands of the work force quickly and easily is important. Many respondents complained of insufficient tool quantities. First, every Central Tool Room (CTR) should maintain a list of tools needed but not on hand. Crewleaders should be made aware of this and the list should be submitted monthly up the chain of command. The Brigade can then plan tool procurement around the list after analysis. Secondly, each unit should charter teams to study their CTR procedures, timeliness and inventory. The local unit can then adapt its CTR to meet the needs of the crews. Lastly, a simple bar code system should be implemented to reduce the administrative headaches brought on by tool issue, tracking and inventory.

6.5 Equipment

Equipment has historically been a sensitive issue with crews in the field. Either they do not have the right piece of equipment or the equipment is down for maintenance. These were the common complaints from the survey as well. The NCF does have one of the best equipment management systems in the world and outstanding maintenance professionals. The main problem comes from constant breakdown of an aging equipment fleet and the difficulty of obtaining parts. The leadership should ensure that the limited funds are spent wisely and the most needed equipment is procured. Next, the parts procurement system should be reengineered similar to the materials procurement system. Standardized construction equipment will allow parts to be procured locally in most cases. Lastly, though the NCF does have a good equipment management system in terms of procedures, the system needs upgraded information technology to speed it and reduce the delay imposed on crews in the field.

6.6 Summary

The Seabees continue to be extremely successful and have proudly carried on the tradition of excellence established by their predecessors. However, because of increasing constraints and a lack of communicated vision, this could change quickly. The NCF needs to return to the basics that led to the successes. The NCF should take on simple projects within the force's capabilities and resources. The current constraints can be removed and lost time can be reduced. Leadership must always remember that support of the work force is their responsibility. The Seabees want to work, give them what they need and productivity will surely increase.

Appendices

Appendix A

Naval Construction Force Survey Questionnaire

(If you are not currently working on a project, answer questions based on the last NCF project you worked on.)

Current Unit: NMCB (Port Hueneme) NMCB (Gulfport) CBU CBMU

Personal Data (Please do not include your name)

1) What is your rate?

BU_____ CE_____ EA_____ EO_____ SW_____ UT_____

2) How long have you been working at your rate (include civilian time)? Number of years:_____

3) How long have you been in the Navy? _____years_____months

4) How many hours do you normally work per week? _____hours in _____days each week

5) On average, how many people are in your crew? Number of Seabees:_____

6) What is your rank?

E-7 or above_____ E-6_____ E-5_____ E-4_____ E-3 _____

Rework

7) Do you often spend time doing work over? Yes_____ No _____

8) How many hours per week would you guess your crew spends doing work over? Do not leave blank.
Number of hours/week _____

9) What do you think are the major causes of rework?
Customer changes _____ Design error_____
Prefab error _____ Field error _____
Damaged material _____ Unknown _____
Coordination/Layout_____
Other; please explain: ______________________________

10) What do you think could be done to reduce rework?
____
____

Materials

11) Do you often have to stop work and wait or move to another task because you do not have the materials to work with?

Yes ______
No ______

12) How many hours per week would you guess you spend waiting for materials, getting materials, or moving to a different task because of no materials? Do not leave blank. (Supervisors: estimate hours per week for one Seabee).

Number of hours/week ______

13) In your opinion, why is getting materials to work with a problem?

Material is not located prior to beginning a construction activity	______
Vendor or Supplier did not deliver items on time	______
Too much paperwork required to get material	______
Inefficient operation in MLO warehouse	______
Materials are too far away from work area	______
No proper transporting equipment to move material	______
Not enough MLO personnel	______
No on site storage area	______
Material was not ordered with adequate lead time	______
Unknown	______
Other: explain	______

14) How do you think materials problems could be improved?

____

____

____

Tools

15) Do you often have to stop work and wait or move to another task

because you do not have the tools you need?

Yes ______
No ______

16) How many hours per week would you guess you spend waiting for tools, getting tools, or moving to a different task because of no tools? Do not leave blank. (Supervisors: estimate hours per week for one Seabee).

Number of hours/week ______

17) In your opinion, why is getting tools to work with a problem?

Tools are not located prior to starting a construction activity	______
Not enough tools for the size of the work force	______
Tool was broken during work	______
Tool supply is too far from the work area	______
Other crews hoard tools, but they do not use them	______
Lost tools are not replaced	

Inefficient process in CTR	
Tool was not scheduled with enough lead time	
Not enough CTR personnel	
Unknown	
Other: explain	

18) What specific tools do you have the most trouble getting?

____
____
____

19) What consumable items do you have the most trouble getting (for example drill bits, welding rods, electrical tape)?

____
____
____

20) How do you think problems with tools or consumables could be improved?

____
____
____

Civil Engineering Support Equipment (CESE)

21) Do you often have to stop work and wait or move to another task because you do not have the CESE you need?

Yes_____
No _____

22) How many hours per week would you guess you spend waiting for CESE, getting CESE, or moving to a different task because of no CESE? Do not leave blank. (Supervisors: estimate hours per week for one Seabee).

Number of hours/week_____

23) In your opinion, why is getting CESE to work with a problem?

CESE not arranged prior to starting a construction activity	
Someone else is still using the CESE assigned to your crew	
Not enough CESE on site	
Inefficient process in Dispatch	
CESE was not scheduled with enough lead time	
CESE is deadlined or in the shop for PM	
Unknown	
Other: explain	

24) How do you think problems with CESE could be improved?

____
____
____

Crew Interference

25) Do you often have to stop work and wait or move to another task because another crew had to work in that area?

Yes_____
No _____

26) How many hours per week would you guess you spend waiting or moving to a different task because of another crew? Do not leave blank. (Supervisors: estimate hours per week for one Seabee).

Number of hours/week_____

27) What rate is most often responsible for this interference?

____

28) In your opinion, why is interference between crews a problem?

Lack of communication among supervisory personnel	_____
No detail scheduling among crews	_____
Unknown	_____
Other: explain	_____

29) How do you think the crew interference problem could be improved?

____
____
____

Overcrowded Work Areas

30) Do you often have to work in such overcrowded conditions that it slows you down from doing work as efficiently as you could have done the work under normal conditions?

Yes_____
No _____

31) How many hours per week would you guess you lose because of overcrowded working conditions? Do not leave blank.(Supervisors: estimate hours per week for one Seabee).

Number of hours/week_____

32) In your opinion, why are overcrowded work areas a problem?

Unnecessary people assigned to the job	_____
Work area is too small	_____
Lack of coordination among rates	_____
Too many materials laying down and in the way	_____
Work areas are crowded with left trash	_____
Too much equipment laying down and in the way	_____
Too many tools laying down and in the way	_____
Unknown	_____
Other: explain	_____

33) How do you think the overcrowded work area problem could be improved?

____
____
____

Instructions

34) Do you often spend time waiting for someone to give you instructions on what you are supposed to be doing?

Yes_____
No _____

35) How many hours per week would you guess that you spend waiting to get instructions about what you are supposed to be doing? Do not leave blank. (Supervisors: estimate hours per week for one Seabee).

Number of hours/week_____

36) In your opinion, why are instruction delays a problem?

Operations Officer/Chief (S-3/S-3C)	____
Company Commander/Det or Unit OIC (X6)	____
Company/Det/Unit Operations Chief (X3)	____
Quality Control Chief or Petty Officer	____
Project Supervisor	____
Crewleader	____
Unknown	____
Other: explain	____

37) How do you think the instruction delay problem could be improved?

____
____
____

Design Interpretation and Additional Planning/Engineering Information

38) Do you often spend time waiting for design interpretation or additional planning/engineering information?

Yes_____
No _____

39) How many hours per week would you guess that you spend waiting for design interpretation or additional engineering information, or moving to alternative work because of these problems? Do not leave blank. (Supervisors: estimate hours per week for one Seabee).

Number of hours/week_____

40) In your opinion, why are design/planning interpretation and additional engineering information delays a problem?

Poor Drawings/Plans	______
Poor Specifications	______
Lack of coordination with engineer or P&E	______
Complex process to get information or needed change	______
Engineer or P&E is not familiar with actual job conditions	______
Indecision of engineer or P&E	______
Unknown	______
Other: explain	______

41) How do you think the design interpretation and additional information problem could be improved?

____

____

____

Summary

42) How many hours per day (on the average) do you think you spend actively engaged in physical work, whether rework or not. This would be your total hours per day minus all time spent for the problems listed above, any personal time or for any reason not listed above? Do not leave blank. (Supervisors: estimate hours per day for one Seabee.)

Number of hours/day______
"hands on work"

On what length of day are you basing your estimate of active work?

Total hours/day______

43) Please indicate whether or not each of the subjects listed below is an important and common problem in completing specific work on schedule and within budget. (Be sure to check one of the columns for each item unless you have no opinion about that item.)

	Problem	Not Problem
a. Rework	______	______
b. Materials	______	______
c. Tools	______	______
d. CESE	______	______
e. Other crews not finished	______	______
f. Overcrowded work areas	______	______
g. Waiting for instructions	______	______
h. Waiting for design interpretation and additional engineering or P&E info.	______	______
i. Absenteeism/Tardiness (UA)	______	______
j. Turnover	______	______
k. Omitted	______	______
l. Quality of work	______	______
m. Quality of supervision	______	______

n. Amount of supervision ______ ______
o. Safety ______ ______
p. Extended breaks/early quitting time ______ ______
q. Omitted ______ ______
r. Personnel transportation ______ ______

44) From the subjects listed above, which problem, if improved, would have the greatest effect on the job? (List the appropriate letter from question #43.)

Letter________

45) Which problem, if solved, would have the second greatest effect on the job? (List the appropriate letter from question #43.)

Letter________

46) Which problem, if solved, would have the third greatest effect on the job? (List the appropriate letter from question #43.)

Letter________

47) Omitted

48) What do you like most about your job?

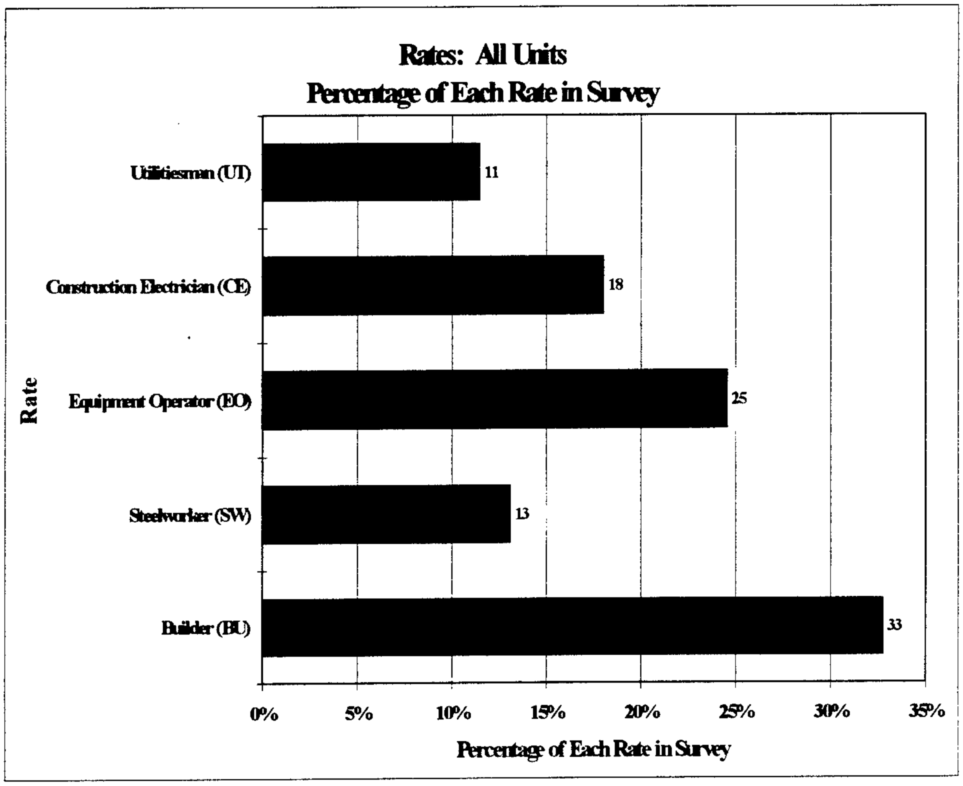
49) What do you like least, or would most like to change about your job?

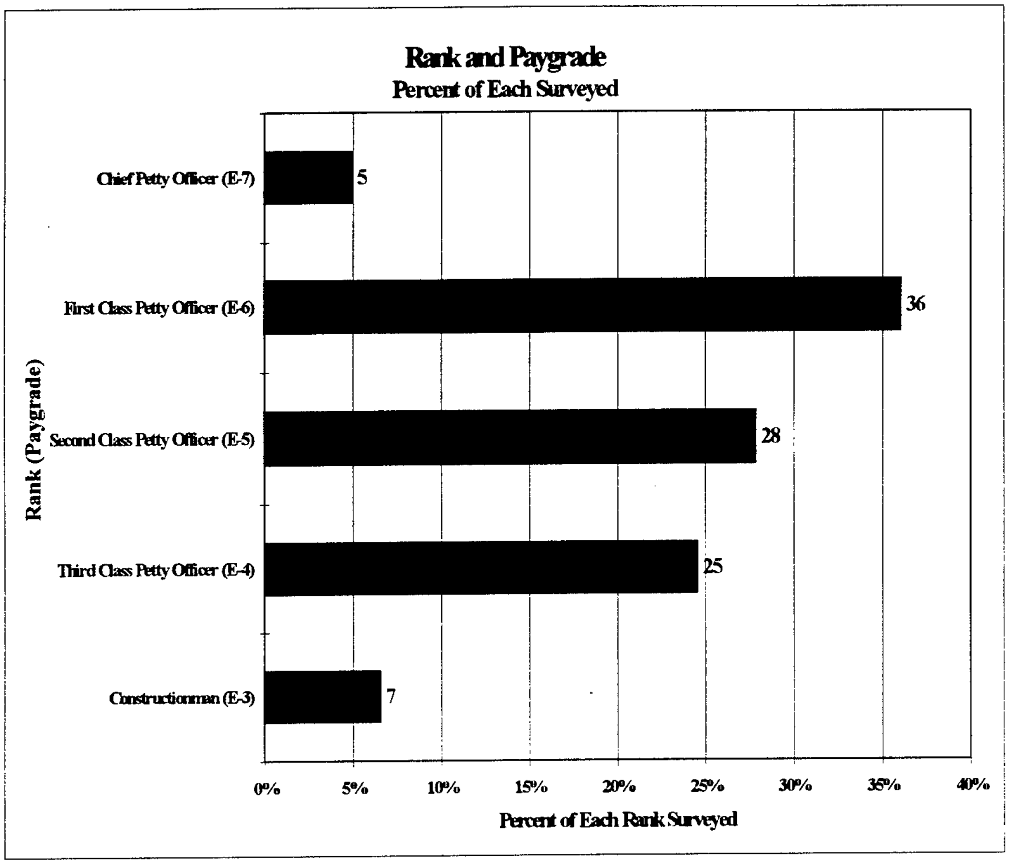
50) Do you have any other comments or suggestions?

Appendix B

Management Summary Report: All Units

This survey includes 61 Seabees working an average of 45.0 hours per week in a 5.0 day work week. The average crew size is 6.84 people.

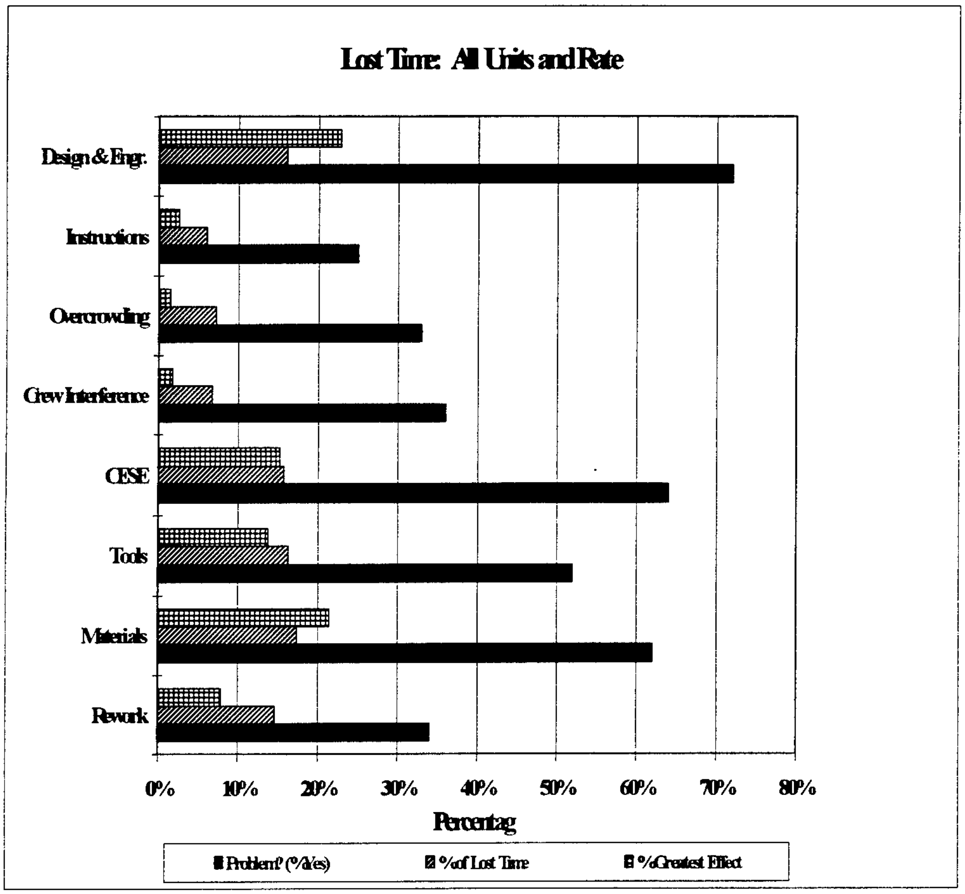



Rank and Paygrade
Percent of Each Surveyed
Chief Petty Officer (E-7)
First Class Petty Officer (E-6)
Second Class Petty Officer (E-5)
Third Class Petty Officer (E-4)
Constructionman (E-3)
Rank (Paygrade)
5
36
28
25
7
0%
5%
10%
15%
20%
25%
30%
35%
40%
Percent of Each Rank Surveyed

Lost Hours of Work Per Week

Based on this survey, 49.6% of the hours on the job are lost time.

The surveyed individual's average 45.0 hours per week with 22.33 lost hours each week.



Explanation:

Problem? (% Yes)

Percentage of Seabees who indicate that this factor is often a problem.

% of Lost Time

Lost hours (as percentage of total lost hours) due to this factor.

% Greatest Effect

Weighted rankings of the problems indicated to have the three greatest effects.

Survey Summary Detail

Personal Data

1) What is your rate?

	Number	%
Builder (BU)	20	32.78
Steelworker (SW)	8	13.11
Equipment Operator (EO)	15	24.59
Construction Electrician	11	18.03
Utilitiesman (UT)	7	11.48

2) How long have you been working at your rate?

Average	Std. Dev.
10.22	6.40

3) How long have you been in the Navy?

Average	Std. Dev.
9.57	5.25

4) How many hours do you normally work per week?

Average	Std. Dev.
45.00	6.26

5) How many people are in your crew?

Average	Std. Dev.
6.84	5.25

6) What is your rank?

	Number	%
Chief Petty Officer (E-7)	3	4.92
First Class Petty Officer (E-6)	22	36.07
Second Class Petty Officer (E-5)	17	27.87
Third Class Petty Officer (E-4)	15	24.59
Constructionman (E-3)	4	6.56

Rework

7) Do you often spend time doing work over?

	Number	%
Yes	21	34.42
No	40	65.58

8) How many hours per week would you guess you spend doing work over?

	Average	Std. Dev.
	3.26	2.46
Percent Loss Per Week	7.25%	

9) What do you think are the major causes for rework?

	Number	%
Customer Changes	43	70.49
Prefab error	9	14.75
Damaged Material	14	22.95
Coordination/Layout error	18	29.51
Design error	32	52.46
Field error	17	27.87
Unknown	1	1.64

Materials

11) Do you often have to stop work and wait or move to another task because you do not have the materials to work with?

	Number	%
Yes	38	62.30
No	23	37.70

12) How many hours per week would you guess you spend waiting for materials, getting materials, or moving to a different task because of no materials?

	Average	Std. Dev.
	3.89	2.60
Percent Loss Per Week	8.63%	

13) In your opinion, why is getting materials to work with a problem?

	Number	%
Material is not located prior to beginning activity	22	36.07
Vendor did not deliver items on time	24	39.34
Too much paperwork required to get material	28	45.90
Inefficient operation in MLO warehouse	1	1.64
Materials are too far away from work area	6	9.84
No proper transporting equipment to move material	12	19.67
Not enough MLO personnel	6	9.84
No on site storage area	13	21.31
Material was not ordered with adequate lead time	32	52.46
Unknown	0	0.00

Tools

15) Do you often have to stop work and wait or move to another task because you do not have the tools you need?

	Number	%
Yes	32	52.46
No	29	47.54

16) How many hours per week would you guess you spend waiting for tools, getting tools, or moving to a different task because of no tools?

	Average	Std. Dev.
	3.64	2.71
Percent Loss Per Week	8.09%	

17) In your opinion, why is getting tools to work with a problem?

	Number	%
Tools are not located prior to beginning activity	7	11.48
Not enough tools for the size of the workforce	33	54.10
Tool was broken during work	29	47.54
CTR is too far from the work area	13	21.31
Other crews hoard tools, but do not use them	11	18.03
Lost tools are not replaced	12	19.67
Inefficient process in CTR	10	16.39
Tool was not scheduled with enough lead time	6	9.84
Not enough CTR personnel	8	13.11
Unknown	0	0.00

Civil Engineering Support Equipment (CESE)

21) Do you often have to stop work and wait or move to another task because you do not have the CESE you need?

	Number	%
Yes	39	63.93
No	22	36.07

22) How many hours per week would you guess you spend waiting for CESE, getting CESE, or moving to a different task because of no CESE?

	Average	Std. Dev.
	3.51	3.02
Percent Loss Per Week	7.80%	

23) In your opinion, why is getting CESE to work with a problem?

	Number	%
CESE is not arranged prior to beginning activity	9	14.75
Someone else is still using the CESE assigned to you	26	42.62
Not enough CESE on site	41	67.21
Inefficient process in Dispatch	6	9.84
CESE was not scheduled with enough lead time	12	19.67
CESE is deadlined or in the shop for PM	28	45.90
Unknown	2	3.28

Crew Interference

25) Do you often have to stop work and wait or move to another task because another crew had to work in that area?

	Number	%
Yes	22	36.07
No	39	63.93

26) How many hours per week would you guess you spend waiting or moving to a different task because of another crew?

	Average	Std. Dev.
	1.49	1.79
Percent Loss Per Week	3.32%	

28) In your opinion, why is interference between crews a problem?

	Number	%
Lack of communication among supervisory personnel	24	39.34
No detailed scheduling among crews	19	31.15
Unknown	2	3.28

Overcrowded Work Areas

30) Do you often have to work in such overcrowded conditions that it slows you down from doing work as efficiently as you could have done the work under normal conditions?

	Number	%
Yes	20	32.79
No	41	67.21

31) How many hours per week would you guess you lose because of overcrowded working conditions?

	Average	Std. Dev.
	1.61	2.06
Percent Loss Per Week	3.57%	

32) In your opinion, why are overcrowded work areas a problem?

	Number	%
Unnecessary people assigned to the job	20	32.79
Work area is too small	18	29.51
Lack of coordination among rates	11	18.03
Too many materials laying down and in the way	5	8.20
Work areas are crowded with left trash	6	9.84
Too much equipment on site and in the way	0	0.00
Too many tools laying down and in the way	1	1.64
Unknown	0	0.00

Instructions

34) Do you often spend time waiting for someone to give you instructions on what you are supposed to be doing?

	Number	%
Yes	15	24.59
No	46	75.41

35) How many hours per week would you guess you spend waiting to get instructions about what you are supposed to be doing?

	Average	Std. Dev.
	1.34	1.91
Percent Loss Per Week	2.99%	

36) In your opinion, why are instruction delays a problem?

	Number	%
Operations Officer/Chief (S-3/S-3C)	11	18.03
Company Commander/Det or Unit OIC (X6)	1	1.64
Company/Det/Unit Operations Chief (X3)	7	11.48
Quality Control Chief or Petty Officer	13	21.31
Project Supervisor	11	18.03
Crewleader	10	16.39
Unknown	0	0.00

Design Interpretation and Additional Planning/Engineering Information

38) Do you often spend time waiting for design interpretation or additional planning/engineering information?

	Number	%
Yes	44	72.13
No	17	27.87

39) How many hours per week would you guess you spend waiting for design interpretation or additional engineering information, or moving to alternative work because of these problems?

	Average	Std. Dev.
	3.59	2.53
Percent Loss Per Week	7.98%	

40) In your opinion, why are design/planning interpretation and engineering information delays a problem?

	Number	%
Poor drawings or plans	43	70.49
Poor specifications	34	55.74
Lack of coordination with engineer	24	39.34
Complex process to get information or needed change	26	42.62
Engineer is not familiar with actual job conditions	25	40.98
Indecision of engineer	19	31.15
Unknown	0	0.00

Summary

42) How many hours per day (on the average) do you think you spend actively engaged in physical work, whether rework or not? This would be your total hours per day minus all time spent for the problems listed above, any personal time or for any reason not listed above.

	Average	Std. Dev.
	5.72	1.38
On what length of day are you basing your estimate?	8.74	0.89

43) Please indicate whether or not each of the subjects listed below is an important and common problem in completing work on schedule and within budget.

	Number	%
a) Rework	24	39.34
b) Materials	47	77.05
c) Tools	40	65.57
d) CESE	42	68.85
e) Other crews not finished	14	22.95
f) Overcrowded work areas	10	16.39
g) Waiting for instructions	16	26.23
h) Waiting for design interpretation and additional info	48	78.69
i) Absenteeism/Tardiness (UA)	3	4.92
j) Turnover	5	8.20
l) Quality of work	7	11.48
m) Quality of supervision	7	11.48
n) Amount of supervision	8	13.11
o) Safety	1	1.64
p) Extended breaks/early quitting time	8	13.11
r) Personnel transportation	27	44.26

44-46) From the subjects listed above, which problem if improved would have the greatest effect on the job? Summary of weighted first, second, and third greatest effects.

	Score	%
a) Rework	28	7.89
b) Materials	76	21.41
c) Tools	49	13.80
d) CESE	54	15.21
e) Other crews not finished	6	1.69
f) Overcrowded work areas	5	1.41
g) Waiting for instructions	9	2.54
h) Waiting for design interpretation and additional info	81	22.82
i) Absenteeism/Tardiness (UA)	1	0.28
j) Turnover	0	0.00
l) Quality of work	7	1.97
m) Quality of supervision	8	2.25
n) Amount of supervision	5	1.41
o) Safety	0	0.00
p) Extended breaks/early quitting time	2	0.56
r) Personnel transportation	24	6.76

Rework Comments

Better planning of tasks or more thought put into specific tasks
Order right material for project. Ensure personnel are skilled on the tasks assigned
Better blueprints - coordination with customer
Have someone who has done the work draw up the design
Have person designing actually check out the project site
Have customer stick to original plans. Individuals on crew understand tasks.
Upper command more open to field change recommendations
Have customer stick to original plans. Crew understand what's to be accomplished before starting
Better communication, better working plans
Better communication between us and customer
Take time to make sure that it is being done right the first time
Once the design is approved stick to it. Customer changes there mind a lot midway through the project. To me that's unsat.
Need good design.
Most of the time there is nothing that can be done to avoid it.
One person in charge at a time
Stay with one design.
Hold the engineers accountable
No rush jobs.
Use resources to fullest extent
Do not change design
Proper planning and estimating
The workers don't get to use there skills or ideas. Always directed.
Go over prints thoroughly before beginning work.
Requirements should not be laid out when the project is almost finished.
More preplanning and communication with crew.
Apply TQL. Stop management by objectives. Improve training.
Better training
Better planning.
Engineers need to make site visits prior to design.
Better coordination and understanding with the customer and designer.
Select projects with less finish work. More concrete, rough construction.
Better design, shipment of materials, field adjustments.
Quality not quantity.
QC makes unrequired and unnecessary changes.
Crewleaders need to QC the work as it is being done.
Make the customers pay real cash for their changes.
Pay more attention to detail. More quality and less quantity
The designer needs to investigate the site.
Be less accepting to customer changes.
Better training, less complex work.
Most rework is due to rushed efforts.
Ensure that material ordered is what's needed.
Communicate changes to everyone.
Less pressure to meet deadlines.
Don't change the blueprints 100 times.

Material Comments

Shop stores carrying more variety of material
Ensure materials are on site when needed. Cut the red tape in processing and ordering materials.
Pick one reliable source and stay with them.
Plan ahead and use 2 week schedules
Know exactly what customer wants and order it before work begins.
Add additional personnel to MLO and provide better training .
Assign more people to assist MLO
Minimize operational area. Spend more time in P&E. Follow up on BM.
Proper planning will allow enough lead time.
Proper MLO facilities needed.
Need a system to buy and deliver material just in time.
Use open purchase. Credit cards.
Have materials on hand before beginning work.
Changes caused material to be wrong.
Eliminate some of the paper trail required. Requests sit on desks too long.
Make sure materials are on hand before project start.
100% Materials on hand before starting work.
No changes to scope after ordering material.
Lack of funding causes problems.
Hold person responsible for getting materials accountable.
P&E not double checked. Change of design results in wrong materials.
Slow down and plan properly
Buy from consistent vendors. One year open purchase contracts.
Shorten the paperwork process. Have an alternate source of getting material.
Use shop stores or open purchase.
Hold vendors accountable. Establish better contracts.
NCF consistently trys to start projects with less than 100% material on board.
Create system to acquire materials quickly.
Cut back on the amount of different forms to get an item.
Ensure 100% materials are on site before beginning work.
Navy doesn't trust it's people. More control over how and where money is spent would create more efficiency.
Devise a more efficient paperwork process.
Need better suppliers.
Better vendor relations.

Tool Comments

More tools available, easier replacement of broken tools (or better quality)
Have a well stocked CTR and get tools needed or newer tools in sync with todays advanced technology. We have been using outdated tools.
More ability to open purchase
Less red tape and less places the paperwork has to go to for a shorter time to receive new tools.
Make sure crew turns in broken tools instead of leaving them in the kit.
Have more consumables on hand. Replace surveyed tools quicker.
Everyone should be able to check out tools.

Add items to bill of materials. Better planning.
Buy quality tools not cheap tools.
Better planning
It gets done one way or another.
Proper planning to balance resources
Simpler paperwork process to get tools.
Keep plenty of consumables on hand.
Plan use of tools.
Buy quality tools.
Survey ancient tools.
Issue each person their own tools.
Replace outdated tools and kits. Use credit card purchases for consumables.
Open purchase and standardize.
Issue tools to each Seabee like a seabag - each person is responsible for their tools.
High demand items should be reordered consistently.
Better CTR/Supply involvement.
Increase on hand quantity of consumables.
Supply system is so slow by the time ordered tool is received, job is complete and tool is no longer needed.
Proper planning.
Give everyone a "tool allowance" similar to the clothing allowance. Require a certain "kit" for each rate.
More accountability
CTR never available when needed.
More accountability for missing/broken tools.

Tools Have Trouble Getting

Torch kits
Drills
Hammers, trowels, jointers
Compactors
Compaction sleds, power tools, jackhammers
Excavation equipment
Concrete saws
Power tools
Drywall and concrete tools
Compaction sled
Saws, hammers
Special tools.
Hilti
Specialty tools.
Ladders
Power tools.
Power tools.
Power tools.
Specialty tools.
Hilti

Concrete saw.
Concrete saw.
Hilti
Voltmeter
Air nailers.
Electrical hand tools
Compactors
Hilti, compactors, vibrators
Hilti
jackhammers, compressors
Fitting wrenches
Hilti
Lineman pliers
pneumatic tools

Consumables Have Trouble Getting

Drill bits, masonry bits
Blades for saws, drill bits, gloves
Drill bits
drill bits, utility knife blades
Blades fro saws
gloves
ear plugs
Safety equipment
All
drill bits
drill bits
bits.
Electrical tape.
tapes.
Drill bits.
Coveralls.
Electrical tape.
Drill bits.
Putty knives, string.
Coveralls.
tape.
gloves
Respirators, coveralls.
All
Saw blades.
Hilti nails.
drill bits, string line
Hilti nails, saw blades
drill bits
stakes
welding rods

CESE Comments

Not getting the right CESE for the job. Update CESE requirement. Replace ancient equipment.
When a piece of CESE goes on deadline equipment should be rented to replace it.
Have more equipment on site
Get modern equipment.
You can't plan a breakdown but have a back up plan in case. Schedule equipment around PMs.
More funding for CESE. Many PMs could be done at the jobsite.
Better CESE needed
Buy the right equipment for the job.
Not enough CESE for everyone.
Need more backhoes.
Don't take on projects if CESE is already committed
Not enough crew vehicles.
Tailor CESE TOA to local environment/projects.
Replace antiquated CESE. Organize and plan CESE requirements.
Buy commercial, readily available equipment.
Set up PM schedule so one type of CESE is all in shop at same time.
Get better software to organize and allocate limited CESE resources.
Need more mechanics to keep CESE in shape and available.
Do more PMs on the jobsite.
Better maintenance.
Permanently assign more CESE and hold accountable.
Too many projects need the same CESE.
Better planning and more equipment.
Make ordering of parts easier.
Smarter PM scheduling.
Use a priority system.

Crew Interference Comments

Other crews should help out to get the job done.
Crewmembers need to work outside of their rate to assist the whole crew.
Better planning.
Better project planning
Better planning among crewmembers of different rates.
Proper planning.
Supervisors overestimate the abilities of the operators.
Crewleaders need to meet and coordinate.
Sub crews need to be involved in P&E process.
Better training for CE's and UT's
Better scheduling
Crewmembers need to understand big picture.
Work with 2 week goals.
Plan and organize thoroughly.

Overcrowding Comments

Coordinate one crew to work at a time
Entire crew should help out with cleanup
Assign Builders to builder work, etc.
Better housekeeping habits. Minimize materials on site.
More projects to spread people.
More people does not equal more accomplishment. Plan ahead.
Clean sites daily. Organize material laydown areas.
Stop pushing people to jobs to keep them busy.
Don't assign people to a crew just to keep them busy.
Prefabricate when possible.
Throwing more bodies at a project than needed will slow things down and frustrate crew.

Instructions Comments

Ask more questions upfront
Plan ahead and let crew know specific goals for next day, week.
Let the crewleader make decisions when obstacles come up.
Too many projects.
Listen to the ideas of the people doing the work.
Move decision authority to lower levels.
Use TQL.
Stop micromanagement.
QC always wants more. They should follow the specs and look for a quality project.
Everyone have mutual objectives.
Trust your people to do the job.
Spend a lot of time extracting info from crewleaders.
Better communication
Customer delay
Discuss plan in morning.

Design Interpretation Comments

Work it all out prior to job start.
Have someone familiar with the work design the project.
Engineers need to provide more detail
Site visits by designer.
Engineers pay closer attention to details. Communicate with crew.
Need to speed up decision making process.
Have PW (design agent) improve inspection and coordination.
Do not begin work without adequate plans
Hold the designers accountable
Have engineer visit project during construction.
Don't "overengineer" the project.
Engineers need to coordinate with each other and with project crew.
Coordinate with engineers.
Better communication

Plan onsite with engineer to produce better product. Ensure customer is informed.
All parties involved need to meet at the jobsite once a week.
Biggest Problem! Engineer doesn't know the project, is unsure of requirements and tries to recycle an old plan.
Ensure engineer is involved in construction phase.
Get engineers more involved.
Hold engineers accountable for quality designs.
Explain to engineers our goals and how they affect them.
Designers should specify code requirements.
Engineer needs to consistently visit site.

What Seabees Like About Their Job

Seeing progress from start to finish. Construction work in general.
To see the accomplishment and completion of a project
Working with my hands on all the various stages of the project.
Satisfaction in seeing a quality job completed.
Hands on training in my rate and sometimes doing cross-rate work.
I enjoy working within my rate
Constantly meeting the challenge of the project. Learning new skills. Receiving recognition for a job well done.
Opportunities, responsibilities. Helping train others.
Challenges involved in working on projects.
To see a project start from the ground and then see a completed quality project.
Getting the job done.
Freedom to schedule my work and execute my plan
Operating large equipment
Completion of a project.
The challenge of the work.
Working with my hands.
Learning my rate.
The work and the people I work with.
Working on complicated electrical work.
Challenging work.
The experience that I'm getting. Learning.
The knowledge and experience I'm gaining.
Hands on training.
Working with my hands.
Getting hands on experience and learning other rates.
Working in different areas. Using and learning new skills.
Feeling like I'm part of accomplishing something.
Being in charge of construction.
Organizing, completing tasks.
The ability to see an end product.
Plan a job and watch it go from idea to existing structure.
Working outside. Working with heavy equipment.
Being able to work on a project from the ground up and to see the outcome.
Chance to start and finish a project.

Starting and completing a project.
Working with my hands. Constructing quality buildings.
Hands on construction. Freedom to work my own plan.
Taking a project from start to finish.
Am free to do my job.
Seeing the finished product.
The finished project.
Chance to develop my skills on a big project.
Working on large projects
Hands on construction
Chance to lead and work on meaningful projects.
Doing the work. The people.
Ability to work on my own project without micromanagement
The work is a great learning experience and I enjoy teaching others.
The construction experience and the travel.
Working outside and building things.
Experience running the equipment.
Working on big projects as a junior Seabee.
Doing the job and taking care of my crew.

What Seabees Dislike About Their Job

Having someone with very little experience in construction change and criticize work and plans.
Instill quality work in ALL our projects.
Difficult to get promoted
All the nit picking we have to deal with.
Cleaning up after people. Change of plans.
Demands of deployment, being away from family
Working with irresponsible people. Lack of initiative among coworkers.
Bad attitudes of some coworkers.
Lack of functioning equipment
Paperwork.
People not listening to others.
Wasted time - admin.
No accountability at higher levels.
Not enough work.
Too many changes. Rushing jobs.
Complicated regulations.
Dealing with lazy, incompetent people.
Paperwork.
Rework.
Rushing to finish.
Lack of training.
Not being able to support the crews with the right equipment.
Administrative stuff.
More freedom to interface with engineer.
Lack of respect.
Micromanagement

Constant changing of plans.
Paperwork.
Lack of resources. Confusion from above.
Too much pressure to get tasking done at all costs.
Too much paperwork.
Micromanagement.
Babysitting irresponsible personnel.
Administration.
Design changes.
Poor equipment
Need more pay and newer equipment
Paperwork.
Red tape.
Politics.
Pay.
Paperwork.
Don't need superiors trying to run my job.
Slow pace.
More input in planning.
Micromanagement.

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Vita

Darren Christopher Morton was born in Salisbury, North Carolina on August 1, 1967, the son of Shirley Graeber Morton and James Franklin Morton. After completing his work at South Rowan Senior High School, China Grove, North Carolina, in 1985, he entered North Carolina State University in Raleigh, North Carolina. He received the degree of Bachelor of Science in Aerospace Engineering in May 1989 and the degree of Bachelor of Science in Mechanical Engineering in December 1989, both degrees from North Carolina State. Upon graduation and subsequent completion of Officer Candidate School he was commissioned as an Ensign in the United States Navy Civil Engineer Corps. While assigned to U.S. Naval Mobile Construction Battalion THREE he was assigned as Officer-In-Charge of Detail Zagreb, Croatia and as Officer-In-Charge of Detail San Diego, California. He is married to the former Jodi Haley of Camp Lejeune, North Carolina and they have one daughter, Elizabeth. He is an Engineer in Training in the state of North Carolina. In August, 1996 he entered the Graduate School of the University of Texas.

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