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Construction Management Training
in the
Navy Seabees

by

Steven G. Challeen

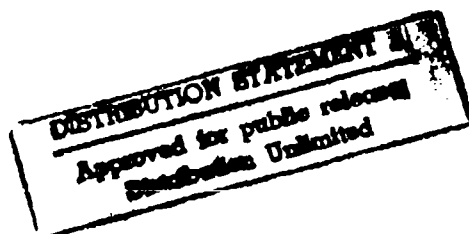
Submitted in partial fulfillment of the
requirements for the degree of

Master of Civil Engineering

Texas A&M University

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"It cannot be too often repeated that in modern war, and especially in modern naval war, the chief factor in achieving triumph is what has been done in the way of thorough preparation and training before the beginning of war"

- Theodore Roosevelt

Graduation Address, U.S. Naval Academy, June 1902

I. Introduction:

The armed forces are facing challenges to maintain operational readiness with fewer personnel and leaner operating capital due to shrinking defense budgets. One way to optimize personnel assets is to provide effective, high quality training. Quality training programs serve two purposes: First, they maintain or improve their operational readiness by increasing the skill level of personnel; and second, they provide an incentive for recruiting high quality personnel who seek training opportunities in our all-volunteer armed forces.

This report will deal exclusively with the Navy's Construction Forces called the "Seabees". It will investigate the timeliness and thoroughness of project management training given to project supervisors and crew leaders in Naval Construction Battalions (NMCB's) and Construction Battalion Units (CBU's). Project supervisors are responsible for overall construction of a project. Crew leaders are responsible for the construction of major work areas such as carpentry, excavation, plumbing, electrical, and heating.

Questionnaires were sent to 430 Seabees currently serving as project supervisors, crew leaders, and crew members in NMCB's and CBU's to identify potential problem areas in project management. The questions covered construction management training, project planning, project execution, safety, quality control, materials management, and tools and equipment maintenance. The Seabees rated their knowledge in each of these construction management areas and the responses were statistically analyzed to identify significant differences among groups of Seabees based on their job description, skill area, and experience. Conclusions were drawn from the

data that identify significant strengths and weaknesses among respondents, and recommendations were made for possible improvements in training programs.

Appendix A contains an alphabetical listing of definitions to help clarify unique military term and acronyms used throughout this report.

A. Background

The Navy's Construction Force originated in 1942 as a result of repeated attacks by Japanese forces on civilian construction workers in the Pacific who were unable to arm themselves because of strict Rules of War. To remedy this problem, the Navy enlisted civilian construction workers and formed them into construction battalions (CB's), hence their nickname "Seabees". Today, the Naval Construction Force (NCF) is comprised of eight Naval Construction Battalions (NMCB's), two Amphibious Construction Battalions (ACB's), two Underwater Construction Battalions (UCT's), 21 Construction Battalion Units (CBU's), and one Construction Battalion Maintenance Unit (CBMU). Because of the diverse missions of these units, this report will focus on training associated with Naval Mobile Construction Battalions (NMCB's) and Construction Battalion Units (CBU's).

B. Problem Statement

Seabees are required to supervise a construction project or lead a construction crew relatively early in their career compared to their civilian counterparts. Some are afforded formal training in project management while others must rely on in-house or on-the-job training to gain

needed skills. Inadequate project management training may result in poorly planned projects and lead to reduced productivity, morale, construction quality, and increased rework.

Because the mission of NMCB's and CBU's is so diverse, only a portion of their training is dedicated to improving construction management skills. The classes that are offered are limited by time, financial, and space considerations. This means that many Seabees who desire special training cannot get it when needed or desired. Since training is a major motivation to enlisting in today's armed forces, the lack of desired training may affect morale and retention.

C. Scope

Because of the breadth of missions undertaken by Naval Construction Forces, this report will be confined the roles of Seabees in Naval Mobile Construction Battalions (NMCB's) and Construction Battalion Units (CBU's). Seabees may serve in both NMCB's and CBU's throughout their career, so it is imperative they receive equal training. This report will evaluate the knowledge level of randomly selected Seabees and identify areas of significant strength of weakness. Recommendations will address training options reasonably available or attainable.

Specifically, this report will:

- ▶ Appraise the knowledge level of Seabees in basic project management skills.
- ▶ Identify areas of significant strength and weakness of project management skills common among Seabees.
- ▶ Research construction training methods employed by the construction industry.
- ▶ Identify construction management courses currently offered in the Navy.

- Make cost-effective recommendations to improve the training programs of NMCB's and CBU's and skill deficiencies.

D. Approach

There are three major areas of effort in this report. These are to evaluate and analyze the construction management knowledge level of project supervisors, crew leaders, and crew members; to research innovative and cost-saving training methods used by construction industry that can be incorporated into NMCB's and CBU's unit training programs; and to recommend cost-effective measures to improve training for project supervisors and crew leaders.

Questionnaires covering broad categories of topics in project management were randomly sent to Seabees in all NMCB's and several CBU's. The respondents rated their knowledge of each question on a scale of 1 to 4 with 1 being very knowledgeable, and 4 having no knowledge of the subject. The questionnaires were kept anonymous to encourage truthful responses. Respondents were categorized by job description, construction craft called a rating, and years of service in the Navy, and spreadsheets were used to compile and statistically analyze the responses assuming a t distribution. The responses were then statistically analyzed using a t test to compare the difference between the mean value of a selected group of Seabees against the mean value of remaining Seabees.

The literature review looked into training methods commonly employed by the Navy and the construction industry. The goal was to identify cost-effective construction management tools

and techniques that can be employed by the NMCB's and CBU's.

E. Problem Structure

The first question this report will address is: What are Seabees' strengths and weaknesses in construction project management? This question will evaluate the level of construction management training Seabees receive throughout their career. In-house and on-the-job training are strongly encouraged to augment formal training requirements [U.S. Navy, 1987, Seabee Command, p.1]. A survey questionnaire was used to rate the Seabees' knowledge of various project management areas. The responses were statistically analyzed to identify trends of strength and weaknesses common to a majority of respondents.

The second question is: How can we provide better training within current time and budget constraints? This was answered through an analysis of current Navy training in construction management as well as applicable training methods used in the construction industry. The training recommended in this report will be most effective if it is cost effective, pertinent to project management and control, and capable of being implemented in small groups with basic classroom facilities (i.e. chalkboard or easel chart).

II. Background on the Seabees

The mission of NMCB's is to construct advanced base facilities in support of Navy, Marine Corps, or other armed forces, and to provide disaster recovery operations for natural or man-made disasters. Under most scenarios, the Naval Construction Force provides this support to the Marine Air-Ground Task Force (MAGTF) which varies in size depending on the nature of the contingency. NMCB's and CBU's are equipped to perform both vertical and horizontal construction. Vertical construction is typically comprised of:

- ▶ One story wood, concrete, steel, or masonry structures
- ▶ Wood or concrete bunkers
- ▶ Wood or steel towers and antennas.

This construction includes all above and below ground utilities, HVAC, and refrigeration.

Horizontal construction is typically comprised of:

- ▶ Dirt or asphalt roads
- ▶ Wood or steel bridges
- ▶ Aircraft runways and runway repair.

Special capabilities include water well drilling, water treatment, and hospital construction.

Seabees surveyed in this study were Navy enlisted personnel who currently work as project supervisors, crew leaders, or crew members. Most prospective Seabees enter the Navy following high school and often have little or no construction experience. A primary motivation for entering the service is to learn a skill that is applicable to commercial industry. After completing Navy basic recruit training, most often referred to as "boot camp", all Seabees attend

an entry level training course ("A" School) that is generally 12 to 16 weeks in length. It is here they learn basic craft skills in one of seven construction craft specialties called "ratings". These seven Seabee rating encompass all construction crafts, so a Seabee does not become a specialist, but rather a "Jack-Of-All-Trades". They are further cross-trained throughout their career to promote flexibility and breadth of knowledge to prepare them for higher management positions.

The seven ratings are:

- ▶ Builders. Perform as carpenters, working with wood and concrete. They also perform tasks of masons, drywall/sheet-rockers, and painters.

- ▶ Steelworkers. Fabricate and erect steel structures, bend and install reinforcing steel, weld most metals, fabricate and install ventilation ductwork. They are also trained in rigging methods.

- ▶ Engineering Aides. Perform drafting and minor design work, surveying, material sampling and testing.

- ▶ Construction Electricians. Install and service exterior high voltage power distribution systems, install interior electrical wiring and motors, operate power generators, and maintain telecommunication systems.

- ▶ Utilitiesmen. Install and service mechanical systems, interior and exterior water and wastewater lines, and maintain HVAC control systems. They also operate water and wastewater treatment facilities and refrigeration systems.

- ▶ Equipment Operators. Operate light to heavy construction equipment including cranes. They also operate rock quarries, concrete and asphalt plants, conduct blasting operations and water well drilling operations.

► **Construction Mechanic.** Maintain and service all automotive, material handling, and construction equipment as well as electrical power generators and small gas powered tools.

Project supervisors and crew leaders come from any of the seven ratings except Construction Mechanic, and only on rare occasions Engineering Aides. Project Supervisors are typically Seabees of paygrade E-6 to E-7. E-6's have from 7 to 26 years and E-7's with anywhere from 7 to 30 years of service in the Navy. Crew leaders are junior to project supervisors and have from 27 months to 26 years of service in the Navy.

A. Naval Mobile Construction Battalions (NMCB's)

NMCB's are rapidly deployable units capable of independent operations. They deploy by air, land, or sea and are comprised of approximately 500 Seabees plus 100 non-construction support personnel such as cooks, clerks and storekeepers. NMCB's are deployed throughout the Pacific, Caribbean, and Europe on a 7-7 rotation schedule where they spend seven months in homeport to undergo preparatory training and project planning for their seven month deployment. At any given time, there are four NMCB's in homeport, and four NMCB's deployed. NMCB's are line/staff organizations as shown in Figure 1.

Homeport training is run by the NMCB's and overseen by Naval Construction Regiments (NCR's). The NMCB is expected to spend approximately 75 percent of the available mandays in formalized technical, military, and general training [U.S. Navy. 1989. NAVEDTRA 10601]. The training is very regimented and is the responsibility of the NMCB's to maximize its

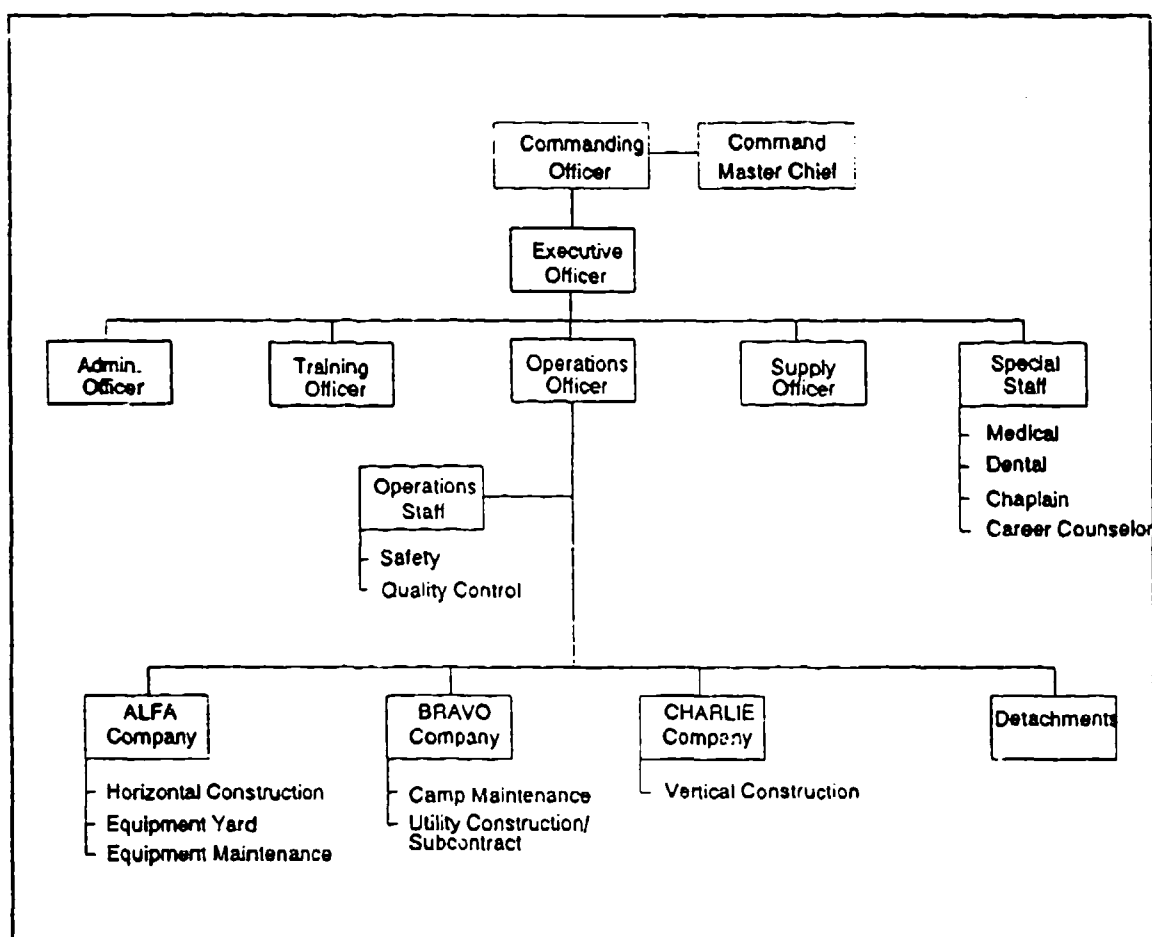


Figure 1 NMCB Organization

benefits. In addition to homeport training, the battalion must plan construction projects for their upcoming deployment. They also undertake minor homeport projects and staff the functional outlets on their homeport naval bases such as the equipment yard, maintenance shops, material warehouses, tool rooms, supply warehouses, and the galley. They also undergo a sequence of inspections and military exercises. On deployment, two Saturdays a month are dedicated to training. These are commonly referred to as "Training Saturdays". Training topics are organized by the training department and attended by all hands.

Each NMCB is staffed to coordinate training from in-house and outside sources. Training requirements for NMCB's are formally outlined in COMCBPAC/COMCBLANT/COMRNCF INSTRUCTION 1500.20J. The NMCB's training department is headed by the Training Officer, usually a lieutenant (O-3), and staffed as shown in Figure 2. Construction management training falls under the Technical Training branch of the Training department.

Training in the NCF is divided into a number of categories:

- ▶ Formal Schools. These are schools taught at naval bases across the country that grant graduates a Navy Enlisted Classification (NEC). Enrollment for all Navy personnel is controlled by the Naval Military Personnel Command (NMPC) in Washington, DC. NEC's are used to determine readiness of NMCB's and CBU's, and are valuable assets for Seabees desiring advancement. Schools are generally from two to six weeks long and carry qualification prerequisites, most often minimum years of service to date and years of service remaining in their enlistment. An NEC may also be received by achieving equivalent construction skills through the Personnel Readiness Capability Program (PRCP), or appropriate civilian experience. Formal construction management training is provided by the Naval Construction Training Centers located in Port Hueneme, California and Gulfport, Mississippi, and at the Naval School for Civil Engineer Corps Officers also located in Port Hueneme. Port Hueneme and Gulfport are also the homeports for all NMCB's. Because of this, training is readily available to the NMCB's. CBU's on the other hand must use training and travel funds if they wish to attend these courses.

- ▶ Special Construction Battalion Training (SCBT's). Short courses offered by Naval

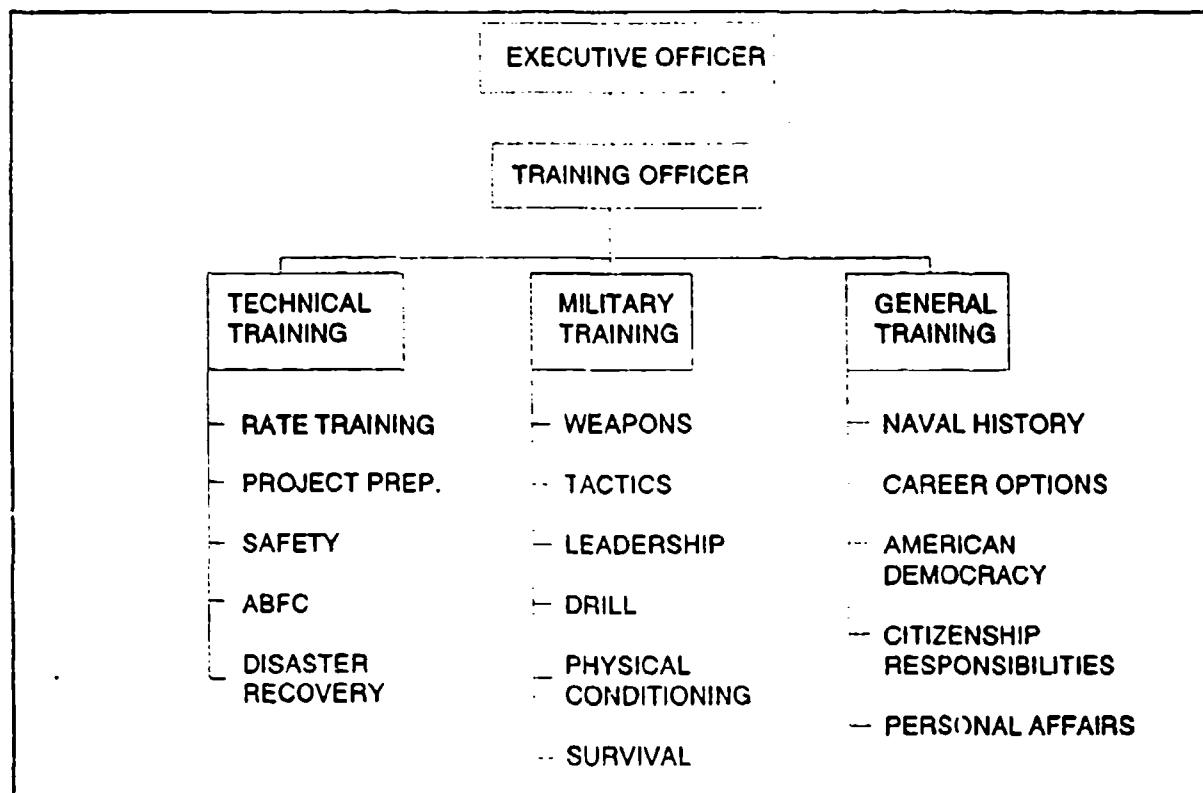


Figure 2 Training Organization Chart

Construction Training Centers (NCTC's) that substantially duplicate material taught at formal schools.

► **Repetitive Training.** Courses in construction and Seabee operational skills taught by the NCR's and other sources outside the battalion.

► **Drills and Exercises.** Overseen by the NCR's and designed to exercise construction and combat unit skills and command and control under contingency conditions.

► **Unit Level Training.** Designed to be taught in-house throughout the deployment cycle directed toward rate specific construction skills as well as general topics such as substance abuse programs, physical fitness, first aid and personal hygiene, and local customs of the deployment site.

► On-The-Job-Training. Both in homeport and on deployment designed to augment classroom training in developing a variety of skills. Skills attained are recorded under the Personnel Readiness Capability Program (PRCP) and reflected in the Seabee's training record.

Navy courses specifically directed toward construction management are [U.S. Navy Instruction 1500.20J]:

A. Formal Schools:

- Advanced Rate Training - Provides advanced instruction in each of the Seabee ratings.
- Construction Planner and Estimator (NEC BU-5915) - Covers topics in project planning and material estimating.

B. Special Construction Battalion Training (SCBT):

- Project Supervisors Safety (Functional Skill 090.2) - Hands on safety course required for all crew leaders and project supervisors.
- Hazard Communication (094.1) - Federal Hazard Communication Training Program required by 19CFR1910.1200. This course is required for all personnel. Those exposed to hazardous chemicals receive 4 hours of training and all others receive 1.5 hours.
- Safety and Health Requirements (092.1) - U.S. Army Corps of Engineers Safety and Health Requirements Manual (EM-385-1-1) - Construction Safety training required of all Seabees.

- ▶ Respiratory Protection (093.1)
- ▶ Personal Readiness Capability Program (PRCP) Interviewers (833.1) - Provides skills required to determine and record skills attained through on-the-job training.
- ▶ Storage of Hazardous Materials (903.1) - Cover transportation and storage of hazardous materials.
- ▶ European Construction (192.1S) - Special training in construction materials and techniques for units deploying to the European theater.
- ▶ Construction Battalion Construction Management (CBCM) - The Naval School for Civil Engineer Corps Officer offers this two part course for project supervisors and crew leaders. The course is designed around each of the NMCB's homeport schedule to best support project supervisors and crew leaders in planning their deployment projects. CBCM I is a five day course offered early in the homeport and covers topics in project planning, Microtraks computer software application, safety, quality control, material management, and equipment management required by the project supervisor and crew leaders to plan their projects. CBCM II is also a five day course and is offered late in the homeport period. It covers topics in project execution, job site management, project monitoring, close-out and turnover. The benefits of this course are its short duration, breadth of topics, availability, and instructional material the students retain at the end of the course. It is currently offered in Port Hueneme and Gulfport. Although tailored specifically for NMCB's, CBU's can benefit from this course.

Other military courses can be found in:

1. Catalog of Navy Training Courses (CANTRAC), NAVEDTRA 10500, 1992

and health of personnel. Two of the twenty-one CBU's specialize in erecting and maintaining mobile hospital units. CBU's receive berthing, messing, disbursing, and accounting assistance outside their command and are, therefore, not self-sufficient.

Unlike NMCB's, CBU's do not have a homeport period to train and must rely on in-house training programs as well as Navy resources described on pages 12-14 to fulfill their training needs. Seabees may be assigned to NMCB's or CBU's throughout their career, so the CBU's training program must be conducive to the readiness of the CBU as well as the career development of the Seabee.

IV. Data Gathering

This chapter will describe how data was gathered to assess the Seabees' knowledge of construction management skills and give characteristics of that data. Data was gathered by a mail survey of project supervisors, crew leaders, and crew members from all eight NMCB's and seven of twenty-one CBU's. Since Seabees may serve in both NMCB's and CBU's throughout their career, Seabees in NMCB's and CBU's represent the same population. A copy of the questionnaire is found in Appendix B.

The survey questionnaire was divided into sections titled General Information, Training, Manday Estimating, Project Planning, Project Controlling, Materials Management, Safety/Quality Control, Tools and Equipment Maintenance. General Information requested data about the respondent's rate, paygrade (i.e. seniority), years of experience, job description, and whether they are attached to an NMCB or a CBU. This information was used to categorize the Seabees for statistical analysis. The Training section rated the Seabees' opinion of Navy training effectiveness on a scale of 1 to 4, with 1 being *thoroughly beneficial*, and 4 *providing no benefit*.

The remaining sections contained 76 questions that asked the Seabees to rate their knowledge of construction management skills and their opinion of Navy management practices. Responses were again on a scale of 1 to 4 with 1 being *very knowledgeable* and 4 *having no knowledge of the topic*. A number of questions requested YES/NO responses due to their nature.

Specifically, the manday estimating section was comprised of questions about techniques used to calculate construction duration estimates, to adjust those estimates to take into account crew experience and local conditions, and to track time spent on the job. These skills are required of project supervisors and crew leaders alike.

The Project Planning section addressed skills and tools used when planning a project. Examples include reading plans and specifications, understanding project schedules, balancing project resources, planning detailed work from project schedules, and working with project planning computer software. Many of these skills are required of project supervisors and crew leaders. This section also requested information on construction management schooling the respondent may have received.

The Project Control section addressed skills required to calculate and report construction progress. Materials Management tested their understanding of material planning, the Navy's procurement system, and what materials are inherently difficult to procure and store on the job site. Safety/Quality Control attempted to measure awareness of basic requirements as well as opinions on the effectiveness of current safety and quality control programs. It also requested information on safety training the Seabees had received.

The last category, Tools and Equipment Management, covered very basic skills in tool accountability and procurement along with equipment maintenance practices. These are skills taught to Seabees very early in their career.

The questionnaire was pretested prior to distribution by surveying 15 Seabees undergoing construction management training at the Naval School for Civil Engineer Corps Officers. The purpose of this pretest was to ensure the questions could be answered accurately by newly trained project supervisors and crew leaders.

Questionnaires were then sent to all eight Naval Mobile Construction Battalions (NMCB's), and seven of the twenty-one Construction Battalion Units (CBU's). 430 questionnaires were distributed: 45 to each NMCB, and 10 to each CBU. This represents approximately 86% of all project supervisors and crew leaders currently serving in NMCB's and CBU's. The questionnaires were sent to the Commanding Officer/Officer-In-Charge of each NMCB/CBU and were distributed by their representatives equally to each of the construction companies to encourage equal representation of all Seabee construction specialties (i.e. ratings).

A total of 259 responses (60%) were received. 79% of the responses represents seven of the eight NMCB's, and 21% of the responses represent the seven CBU's surveyed. 27 of the responses were from Construction Mechanics, Engineering Aids, and Naval Officers. These were excluded from the analysis because their scope of duties fall outside those of the project supervisor, crew leader, or crew member. Construction Mechanics maintain and repair light and heavy equipment, Engineering Aids perform drafting, surveying, material testing and sampling. Naval officers were excluded since Seabees include only enlisted paygrades. The remaining 232 responses represent approximately 65% of all project supervisors and crew leaders currently serving in all NMCB's and CBU's.

V. Analysis

The survey provided information on the knowledge level of project supervisors and crew leaders in construction project management areas of training, manday estimating, project planning, project control, materials management, safety, quality control, tools and equipment maintenance. The entire sample was categorized in Tables I through III to show the Seabee job description, rate, and years of experience. These categories reflect significant stages in a Seabees' career are used throughout the analysis. Job description reflects their level of proven performance. Typically, a Seabee begins as a crew member and is promoted to crew leader and to project supervisor as they mature and show potential for further success. The Seabees' rate will determine which schooling they may receive throughout their career. Each rate has their own sequence of schooling. For example, an electrician will go through "A" School, and has the option of attending schools in power distribution, electric generators and motors, cable splicing, and telephone repair. Years of experience are divided to represent various levels of commitment to Naval service. 1-4 years will group all Seabees in their initial enlistment. 5-10 years categorize those who have reenlisted at least once and show potential for career retention. Seabees who have served over 11 years are considered career-minded.

The questions were answered by choosing one of five responses:

- (1) Thoroughly understand this topic.
- (2) Understand basic ideas.
- (3) Don't know the answer, but know where to find it.
- (4) Don't know.

The mean value responses ranged from 1.14 to 2.74, and standard deviations from 0.46 to 1.12.

The mean of responses to each category are:

<u>CATEGORY</u>	<u>CATEGORY MEAN</u>
(1) Training -	2.09 *
(2) Manday Estimating -	1.92
(3) Project Planning -	2.00
(4) Project Control -	2.38
(5) Materials Management -	1.88
(6) Safety/Quality Control -	1.53
(7) Tools and Equipment Maintenance -	1.36

* - The category of Training was rated on a scale of 1 to 4 with 1 being *very beneficial*, and 4 *providing no benefit*.

Each of these categories will be interpreted in part two of the Results of Analysis section. A summary of the results of all questions are found in Appendix C.

The highest mean values were found in the areas of Project Control, Training, Project Planning, and Manday Estimating. Manday Estimating, Project Planning, and Project Control all tested the Seabees' knowledge of fundamental construction project management skills. These categories were chosen for further analysis to identify training weaknesses. As an initial qualifier, all questions with a mean response greater than 2.00 were chosen. The Manday Estimating qualified three questions. The second question is redundant with the first and was eliminated from further analysis. Project Planning qualified six questions. The last question

concerning rebar scheduling and concrete forming plans was eliminated because it was relevant to only the Builder and Steelworker rates. Project Controlling qualified all three questions, but two were deleted because they represent skills not taught at all Navy schools. This left eight questions for the final analysis:

1. Calculating the Production Efficiency Factor for a job site.
2. How to use the Availability Factor for a job site.
3. The difference between Free Float and Total Float.
4. Resource Levelling.
5. The purpose of an "S" curve.
6. Completing Two-Week Windows from Level III bar charts.
7. Working with Microtraks project management software.
8. Calculating construction percent completion.

These eight questions were evaluated by testing the difference between their means using a *t Test* [Bohrnstedt and Knoke, p.201]. The first round of analysis looked at how various groups responded to each question. In this analysis, each question was taken as a dependent variable, and the respondents job description, rate, and years in the Navy were taken as independent variables. Examples of independent variables are:

Job description - These are subdivided into project supervisor, crew leader, and crew member. Project supervisors are the most senior of the three subcategories and are responsible for all aspects of project construction. Crew leaders are responsible for the construction of major work areas of the project such as excavation, carpentry, plumbing, electrical, etc.

Rate - The respondents craft specialty which includes Builders, Construction Electricians, Equipment Operators, Steelworkers, Utilitiesmen, Construction Mechanics, and Engineering Aids. Because Construction Mechanics and Engineering Aids do not typically manage construction projects, their responses were not tested.

Years in the Navy - Categorized by typical enlistment commitments, namely 1 - 4 years, 5 - 10 years, and 11 or more years of service.

The mean and standard deviation of each question was calculated to provide input for further analysis. The weighted variance of the samples being compared was calculated rather than arbitrarily choosing one of variances as the estimate. This was calculated using the formula:

$$s^2 = \frac{(N_1 - 1) s_1^2 + (N_2 - 1) s_2^2}{N_1 + N_2 - 2}$$

where $N_1 + N_2 - 2$ are the degrees of freedom associated with s^2 . N_1 and N_2 are the sample sizes, and s_1 and s_2 are the standard deviations of those samples.

For each question, null and alternate hypotheses were formulated. The t test was used to identify significant differences between the two means at a 95% confidence level. This test will determine if the null hypothesis may be accepted or rejected in favor of the alternate hypothesis. The test statistic for the difference between the two means under the null hypothesis is:

$$t_{(N_1+N_2-2)} = \frac{\bar{Y}_2 - \bar{Y}_1}{s \sqrt{\frac{1}{N_1} + \frac{1}{N_2}}}$$

where $\bar{Y}_1$ and $\bar{Y}_2$ are the sample mean values. The results of the t test will be compared to its critical value at a significance level of 0.05 for a two-tailed t distribution. If the resulting value of the t test is greater than its critical value, the null hypothesis will be rejected in favor of the alternate hypothesis.

The t test will then be used to analyze responses that failed the null hypothesis test. This will identify significant relationships between Seabees who have received formal schooling against Seabees who have not received formal schooling in construction project management. Formal schools are defined in this paper as all C-1 Advanced schools offered by the Naval Construction Training Centers (NCTC), NCTC Planning and Estimating courses, and Construction Battalion Construction Management courses offered by the Naval School for Civil Engineer Corps Officers.

VI. Results of Analysis

The results of this analysis are presented in four sections. The first is an overall characterization of the data that shows the response number and percentage of each test category. Part B will analyze each survey category and draw conclusions as to the quality of training received. The third section will statistically analyze the eight selected questions. It will identify significant relationships between each question and the respondents job description, rate, and years in the Navy. The last section will test responses to each question of Seabees who have received formal schooling against those who have not in construction project management. The results of the survey is presented in Appendix C.

Part A: Overall Characterization of the Data

Of the 232 responses, 79% were from the eight NMCB's, and 21% were from the seven CBU's. This represents approximately 65% of all project supervisors and crew leaders currently serving in NMCB's and CBU's. All respondents are considered to be from the same population because Seabees rotate between NMCB's and CBU's throughout their career and receive training from the same sources. This is a realistic representation of the population of project supervisors and crew leaders. The sample of crew members represents less than 5% of all crew members in NMCB's and CBU's, and may not be a realistic representation of all crew members. Because of this, conclusions and recommendations will be limited to project supervisors and crew leaders. The average Seabee has served 9.83 years in the Navy. Tables 1, 2, and 3 shows

responses by job description, rate, and years in the Navy, respectively.

Table I Response by Job Description

Job Description	No. Responses	Percent Response
Project Supervisor	87	38%
Crew Leader	115	50%
Crew Member	<u>30</u>	<u>12%</u>
	232	100%

Table II Response by Rate

Rate	No. Responses	Percent Response
Builder	90	38%
Construction Electrician	34	15%
Equipment Operator	58	25%
Steelworker	15	7%
Utilitiesman	<u>35</u>	<u>15%</u>
	232	100%

Table III Response by Years in the Navy

Years in Navy	No. Responses	Percent Response
1 - 4	49	21%
5 - 10	88	38%
11 +	<u>95</u>	<u>41%</u>
	232	100%

Part B: Analysis of Survey Categories

The first category of the questionnaire, Training, had a response mean of 2.09 which means that training is adequate to meet their needs. Seabees feel on-the-job (OJT) training is more effective than formal training, but that their current job only provides adequate training. This may indicate that OJT is not fully utilized, or the Seabee is working outside their rate. They also feel that the Navy's system of recording OJT could use improvement. Seabees feel formal training is more effective than Special Construction Battalion Training (SCBT). Since SCBT's are an abbreviated version of formal schools, this may indicate the SCBT's do not allow sufficient time to learn and retain management skills. Seabees rated Training Saturday's as the least beneficial training method. Two Saturdays a month are devoted to training when the NMCB is deployed. The training schedule is the responsibility of the NMCB's training department. This may indicate that more effort must be made by the training department to provide effective training during time allotted, or increase the number of Training Saturdays.

Seabees are very knowledgeable in performing tool kit inventories and in requisitioning tools. A mean response of 1.61 shows they know more than basic steps of first echelon maintenance and 81% feel that equipment is adequately maintained.

Safety and Quality Control scored very well with a mean response of 1.53 which means that nearly half are thoroughly knowledgeable in this area. This is even more significant when only 24% have received more than the required 40 hour of safety training. The highest response of

1.31 was in knowing their job's safety requirements. The lowest was 1.79 in knowing their job's quality control requirements. Only 66% have read the quality control plan for their job and 88% know who their quality control petty officer is. More attention can be paid to this area. Only 36% of all respondents know how many people on the job site must be First Aid/CPR qualified. This is even more alarming since only 46% of project supervisors know the answer to this question.

Materials Management reported that only 6% of Seabees received training. Most know how to fill out a 1250-1 request chit, but few are proficient at conducting a Bill of Material/Material Take-Off bounce, comparing job site Bill of Materials (BM's) with the Material Liaison Office (MLO), and in tracking requisitions. Seventy percent of the respondents report they compare their job site BM's with MLO periodically. Only 54% know how much their portion of the project costs, and even fewer know their estimated cost of completing the project. This lack of knowledge may influence their ability to control costs and meet budgets.

Seabees showed a good handle on filling out time cards and converting mandays from workdays. They showed less than basic knowledge of how to adjust their manday estimates to account for variable job site conditions and crew mix. Without experienced help, their estimates could be inaccurate.

Seabees perceive themselves as having only basic knowledge of fundamental project planning skills. They were most proficient in reading plans and specs, but less proficient at

adjusting those plans to record field changes. Skills used at the project supervisor level, such as resource levelling and computer project management, scored highest. At the crew leader level, the weakest areas were in completing two-week construction plans, and in understanding the difference between various construction bar chart schedules. These two skills are used routinely by project supervisors and crew leaders. The fact that only 61 % of project supervisors and 37% of crew leaders have received formal schooling in construction project management may affect these results, and may indicate that current OJT will not produce thorough knowledge in these areas.

Seabees perceived themselves to have the least knowledge of Project Control. All showed less than basic knowledge of how to calculate construction percent completion, how to complete paperwork for a Field Adjustment Request, and fewest knew how to provide information for Situation Reports. This may affect the accuracy of information the Operations Department receives to report construction progress to higher commands. Only 65% report that two-week construction schedules are followed in the field. This indicates that schedules are routinely unrealistic or not enforced by supervisors.

Part C: Results of Analysis based on Question Response

The eight questions described earlier will be statistically analyzed in this section. Responses rated the Seabee's knowledge of project planning and control skills on a scale of 1 to 4 as follows:

- (1) Thoroughly understand this topic.
- (2) Understand basic ideas.
- (3) Don't know the answer, but know where to find it.
- (4) Don't know.

In all questions, the null hypothesis is that all Seabees are equally proficient at project management skills. The alternate hypothesis is that some factor, either their job description, construction specialty (rate), or years of experience affect their knowledge of these skills. The mean values represent the mean response for that category only (e.g. the project supervisor's mean response in Table IV was 1.89 and did not include responses of crew leaders or crew members). The *t* test compared the project supervisor's mean to the combined mean of crew leaders and crew members. Throughout the analysis, the mean of each category will be compared to the combined mean of all other category means. The combined means will be referred to as the "overall mean". The critical *t* value at 0.05 level of significance is 1.96.

1. Do you know how to calculate the Production Efficiency Factor for a job site?

This skill is required of the crew leader and project supervisor to determine how efficient they can work given specific crew, equipment, material, and job site conditions. It takes into account variables such as climate, crew skill level, supervisor's skill, work load, job type, equipment, site conditions, and logistics. The project planner rates each of these on a scale of 1 to 100 with 67 being considered average. The average of all eight variables is the Production Efficiency Factor. Once calculated, the value 67 is divided by the Production Efficiency Factor

to arrive at a Delay Factor the project planner uses to either increase or decrease their manday estimate. The results are shown in Table IV:

Table IV Production Efficiency Responses by Job Description

Job Description	No. Responses	Mean Value	t Value
Project Supervisor	85	1.89	5.31*
Crew Leader	113	2.44	-2.04*
Crew Member	29	3.03	-4.61*
No Response	5	n.a.	n.a.
	232		

* Significant at $p < 0.05$

Of the three categories, project supervisors appear to have the most knowledge of how to calculate Production Efficiency Factors. Their mean value is also statistically different than the mean of crew leaders and crew members at a significance level of 0.05 since $5.31 > 1.96$. Crew leader's score implies they understand less than the basic concepts of this calculation and is significantly less than the mean of project supervisors and crew members. Crew members also scored significantly lower than the mean of crew leaders and project supervisors. Responses by rating are shown in Table V:

Builders have significantly more knowledge of calculating Production Efficiency Factors when compared to the overall mean. Utilitiesmen show the least knowledge in this area compared to all other rates. Responses by years in the Navy are shown in Table VI:

Table V Production Efficiency Response by Rate

Rate	No. Responses	Mean Value	t Value
Builder	87	2.06	3.22*
Construction Electrician	34	2.44	-0.85
Equipment Operator	58	2.45	-1.41
Steelworker	13	2.23	0.33
Utilitiesman	35	2.63	-2.16*
No Response	5	n.a.	n.a.
	232		

* Significant at $p < 0.05$

Table VI Production Efficiency Factor Response by Years in the Navy

Years in the Navy	No. Responses	Mean Value	t Value
1 - 4	49	2.86	-4.71*
5 - 10	84	2.27	0.47
11 +	94	2.04	3.65*
No Response	5	n.a.	n.a.
	232		

* Significant at $p < 0.05$

Although all respondents showed less than basic knowledge of this category, those who have less than 5 years and greater than 10 years of service were significantly different than the overall mean. Not surprising, those with more than 10 years of service show more knowledge of the subject than those with less than 5 years. This may show that by the time a Seabee has served 11 years, they have learned the skill better than the other groups through formal schooling or on-the-job training.

2. Do you know how to use Availability Factors for a job site?

The Availability Factor is based on historical data from each of the Seabee's deployment

sites. It takes into account time the average Seabee is not available to work due to sickness and administrative absences. Availability Factors are given to the NMCB's by their operational commander. These factors are used by project supervisors and crew leaders as a multiplier when calculating their activity or project durations. Responses by job description are shown in Table VII:

Table VII Availability Factor Response by Job Description

Job Description	No. Responses	Mean Value	t Value
Project Supervisor	84	1.76	4.74*
Crew Leader	113	2.23	-1.82
Crew Member	29	2.72	-4.38*
No Response	6	n.a.	n.a.
	232		

* Significant at $p < 0.05$

Project supervisors showed the most knowledge in using Availability Factors and their response was significantly better than the mean of other groups. Crew leaders and crew members responded they know less than basic concepts of how to use Availability Factors. Crew leaders are expected to estimate the duration of their activity and should know how to use Availability Factors. Only crew members scored significantly lower than the overall mean. Responses by rate are shown in Table VIII:

All ratings show the same proficiency at using Availability factors. Responses by years of service in the Navy are shown in Table IX:

The results from the responses for this question are the same as in question 1. Part D of this section will test the relationship between the knowledge level of Seabees against the level

Table VIII Availability Factor Response by Rate

Rate	No. Responses	Mean Value	t Value
Builder	87	2.01	1.41
Construction Electrician	34	2.29	-1.25
Equipment Operator	57	2.25	-1.39
Steelworker	13	1.92	0.83
Utilitiesman	35	2.20	-0.59
No Response	6	n.a.	n.a.
	232		

Table IX Availability Factor Response by Years in the Navy

Years in the Navy	No. Responses	Mean Value	t Value
1 - 4	49	2.86	-4.71*
5 - 10	84	2.27	0.47
11 +	93	2.04	3.65*
No Response	6	n.a.	n.a.
	232		

* Significant at $p < 0.05$

of training they have received. This will determine the effect formal and on-the-job training has on the mastery of construction management skills.

3. Do you know the difference between Free Float and Total Float?

The Navy uses the Critical Path Method (CPM) to plan and schedule work activities and resources. Work activities, often referred to simply as an activity, is a subcategory of work within the project scope. As an example, you would schedule the activity *Erect CMU Walls*

before you would schedule the activity *Set Roof Panels*. Part of this planning process involves scheduling activities simultaneously. The CPM recognizes two categories of float an activity may use. Free Float is the number of days an activity may be delayed without affecting the early start date of any other activity. Total Float is the number of days an activity may be delayed without affecting the project completion date. The critical path is the sequence of activities that have zero Free Float or Total Float. Results of job description are in Table X:

Table X Free and Total Float Response by Job Description

Job Description	No. Responses	Mean Value	t Value
Project Supervisor	84	1.62	6.82*
Crew Leader	111	2.06	-2.01*
Crew Member	28	3.32	-6.94*
No Response	8	n.a.	n.a.
	232		

* Significant at $p < 0.05$

Project supervisors scored significantly better than the combined mean of crew leaders and crew members. Crew leaders and crew members, in turn, scored significantly lower than the overall mean. This response is not surprising because it is generally the project supervisor who will Resource Level the project. It does show that less than half of the project supervisors feel they thoroughly understand the difference between Free and Total Float. Responses by rate are shown in Table XI:

These results show that Builders are more knowledgeable and Utilitiesmen less knowledgeable of the types of float than other ratings. An equal percentage of Steelworkers and Utilitiesmen represent project supervisors, yet Steelworkers scored higher than Utilitiesmen. This may indicate that Utilitiesmen do not receive the quantity or quality of schooling in project

Table XI Free Float and Total Float Response by Rate

Rate	No. Responses	Mean Value	t Value
Builder	87	1.94	2.80*
Construction Electrician	34	2.06	0.75
Equipment Operator	55	2.27	-0.91
Steelworker	14	2.29	-1.41
Utilitiesman	34	2.53	-5.37*
No Response	8	n.a.	n.a.
	232		

* Significant at $p < 0.05$

management they require. This is significant because a senior Utilitiesman may be placed in upper level management positions where project supervisors report to him/her. Understanding the concept of Free and Total Float will prove valuable in that case. Responses by years in the Navy are shown in Table XII:

Table XII Free and Total Float Response by Years in the Navy

Years in the Navy	No. Responses	Mean Value	t Value
1 - 4	49	2.57	-3.12*
5 - 10	84	2.17	-0.14
11 +	91	1.77	5.17*
No Response	8	n.a.	n.a.
	232		

* Significant at $p < 0.05$

The results are similar to those in questions one and two.

4. Do you know how to Resource Level your project?

Resource levelling utilizes Free and Total Float to move activity start dates within a project

to balance personnel and equipment resources. In NMCB's, personnel are assigned to construction companies by the Operations department early in the homeport period for the upcoming deployment. Construction companies, in turn, assign personnel to project crews early in the project planning phase. Although the crew size may vary slightly, the crew leader and project supervisor should have a good feel for the size of their work force. CBU's do not rotate their personnel as often as NMCB's, and therefore will most likely have less turnover within construction companies. When Resource Levelling, the project planners take crews of known size and balance them throughout the project duration. The results are analyzed by job description as shown in Table VIII:

Table XIII Resource Levelling Response by Job Description

Job Description	No. Responses	Mean Value	t Value
Project Supervisor	86	1.73	6.31*
Crew Leader	113	2.41	-2.56*
Crew Member	28	3.11	-5.28*
No Response	5	n.a.	n.a.
	232		

* Significant at $p < 0.05$

All categories were significantly different from the mean. The project supervisor's positive score may indicate that, aside from possibly receiving more schooling, Resource Levelling may be learned to a large extent on the job since the project supervisors is ultimately responsible for planning the project. This will be tested in Part D of this chapter.

Results by rate shown in Table XIV:

The mean response for Builders is once again significantly different than the mean of other rates. Equipment Operators scored significantly below the mean of all other rates. Results by

Table XIV Resource Levelling Response by Rate

Rate	No. Responses	Mean Value	t Value
Builder	88	2.02	2.59*
Construction Electrician	34	2.35	-0.73
Equipment Operator	57	2.47	-2.35*
Steelworker	13	2.15	0.32
Utilitiesman	35	2.37	-0.86
No Response	5	n.a.	n.a.
	232		

* Significant at $p < 0.05$

years of service are in Table XV:

Table XV Resource Levelling Response by Years in the Navy

Years in the Navy	No. Responses	Mean Value	t Value
1 - 4	49	2.88	-5.34*
5 - 10	85	2.32	-0.94
11 +	93	1.86	4.91*
No Response	5	n.a.	n.a.
	232		

* Significant at $p < 0.05$

There is again a significant difference for those with more than 10 and less than 5 years experience.

5. Do you know the purpose of an "S" curve on bar charts?

Bar charts are planning tools that plot the project or activity on the y-axis against time on the x-axis. Seabees use bar charts to schedule activities within a project, or to schedule projects within a deployment. There are three types of bar charts:

- ▶ Level I - Plots project durations for the NMCB or CBU. This is the responsibility of

the Operations department to plan, implement, and monitor.

► Level II - Plots master activity durations within a project and is the responsibility of the project supervisor. Examples of a master activities are *Site Work*, *Foundation/Slab*, *Walls*, and *Roof*.

► Level III - Plots construction activity durations within a master activity. This is the responsibility of the crew leader to plan, implement and monitor. As an example, within the master activity *Roof* would be the construction activities *Set Bar Joists*, *Set Roof Planks*, *Install Built-Up Roof*. The "S" Curve represents the cumulative effort to accomplish the items on the bar chart. The concept is to have the "S" curve flat on the bottom and on the top. A flat bottom allows for slow project start-up, plus allow Seabees to adjust to the deployment site climate which is typically more severe than homeport. The flat top allows for reduced crew size typical of project close-out, and additional administrative requirements the Seabee must undergo to prepare for retrograde to homeport. Figure 3 shows a typical bar chart with a superimposed "S" curve:

Response by job description is shown in Table XVI:

Table XVI "S" Curve Response by Job Description

Job Description	No. Responses	Mean Value	t Value
Project Supervisor	86	2.12	5.16*
Crew Leader	112	2.71	-2.72*
Crew Member	28	3.07	-3.07*
No Response	6	n.a.	n.a.
	232		

* Significant at $p < 0.05$

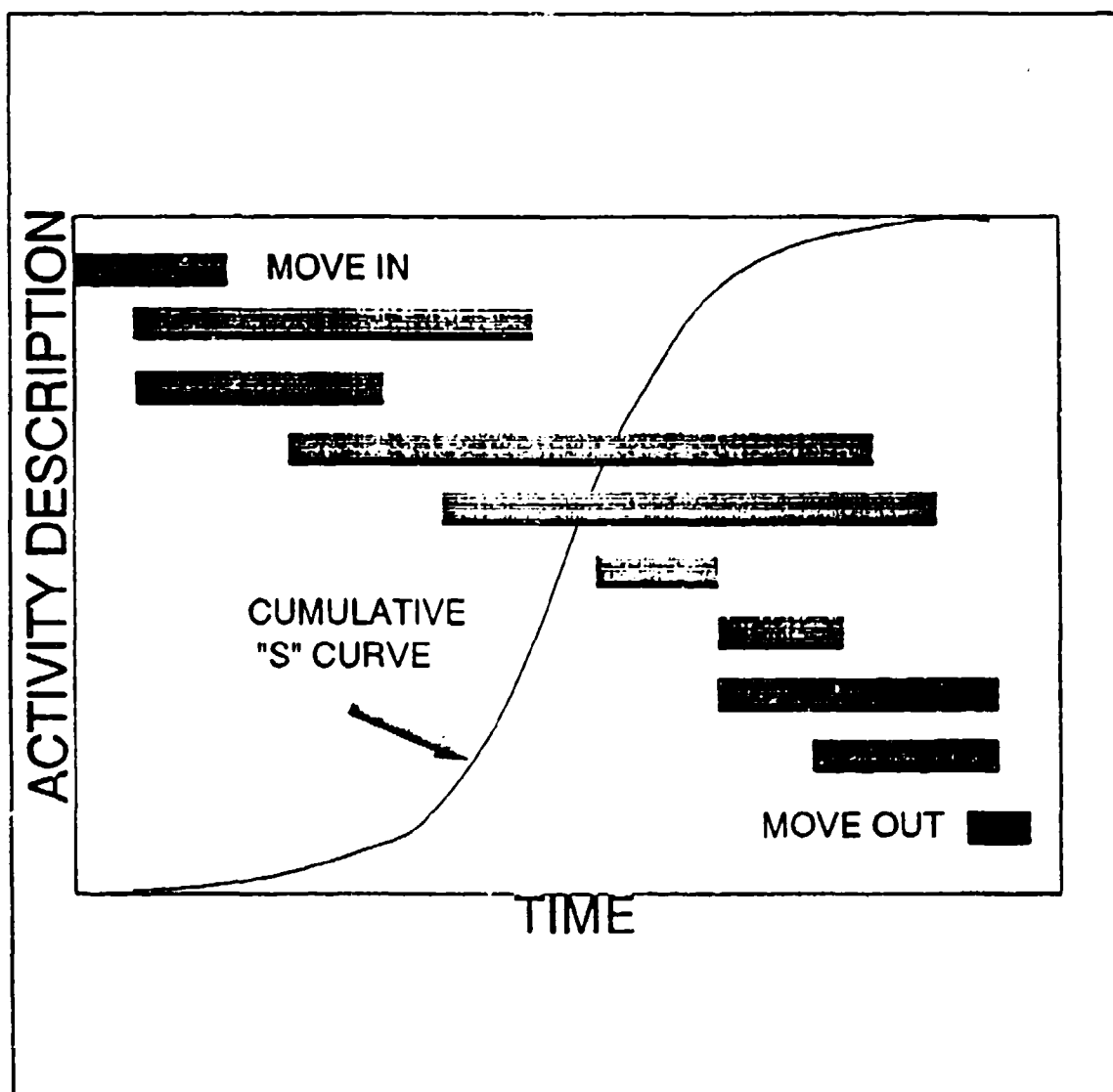


Figure 3 Bar Chart with "S" Curve

In this analysis, project supervisors scored significantly higher than the mean. Crew leaders and crew members scored significantly lower than the mean. The relatively close score between crew leaders and crew members may indicate little knowledge is gained between the time the Seabee is a crew member and a crew leader. Response by rate are shown in Table XVII:

As with Resource Levelling responses, Builders show the most knowledge, and Equipment

Table XVII "S" Curve Response by Rate

Rate	No. Responses	Mean Value	t Value
Builder	87	2.26	3.31*
Construction Electrician	33	2.73	-1.22
Equipment Operator	57	2.77	-2.36*
Steelworker	15	2.07	1.87
Utilitiesman	34	2.74	-1.29
No Response	6	n.a.	n.a.
	162		

* Significant at $p < 0.05$

Operators the least knowledge of using "S" Curves. Analysis by years in the Navy are in Table XVIII:

Table XVIII "S" Curve Response by Years in the Navy

Years in the Navy	No. Responses	Mean Value	t Value
1 - 4	49	2.80	-2.08*
5 - 10	85	2.62	-1.08
11 +	92	2.27	3.29*
No Response	6	n.a.	n.a.
	232		

* Significant at $p < 0.05$

Experience once again plays a significant role in the knowledge levels of respondents.

6. Do you know how to complete a Two-Week Windows from a Level III bar chart?

Once the project is planned, crew leaders use their Level III bar charts to plan their work, manpower, and equipment for the upcoming two weeks. The crew leaders submit their

schedules to their project supervisor, who in turn can use it to manage equipment, tools, and other project resources. Responses by job description are on Table XIX:

Table XIX Two-Week Window Response by Job Description

Job Description	No. Responses	Mean Value	t Value
Project Supervisor	87	1.72	5.75*
Crew Leader	108	2.32	-1.87
Crew Member	28	3.14	-5.67*
No Response	9	n.a.	n.a.
	232		

* Significant at $p < 0.05$

Project supervisors responded significantly higher than, and crew members significantly lower than the mean. It is interesting to note that nearly half of crew leaders responded they did not know how to complete a Two-Week Window without help. Because this skill is used weekly by crew leaders and project supervisors, you would expect it to be well understood. It should also be noted that half of the NMCB respondents were in homeport undergoing the project planning process. Even though they are assigned as crew leaders, they may not have received schooling they are scheduled to receive before deploying. Responses sorted by rate are on Table XX:

Builders once again responded better than average in this category, and Equipment Operators responded worse than the average of all other rates.

Response by years of service are shown on Table XXI:

The only difference in this analysis is with Seabees having less than five years experience who

Table XX Two-Week Response by Rate

Rate	No. Responses	Mean Value	t Value
Builder	86	1.96	2.63*
Construction Electrician	34	2.35	-0.99
Equipment Operator	57	2.53	-3.33*
Steelworker	14	2.14	-0.19
Utilitiesman	32	2.16	0.22
No Response	9	n.a.	n.a.
	232		

* Significant at $p < 0.05$

Table XXI Two-Week Window Response by Years in the Navy

Years in the Navy	No. Responses	Mean Value	t Value
1 - 4	46	2.80	-3.38*
5 - 10	83	2.62	-0.96
11 +	94	2.27	1.90
No Response	9	n.a.	n.a.
	162		

* Significant at $p < 0.05$

responded significantly lower than those with five or more years experience.

7. Do you know how to work with Microtraks project management software?

The Naval Construction Force has adopted the project planning software Microtraks as a tool for project planners. Microtraks allows the user to input activities and resources, and displays the results in critical path format. Although the question was intended to gain a feel of the Seabees' ability to work with the software package, Microtraks also requires they understand the difference between Free and Total Float. This is important because if project planners do not understand float, they cannot use the software to its potential. Output from

Microtraks allows the project planner to Resource Level the project, assign equipment resources, and monitors progress throughout construction. Responses by job description are on Table XXII:

Table XXII Microtraks Response by Job Description

Job Description	No. Responses	Mean Value	t Value
Project Supervisor	84	2.31	5.00*
Crew Leader	109	2.91	-2.37*
Crew Member	29	3.34	-3.27*
No Response	<u>10</u>	n.a.	n.a.
	232		

* Significant at $p < 0.05$

Project supervisors show significantly more familiarity with the Microtraks software than crew leaders or crew members. Crew leaders responded they know more than basic knowledge of the software. Crew leaders are in a position to get involved with the planning process to prepare them for upcoming deployments as a project supervisor. In that scenario, on-the-job training can be a very effective way to learn the software from more experienced project supervisors. Response by rate is shown on Table XXIII:

Builders are more familiar with the software than other rates. This may again be explained by the fact that 42% of the Builders who responded were project supervisors, the group scoring significantly higher to this question. Response by years of experience are in Table XXIV:

Once again, years experience plays a significant measure in response significance.

8. Do you know how to calculate an activity's percent completion?

This skill is required once construction is underway. Each month, construction status is

Table XXIII Microtraks Response by Rate

Rate	No. Responses	Mean Value	t Value
Builder	86	2.47	3.07*
Construction Electrician	33	3.00	-1.54
Equipment Operator	56	2.82	-0.76
Steelworker	13	2.46	0.97
Utilitiesman	34	3.03	-1.75
No Response	<u>10</u>	n.a.	n.a.
	232		

* Significant at $p < 0.05$

Table XXIV Microtraks Response by Year in the Navy

Years in the Navy	No. Responses	Mean Value	t Value
1 - 4	48	3.17	-3.18*
5 - 10	83	2.81	-0.75
11 +	91	2.47	3.25*
No Response	<u>10</u>	n.a.	n.a.
	232		

* Significant at $p < 0.05$

reported by the NMCB and CBU to senior commands. The percent completion is the physical progress the crew has achieved toward the activity's completion. This is commonly referred to as work-in-place, and is not always proportional to the level of effort required to achieve that progress. Actual progress is compared to planned progress on monthly Situation Reports and accurate measurement is essential to provide a solid foundation for projecting the remaining duration for the project. Response by job description are in Table XXV:

This is the third question that all three groups responded they know less than basic knowledge of the skill, and the first where project supervisors did not score significantly higher than all others. This may indicate that on-the-job training is a stronger contributor to acquiring

Table XXV Percent Completion Response by Job Description

Job Description	No. Responses	Mean Value	t Value
Project Supervisor	86	2.26	0.87
Crew Leader	112	2.54	-3.99*
Crew Member	28	3.14	-4.89*
No Response	6	n.a.	n.a.
	232		

* Significant at $p < 0.05$

this skill than formal schooling. This will be explored in the next section of this chapter.

Response by rate are shown in Table XXVI:

Table XXVI Percent Completion Response by Rate

Rate	No. Responses	Mean Value	t Value
Builder	88	2.14	2.39*
Construction Electrician	33	2.21	0.69
Equipment Operator	57	2.61	-2.91*
Steelworker	15	2.20	0.49
Utilitiesman	33	2.82	-3.20*
No Response	6	n.a.	n.a.
	232		

* Significant at $p < 0.05$

Once again, Builders scored significantly higher than the overall mean, Utilitiesmen and Equipment Operators scored significantly lower than the mean. Response by years of service are shown in Table XXVII:

As with several of the other response categories, there is a significant difference between Seabees with less than 5 years and more than 10 years of experience.

Table XXVII Percent Completion Response by Years in the Navy

Years in the Navy	No. Responses	Mean Value	t Value
1 - 4	48	2.90	-4.85*
5 - 10	86	2.42	-1.25
11 +	92	2.07	3.60*
No Response	6	n.a.	n.a.
	232		

* Significant at $p < 0.05$

9. Summary

The eight questions statistically analyzed are construction management skills vital to completing a construction project on time and within budget. They are also among the least known of 76 questions in seven construction management areas. This analysis indicates that Seabees who currently serve as project supervisors have a higher understanding of construction management skills than crew leaders or crew members. Years of experience also has a significant impact on how well Seabees understand these skills. Those with 11 or more years experience have a significantly better understanding than those with less than 11 years experience. In turn, those with less than five years experience have significantly less understanding of the same skills than those with five or more years experience. A Seabees' construction specialty also plays a significant role in their construction management knowledge. Builders have knowledge of these skills that are significantly better than other rates. This is not surprising since 42% of all project supervisors are Builders. On the other hand, Equipment Operators and Utilitiesmen show their level of construction management is significantly lower than all other rates. Equipment Operators represent 22%, and Utilitiesmen 10%, of the project supervisors in this study. Their lower level of knowledge may reflect limited opportunities to

use these skills on the job. It may also indicate an inadequate quantity or quality of construction management training from courses taught within their rate, such as their C-1 Advanced courses.

Part D: Results of Analysis based on Schooling Received

This section will test the impact of formal construction management training on the knowledge of all project supervisors, crew leaders, and Seabees with 11 or more years experience. It will use the *t* test to compare those who have received formal schooling in project management against those who have not received formal schooling. The purpose is to determine any statistical difference between knowledge gained on-the-job against knowledge gained in schools.

The null hypothesis for this test is that Seabees are equally knowledgeable in construction management skills regardless of the type of training they have received. The alternate hypothesis is that Seabees formal training provides better training than on-the-job training. A breakdown of response categories are in Table XXVIII:

Table XXVIII Characterization of Sample

Category	No. Responses	% Formally Schooled
Project Supervisor	87	61%
Crew Leader	115	37%
11+ Years Experience	<u>95</u>	56%
	297	

The categories are not independent of each other as shown by the response total exceeding

the actual 232 respondents. This is because some project supervisors and crew leaders have 11 or more years experience. The test samples are independent because the test only compares Seabees who have and have not received schooling within each category. The values found under School Mean are the mean of all respondents in that category who answered "YES" to question B-20, "have received schooling in project management". The OJT Mean is all respondents who answered "NO" to the same question. The *t*-critical value for this test is 2.00 at a significance level of 0.05. The results of this analysis are found in Table XXVIII.

The results for project supervisors indicate that on-the-job training provides the same degree of skill mastery as formal training in the categories of using Availability Factors, understanding Free and Total Float, Resource Levelling, completing Two-Week windows, and using Microtraks software. Formal schooling provides significant benefit in calculating Production Efficiency Factors, understanding the "S" curve, and a large benefit in calculating work Percent Completion. It is surprising that formal schooling does not seem to provide significant benefit in using Microtraks software by the time Seabees progress to the position of project supervisor.

Results for crew leaders indicate that formal training is very beneficial in all areas but calculating Percent Complete. The magnitude of the *t* value shows that crew leaders who attended formal schools in project management responded much higher than those who had not. This may indicate that Seabees receive the greatest benefit if they attend school as a crew leader.

The results for those with 11 or more years of experience indicate that on-the-job training

Table XXIX Test of Formal v. Informal Schooling

A. Calculating Product Efficiency Factors

Category	School Mean	OJT Mean	t Value
Project Supervisor	1.68	2.25	3.15*
Crew Leader	2.05	4.65	7.15*
11+ Years	1.75	2.41	3.64*

B. Using Availability Factors

Category	School Mean	OJT Mean	t Value
Project Supervisor	1.63	1.97	1.81
Crew Leader	2.10	4.67	6.22*
11+ Years	1.75	2.24	2.82*

C. Understanding Free and Total Float

Category	School Mean	OJT Mean	t Value
Project Supervisor	1.53	1.78	1.39
Crew Leader	1.74	3.10	6.90*
11+ Years	1.62	1.97	1.88

D. How to Resource Level a Project

Category	School Mean	OJT Mean	t Value
Project Supervisor	1.62	1.91	1.51
Crew Leader	2.00	3.29	6.11*
11+ Years	1.75	2.00	1.34

E. The Purpose of an "S" Curve on Bar Charts

Category	School Mean	OJT Mean	t Value
Project Supervisor	1.88	2.47	2.63*
Crew Leader	2.45	3.91	5.80*
11+ Years	2.06	2.54	2.35*

F. Completing Two-Week Windows

Category	School Mean	OJT Mean	t Value
Project Supervisor	1.60	1.91	1.60
Crew Leader	2.13	2.95	3.80*
11+ Years	1.69	2.47	3.82*

G. Using Microtraks software

Category	School Mean	OJT Mean	t Value
Project Supervisor	2.31	2.30	-0.05
Crew Leader	2.69	4.42	5.70*
11+ Years	2.39	2.58	0.79

H. Calculating Percent Complete

Category	School Mean	OJT Mean	t Value
Project Supervisor	1.77	3.00	6.26*
Crew Leader	2.16	2.20	0.14
11+ Years	1.85	2.36	2.67*

* Significant at $p < 0.05$

provides equal benefit to formal training in understanding Free and Total Float, in Resource

Levelling, and in using Microtraks software. Formal schools provided significant benefit in all other categories based on their responses. This may show that experience will eventually provide the same results as formal training with the exception of the three skills stated above.

VI. Training Methods in the Construction Industry

To this point, we have looked at formal Navy training available to NMCB's and CBU's and have identified Seabees' strengths and weaknesses in construction management. Thirty-five percent of those who received formal training received it through C-1 Advanced courses offered at the Naval Construction Training Centers (NCTC). C-1 Advanced courses provide advanced technical and management training for each Seabee rate. Thirty-four percent received it from Construction Battalion Construction Management courses offered by the Naval School for Civil Engineer Corps Officers. Sixteen percent received formal training from Construction Planner and Estimator also offered by the NCTC's. Ten percent attended some other type of construction management training, and five percent have attended more than one of these schools. Both NMCB's and CBU's rely heavily on in-house training to fulfill all their training needs. All In-house and formal training is coordinated by a full-time training staff. This chapter will look at training methods used in the public and private sectors of the construction industry to look for training techniques and/or tools the NMCB's and CBU's can use to enhance their training programs. It will focus on the procedures for establishing, operating, maintaining, and evaluating a training program and conclude by comparing industry methods to Navy methods of training.

A. Background

There is little debate as to the importance and benefits of training workers and managers to improve job site productivity and safety [ENR Mar 15, 1990, p.12]. The debate lies in the methods used to train them. A great deal of attention has been given to construction

management training since the late 1970's that has been aimed at improving project implementation through improving the skills and knowledge of supervisory and management positions [International Labour Organisation, p.42].

Despite the potential benefits of training, a survey published in Engineering-News Record showed that 123 top executives of civilian construction firms spend less than \$25,000 on technical, managerial, and safety training each year. Only officials from companies with annual revenue of greater than \$200,000,000 spend more. Their top priority was leadership, scheduling, and job control. Another survey from the same article showed that 145 respondents found training skilled labor more difficult than it was 5 years ago. 72% felt that the skill level of their new employees was less than expected [ENR Apr 19, 1990, p.18-19]. In a study conducted at the University of Wisconsin Management Institute, none of the 215 first-line foremen and supervisors surveyed had received formal training for their position. They learned required skills by trial and error, by watching their predecessors, through coaching by their supervisors, or by crisis management [Kirkpatrick, p. 48].

Some contractors are attacking this problem. Korte Construction Company of St. Louis, Missouri has put together an aggressive training program aimed at marketing, production, control, and general studies. "Korte U", as it has become known, offers 30 courses twice a year which equates to 8-12 classes per week. Employees may take classes in steel, concrete, job site management and layout, earthwork, and carpentry. They recruit their top performers from within the company to instruct the classes and spend between \$400,000 to \$500,000 per year on

training [ENR, Apr 6, 1989, p.31].

Seabee project supervisors and crew leaders, like many of their civilian counterparts, begin as technicians and are promoted to management positions. This "transition from non-supervisory to supervisory work is probably the most difficult transition an organization can ask of an employee" [Boyd, p. 84]. Seabees must be proficient within their rate plus understand the techniques and capabilities of other rates to prepare them for higher levels of management. This cross-training is also valued by the civilian sector to combat foreign competition and keep a competitive edge with American firms [Schriener, p.15].

It can be seen from these studies that training deficiencies also exist in the private sector. While large organizations provide more resources and capital toward training, many supervisory personnel continue to learn through the "school of hard-knocks". Similarities continue between Seabees and civilian construction supervisors in their weak control over construction finances [Constructor Magazine, Aug 1988, p.52]. If their problems are similar, then the solutions may also be similar.

B. Establishing a Training Program

Because of changing technology, the need to improve employee competence, and advancement and turnover of employees, training must be a continuous cycle [Tenah, p.4]. The cycle begins with assessing the needs of the organization, designing a training program, implementing that program, and evaluating it's effectiveness as shown in Figure 4.

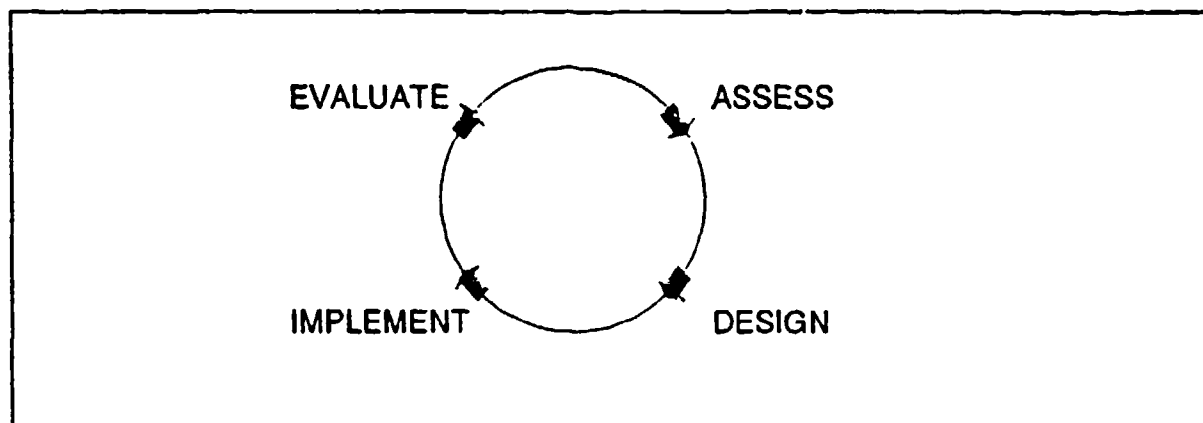


Figure 4 Continuous Training Cycle

The first step to implementing a training program is to establish a steering committee to define problems, identify weaknesses, and set goals [Tenah, p.5]. A steering committee should consist of top level managers from training, quality control, and major operating and staff positions.

The specific mission of the steering committee is to [Juran, p.327]:

- ▶ Identify training needs/goals
- ▶ Propose a curriculum of courses to meet those needs/goals
- ▶ Identify which categories of personnel should receive the training
- ▶ Identify sources of training material
- ▶ Identify needs of the trainers
- ▶ Propose a time table
- ▶ Estimate a budget

While goals may differ depending on the experience of personnel within the NMCB or

CBU, common goals for all Naval Construction Force units are to:

- ▶ Maintain technical knowledge within a Seabees rate
- ▶ Provide technology transfer from industry and academia
- ▶ Increase technical knowledge within a Seabees rate
- ▶ Teach new technical and managerial skills
- ▶ Orientate new employees
- ▶ Provide cross training

Cross training is especially important in the military to maintain flexibility without sacrificing productivity.

Training may be received through a number of methods [Kirkpatrick, pp. 55-63]:

1. On-the-Job-Training (OJT) - This is one of the most widely used forms of training in industry. General Electric found that 90% of the development of their people is performed on the job with the worker's boss [Lusterman p.7]. The benefits are that production continues throughout the learning process, the training is cost effective, and the supervisor can control the training. The negative side is that the training may be haphazard and unplanned, and the consequences of learning errors costly.

2. Classroom Training - Another common form of training which can be used to quickly pass information. Classroom training should include enthusiastic presentation, visual aids, and practical application to maximize it's benefit. Guided discussion, films, case studies, tests, management games, and role playing should be used to involve the entire group. The negative side of classroom training is in selecting instructors. Training conducted by even a highly

skilled technician or supervisor with no instruction experience will usually be erratic and uneven [Lusterman p.7]. Consistency must be maintained in skills and techniques taught throughout the Naval Construction Force (NCF). To ensure this consistency, all training in the Navy is coordinated by the Chief of Naval Education and Training. Below him is the office of the Chief of Naval Technical Training. This office puts forth training requirements for instructors and instructional materials. It also approves and monitors all training conducted by the Naval Construction Training Centers (NCTC) and the Naval School for Civil Engineer Corps Officers to ensure this consistency is maintained.

3. Selected Reading - This type of training requires the participant's self-motivation to read anything from short articles or pamphlets to long, sophisticated books. Maximum benefit may be achieved if the readings are related to the present job of the project supervisor or crew leader, and written so they can be easily understood. Students can be motivated to read if their supervisor creates interest in the readings by showing students they can benefit from the reading, by making it readily available to them, and by following up the readings with meaningful discussion.

4. Correspondence Courses - Correspondence courses are completed by the student at home and contain reading material plus exercises, reports, and tests. Their effectiveness depends on the subject content, motivation of the student, and effectiveness of the grader. Subject content must be relevant to the current or prospective position of the student, and the grader may have greater impact on the learning process if they provide meaningful feedback to the student. Aside from military correspondence courses, there are a number of organizations that offer supervisory correspondence courses [Kirkpatrick p.59]

- A. Independent Study, University of Wisconsin-Extension
432 North Lake Street
Madison, WI 53706
- B. International Correspondence Schools
1528 Prospect Avenue
Scranton, PA 18505
- C. National Home Study Council
1601 Eighteenth Street Northwest
Washington, D.C. 20009

5. Programmed Instruction - Under this fairly new method, the student can proceed at their own pace using text books. Several questions are posed to the student and, after answering correctly, the learning is reinforced by reviewing the thought before proceeding. Some program methods use a combination of picture and word associations to teach a fact, principle, or technique. The most comprehensive reference guide to programmed instruction is: *Programmed Learning: A bibliography of Programs and Presentation Devices*, compiled and published by Carl H. Hendershot, 4114 Ridgewood Drive, Bay City, MI 48706. Other organizations who develop these materials are:

- A. Addison-Wesley Publishing Co., Reading, MA 01867
- B. Argyle Publishing Corp., 235 Park Ave. So., New York, NY 10003.

6. Extension or professional organization sponsored training - This may take the form of any of the above five methods. Military bases stateside and overseas have Educational Services Offices that coordinate training that includes extension courses from colleges or universities. Other examples are the Supervisor Training Program sponsored by the Association of General Contractors [Constructor Magazine, Nov. 1986 pp.24-26] and the Construction Inspection Training program developed by the Texas Engineering Extension Service [Tenah p.8]. The

content of courses must fulfill needs inherent to the organization, but there are skills common to all managers and supervisors:

1. Construction management tools and techniques
2. Understanding and motivating employees
3. Effective communications
4. Problem solving
5. How to manage change
6. Orienting and training new employees

Topic number 1, Construction management and techniques, are taught in Navy courses such as Construction Planner and Estimator, Construction Battalion Construction Management, and all C-1 Advanced schools teach construction management tools that are designed for Seabees in project supervisor and crew leader positions [U.S. Navy, 1989, COMCBPAC/COMCBLANT/COMRNCF INST 1500.20J]. Manuals published by the Navy for each construction trade, or rating, also contain instruction on management techniques [U.S. Navy, 1992, NAVEDTRA 10500]. Navy courses such as Naval Leadership Management and Training (LMET), Chief Petty Officer Management, E-8/9 Management, and the Senior Enlisted Academy cover general management skills identified in topics 2 through 6.

Since formal schools have limited attendance capacity, in-house training can be a valuable and effective tool to provide construction management training [U.S. Navy 1500.20J]. When

putting an in-house training program in place, there are a number of problems to overcome [Kirkpatrick p.175]:

Problem 1 - Maintain the quality of learning without depending too much on the instructor. Deviation between instructors can be minimized by using standardized instructor guides, text books, booklets, videotapes, and films. Care must also be taken when choosing instructors. Many training experts feel that training program failures are not the result of deficiencies in concept or design, but the result of limitations in the capabilities of training personnel or their preparation for the program [Boyd, p.120]. All formal Naval instructors must undergo training in instructional techniques commonly referred to as "train-the-trainer" [U.S. Navy, 1991, CNET INST 1500.22]. Enlisted personnel serving at training commands who fulfill training, experience, and performance criteria may be certified a "Master Training Specialist" [U.S. Navy, 1983, CNET INST 1640.4]. This certification recognizes their ability to effectively instruct formal classes and the certification is valid throughout their career.

Problem 2 - Make training relevant and useful to project supervisors and crew leaders. This requires the instructor to compile quality material and maximize student participation through class discussion, small group activities, exercises, and role playing.

Problem 3 - Minimize the administrative load of course instructors. With in-house training programs, training will most likely be a collateral duty performed by supervisors. To ease their burden, the training department should provide instructors with everything required to present a class. An example may be to include:

A. A detailed Instructor's Guide which:

► Indicates preparations to be made.

- ▶ Provides detailed notes on how the class should be presented. This should be weighed with the skill of the instructors.

- ▶ Provides a lesson plan outline with recommended timing. Experienced instructors often prefer only a rough outline to use as a guide while others prefer detailed notes to accompany the outline [Boyd p.6].

- ▶ Provides master copies of all exercises and student material.

B. All audiovisual material for the class such as videotapes, films, slides, or tapes.

C. All student material such as exercises, tests, and handouts.

The Navy maintains strict standards on developing courses and preparing instructor guides to ensure continuity, consistency, and thoroughness in all courses [U.S. Navy, 1981, NAVEDTRA 110A]. All instructor guides are reviewed periodically by the training command and representatives of the Chief of Naval Technical Training.

Problem 4 - Keep the costs reasonable. Costs can be limited by maintaining a library where all instructor guides and supporting equipment can be checked out.

C. Measuring The Results of a Training Program

Once skills are identified that require additional training, a training program established and implemented, the training cycle must be completed by evaluating it's effectiveness. Training evaluations may be objective, subjective, or both, but should cover these four areas [Boyd, p.131]:

- ▶ Reaction - How well did the students like the program? This can be accomplished through use of a questionnaire. Questions may be YES/NO, rated on a scale, fill in, or a

combination of any the above.

- ▶ **Learning** - To what extent did the students learn the principles and approaches taught in the class? Learning is best measured on the job before the class, and on the job after the class. It can also be measured with a pre- and post-test, survey questionnaire, or personal interview.

- ▶ **Behavior** - To what extent did their behavior on the job change because of the training? The best way to measure behavior changes is by interviewing the students supervisor before and after the training.

- ▶ **Results** - What measurable results were achieved? The most quantifiable areas to measure are productivity, costs, absenteeism, turnover, grievances, and morale.

D. Comparison of Industry and Navy Training

The major similarity between the construction industry and the Navy is that both rely heavily on on-the-job training to fulfill training needs. The Navy has the advantage of establishing and standardizing training schools and training curriculum through a central agency, the Chief of Naval Training and Education. The similarity continues in that both rely on several methods of training: Classroom training, on-the-job training, correspondence courses, professionally sponsored training, and selected readings. The Navy also evaluates their training effectiveness through assessment questionnaires that are filled out by students at the end of each course [U.S. Navy, NAVEDTRA 110A]. The questionnaires often ask students to numerically rate each topic and give constructive comments for course improvement. Individual commands (i.e. NMCF's and CBU's) are required to train specific numbers of Seabees in skills critical to

their mission readiness, but it is the responsibility of the command to determine which Seabees attend this training. Therefore, significant effort must be given at the command level to ensure the correct personnel receive training. This can be accomplished by assessing the knowledge of their prospective project supervisors and crew leaders prior to the homeport training period through questionnaire, personal interview, or pretest. They can measure the results of this training by testing students after they complete the training.

VII. Summary and Conclusions

This paper studied the responses of 232 Navy Seabees to a survey of construction project management skills. The Seabees who responded represent approximately 65% of all project supervisors and crew leaders currently serving in NMCB's and CBU's. Seabees were most knowledgeable in the areas of Tools and Equipment Maintenance, Safety and Quality Control, and Materials Management. They were least knowledgeable in Manday Estimating, Project Planning, and Project Control. The Seabees job description, years of experience, and schooling had a significant effect on their knowledge of several of these construction management skills. Seabees showed they know less than basic knowledge of the concepts of:

1. Calculating the Production Efficiency Factor for a job site.
2. Use the Availability Factor for a job site.
3. Understanding the difference between Free Float and Total Float.
4. Resource Levelling.
5. The purpose of an "S" curve.
6. Completing Two-Week Windows from Level III bar charts.
7. Working with Microtraks project management software.
8. Calculating construction Percent Completion.

These eight questions are construction management skills vital to completing a construction project on time and within budget. They are also among the least known of 76 questions in seven construction management areas.

Seabees were categorized by job description, construction craft called rating, and years of

experience. Their mean value responses to these eight areas were statistically analyzed using a *t* test to identify significant differences between their means at a 95% confidence level. Each of the eight questions were used as dependent factors, and job description, rate, and experience as independent factors.

Results of the *t* test show that project supervisors and those with 11 or more years of service in the Navy are more knowledgeable in these project management skills than crew leaders, crew members, and those with less than 11 years experience. Those with less than five years experience are less knowledgeable of these skills than those with five years or more experience.

Project supervisors have less than basic knowledge of understanding "S" Curves, calculating Percent Completion, and in working with Microtraks software. Formal schooling significantly increases their knowledge of "S" Curves and Percent Completion. Crew leaders showed less than basic knowledge of all eight questions and benefit significantly from formal training in all categories except in calculating Percent Completion.

Seabees trained as Builders tend to be more knowledgeable than other rates in every category except using construction site Availability Factors. All construction rates scored equally in this category. This may show that on-the-job training has the greatest influence over the Seabees' knowledge of Availability Factors. The strong response by Builders may be due to the fact that 40% of all Builders were project supervisors. Project supervisors consistently

score highest in all skill areas.

Equipment Operators were weak in the areas of Resource Levelling, understanding the purpose of "S" Curves, in completing Two-Week construction schedules, and in determining construction Percent Completion. 55% of Equipment Operators have received formal schooling compared to 36% of Builders who scored significantly better than Equipment Operators. This may indicate that construction management skills are not reinforced on the job for Equipment Operators as well as other rates, and, therefore, not as well retained. Another possibility is that the Equipment Operator's C-1 Advanced course does not spend adequate time on developing project management skills.

Utilitiesmen were weak in calculating Production Efficiency Factors, understanding the difference between Free and Total Float, and in calculating construction Percent Completion. 34% of Utilitiesmen have received formal training in project management compared to 36% of Builders, and 23% of the Utilitiesmen were project supervisors. Like Equipment Operators, this may indicate a lack of job site reinforcement or inadequate time devoted to construction management training in Utilitiesman's C-1 Advanced course.

The effect of formal schooling on the Seabees knowledge level was again statistically tested using the *t* test. Project supervisors, crew leaders, and those with 11 or more years of experience were used to test the difference between those that have received formal schooling against those who have not in project management.

Formal schooling has a positive affect on all skill categories. Crew leaders gained significant benefit from formal schools in all areas except calculating construction Percent Completion. Project supervisors benefitted from formal training in three of the eight areas. Seabees with over 11 years experience benefitted from formal training in five of the eight areas.

Specific conclusions are that:

1. NMCB's and CBU's rely heavily on informal construction management training to develop their construction supervisors. 39% of project supervisors and 63% of crew leaders have never attended formal construction management training.
2. The optimum time to send Seabees to formal project management training is when they are first assigned as crew leaders.
3. The effectiveness of on-the-job training depends more on the job Seabees are assigned to rather than years of service alone.
4. Equipment Operators and Utilitiesmen do not receive enough construction management training in comparison to other rates.

IX. Recommendations

To help improve the project management knowledge level of project supervisors and crew leaders, NMCB's and CBU's should:

- ▶ Assess the skill level of project supervisors and crew leaders annually through survey or personal interview. Areas that are targeted for improvement can utilize the Naval Construction Training Centers, Naval School for Civil Engineer Corps Officers (CECOS), and Naval Construction Regiments for courses to fulfill their training needs.

- ▶ Ensure, through survey or personal interview, that project managers understand how to calculate project Percent Completion, how to use Microtraks software, understand "S" Curves on bar charts, and know how to calculate Production Efficiency Factors correctly.

- ▶ Ensure in the same manner that crew leaders understand how to complete Two-Week Windows, how to calculate an activity's Percent Completion, understand the purpose of "S" curves, and know how to calculate Production Efficiency Factors correctly.

- ▶ Ensure all construction management courses are filled to capacity. Project supervisor who have not received training in construction management should have top priority, and crew leaders should fill the remainder of the seats.

- ▶ Maximize project supervisor and crew leader attendance of short duration courses such as Construction Battalion Construction Management I and II (CBCM I & II) and Special Construction Battalion Training (SCBT) Planning and Estimating courses. These are effective for both first-time and refresher training and the Seabee will not be away from the command for extended durations.

- ▶ Utilize in-house talent to establish construction management training programs for:
 1. Seabees unable to attend formal training
 2. Project supervisors and crew leaders desiring refresher training.
 3. Officers who are in charge of construction functions.

The NMCB/CBU's training department should identify seasoned enlisted personnel and Seabees certified as Master Training Specialists who are knowledgeable in project management skills to instruct classes in-house. They can utilize instruction books such as the Crewleader's Handbook that all students who attend CBCM I & II retain. They can also obtain copies of CECOS and NCTC instructor guides to tailor classes for specific needs.

- ▶ Establish a testing program at the NMCB's and CBU's to pretest potential construction management students. This will serve two purposes: It will identify students who need the schooling most, and will measure the quantity of skills they learned at the school if the same test is given after graduation.

Naval Construction Training Centers should:

- ▶ Evaluate the quantity and quality of construction management training Equipment Operators and Utilitiesmen receive in their respective C-1 Advanced courses. The evaluation should initially include a curriculum review of all C-1 courses. NCTC's should also review their method of course evaluation to ensure learning took place equally between all C-1 courses. This can be accomplished through pre- and post-testing students. If all courses have identical questions in construction management, the knowledge level of each Seabee rate can be evaluated and tracked through time and course improvement.

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APPENDIX A

LIST OF ACRONYMS AND DEFINITIONS

ACB - Amphibious Construction Battalion

Availability - A multiplier to adjust manday estimates to account for time a Seabee is historically away from the job site.

Bar Chart - A time schedule used to plan and monitor construction progress at different levels of detail.

Bunkers - Reinforced underground, or partially underground facilities used as command posts, observation posts, or for storage of sensitive materials.

C-1 Advanced - Courses taught by Naval Construction Training Centers in advanced construction and management skills for each of the Seabee ratings.

CBMU - Construction Battalion Construction Maintenance Unit

CBU - Construction Battalion Unit

CECOS - The Naval School for Civil Engineer Corps Officers.

COMCBLANT - Commander, Construction Battalions, Atlantic. The senior command to all NMCB's within the Atlantic theater of operation.

COMCBPAC - Commander, Construction Battalions, Pacific. The senior command to all NMCB's within the Pacific theater of operation.

COMRNCF - Commander, Reserve Naval Construction Forces.

Construction Activity - Categories of work that collectively make up a Master Activity.

Contingency - Emergency action requiring military response.

CPM - Critical Path Method. A method of project planning and scheduling that recognizes construction activities with zero float as top priority, and hence, the critical path.

Crew leader - Responsible for major portions of the construction project under the cognizance of the project supervisor.

Deployment - 7 months when the NMCB constructs facilities for Naval Stations. Main Body deployment sites include, Puerto Rico, Rota, Spain, Guam, and Okinawa.

Detachment - A small groups of Seabees from the NMCB who organize for independent construction operations apart from the Main Body.

Disaster Recovery - Assistance the NCF provides to assist in recovering from natural or man-made disasters.

Float - Time a construction activity can be delayed without affecting construction schedules.

Homeport - Located in Port Hueneme, California and Gulfport, Mississippi where NMCB's undergo 7 months of training in preparation for their upcoming deployment.

LMET - Leadership, Management Education and Training. A course in management and leadership designed for senior enlisted naval personnel.

MAGTF - Marine Air-Ground Task Force - The method the Marine Corps organizes for Main contingency operations.

Main Body - The bulk of the NMCB.

Manday - The amount time one Seabee can work in a normal day.

Master Activity - Major components of a project such as Pour foundation, erect walls, install underground utilities, etc.

Microtraks - The computer software used throughout the Naval Construction Force.

NCF - Naval Construction Force

NCTC - Naval Construction Training Center

NEC - Navy Enlisted Classification. A code given to Sailors to identify recognized skills.

NMCB - Naval Mobile Construction Battalion.

OJT - On-The-Job Training.

PEF - Production Efficiency Factor. A multiplier to adjust manday estimates to accounts for crew mix, experience, climate, job complexity, job site conditions, and equipment.

Percent Completion - A measure of the actual construction progress.

Project Supervisor - The person overall responsible for the construction project. Working for him/her are several crews of various specialties.

Resource Level - Balancing construction resources that include personnel, equipment, and materials to optimize assets.

SCBT - Special Construction Battalion Training. Abbreviated versions of formal courses offered by NCTC's.

Seabees - Enlisted personnel in the OF-13 category trained in construction skills.

Two-Week Window - A tool used to schedule personnel and resources for the upcoming 2 weeks of construction.

UCT - Underwater Construction Team.

APPENDIX B

QUESTIONNAIRE

PLEASE DO NOT SIGN YOUR NAME

I. INTRODUCTION: This questionnaire is designed to identify the effectiveness of construction management training in the Naval Construction Force (NCF). The responses will be evaluated to determine the quality and effectiveness of our current training programs and make recommendations for improvement.

II. GENERAL INFORMATION: Please provide the following information about yourself:

- A. Rate: _____ Paygrade: _____
Years of Service: _____ Years at your present Command: _____
- B. Position: [Check one]
[] Project Manager [] Crew Leader [] Crew Member
- C. Organization Type: [Check one]
[] NMCB [] CBU

III. TRAINING: The following questions relate to training you have received in the Navy.

- 1 = Thoroughly Beneficial
2 = Adequate
3 = Somewhat
4 = Provides No Benefit

A. List the school(s) that best prepared you for your current assignment.

B. What school(s) would better prepare you for your current position?

C. What school(s) do you want to attend in the next year?

- | | YES | | | NO | |
|--|-----|---|---|----|-----|
| D. Would you extend or reenlist for these school(s)? | | | | | |
| E. Do formal schools provide adequate training for your assigned duties? | 1 | 2 | 3 | 4 | N/A |
| F. Do your current duties provide adequate on-the-job-training? | 1 | 2 | 3 | 4 | N/A |
| G. Do you feel on-the-job training is an effective training method? | 1 | 2 | 3 | 4 | N/A |
| H. Do SCBT's provide adequate training for your assigned duties? | 1 | 2 | 3 | 4 | N/A |
| I. Are PAR's an effective way to document on-the-job-training? | 1 | 2 | 3 | 4 | N/A |
| J. Are training Saturdays a valuable training method? | 1 | 2 | 3 | 4 | N/A |

- K. Are homeport projects an effective way to get on-the-job training? 1 2 3 4 N/A
- L. Does the Regiment provide adequate:
1. Military Training? 1 2 3 4 N/A
 2. ABFC training? 1 2 3 4 N/A

IV. PROJECT PLANNING: The following questions relate to skills required in planning and executing a project. Please circle the category that best fits your knowledge of the area. You are not expected to know the answer to every question, so please answer them honestly.

- 1 = Thoroughly understand this topic.
- 2 = Understand basic ideas.
- 3 = Don't know the answer, but know where to find it.
- 4 = Don't know.

A. Manday estimating - This section covers Manday concepts and calculations.

1. How to calculate the Production Efficiency Factor (PEF) for a job site. 1 2 3 4 N/A
2. The difference between a Production Efficiency Factor and a Delay Factor. 1 2 3 4 N/A
3. How to fill out a time card. 1 2 3 4 N/A
4. How to use the availability factor for your job site. 1 2 3 4 N/A
5. How to calculate Mandays from workdays. 1 2 3 4 N/A

B. Project planning - This section deals with project planning skills, tools, and techniques.

1. The difference between a Master Activity and a Construction Activity. 1 2 3 4 N/A
2. How to complete a Construction Activity Summary (CAS) Sheet. 1 2 3 4 N/A
3. The difference between Free Float and Total Float. 1 2 3 4 N/A
4. How to read Plans & Specs. 1 2 3 4 N/A
5. How to update as-built drawings. 1 2 3 4 N/A
6. How to Resource Level your project. 1 2 3 4 N/A
7. How to read a Bar Chart. 1 2 3 4 N/A
8. How to read a Precedence Schedule. 1 2 3 4 N/A
9. The difference between a Level I, II, and III Bar Chart. 1 2 3 4 N/A
10. The purpose of an "S" Curve on a Bar Chart. 1 2 3 4 N/A
11. Completing a Two Week Window from your Level III. 1 2 3 4 N/A
12. Working with Microtracks Computer Programs. 1 2 3 4 N/A
13. Develop Rebar Schedule or Concrete Forming Plan. 1 2 3 4 N/A
14. Rate your involvement in planning your project on a scale of 1 to 4 with 1 being little involvement, and 4 being very involved. 1 2 3 4 N/A
15. Have you worked with the P-405? 1 2 3 4 N/A
16. Is adequate time set aside for project planning? YES NO

- | | | |
|--|-----|----|
| 17. Is it worth the time and effort to plan and estimate projects? | YES | NO |
| 18. Are computers an effective tool for project planning? | YES | NO |
| 19. Are 9-Folder Project Packages a useful tool? | YES | NO |
| 20. Have you received schooling in project planning? | YES | NO |
- If so, what was the name of the course? _____

C. Project Controlling - This section deals with tools and techniques used once a project has begun.

- | | | | | | |
|--|-----|---|---|---|-----|
| 1. How to complete a SITREP feeder. | 1 | 2 | 3 | 4 | N/A |
| 2. How to calculate an activity's percent completion. | 1 | 2 | 3 | 4 | N/A |
| 3. How to complete a Field Adjustment Request (FAR). | 1 | 2 | 3 | 4 | N/A |
| 4. Are construction schedules (two-week windows) usually followed? | YES | | | | NO |

D. MLO operations - This section deals with material management tools in the planning and execution phases of your project, as well as paperwork used by supply, CTR, and MLO.

- | | | | | | |
|--|-----|---|---|---|-----|
| 1. How to fill out a 1250-1 chit. | 1 | 2 | 3 | 4 | N/A |
| 2. How to conduct a BM/MTO bounce. | 1 | 2 | 3 | 4 | N/A |
| 3. The purpose of the 45 day material plan. | 1 | 2 | 3 | 4 | N/A |
| 4. The difference between an Add-On and a Reorder. | 1 | 2 | 3 | 4 | N/A |
| 5. How to compare your job site BM with MLO. | 1 | 2 | 3 | 4 | N/A |
| 7. The difference between priority A, B, and C request chits. | 1 | 2 | 3 | 4 | N/A |
| 8. How to track long-lead items with MLO. | 1 | 2 | 3 | 4 | N/A |
| 9. What items are typically long-lead items. | 1 | 2 | 3 | 4 | N/A |
| 10. How to read a Project Control Report or Project Status Report. | 1 | 2 | 3 | 4 | N/A |
| 11. How to complete an Add-On request. | 1 | 2 | 3 | 4 | N/A |
| 12. Do you know how much your portion of the project costs? | YES | | | | NO |
| 13. Know your projects Estimate At Completion (EAC). | YES | | | | NO |
| 14. Do you compare your job site BM with MLO periodically? | YES | | | | NO |
| 15. Are job site BM's effective in project planning and execution? | YES | | | | NO |
| 16. Have you received schooling in MLO Operations? | YES | | | | NO |
- If so, what was the name of the course? _____

E. Safety/QC - This section deals with safety aspects of your projects. Please rate your knowledge of these areas.

- | | | | | | |
|---|---|---|---|---|-----|
| 1. Safety requirements for your job. | 1 | 2 | 3 | 4 | N/A |
| 2. Accident reporting procedures. | 1 | 2 | 3 | 4 | N/A |
| 3. What information is contained on Material Safety Data Sheets (MSDS). | 1 | 2 | 3 | 4 | N/A |
| 4. What QC testing requirements are for your job. | 1 | 2 | 3 | 4 | N/A |
| 5. What safety information is required to be posted on a job site. | 1 | 2 | 3 | 4 | N/A |
| 6. Have you read your project safety plan. | 1 | 2 | 3 | 4 | N/A |
| 7. How to fill out an injury report. | 1 | 2 | 3 | 4 | N/A |

- | | 1 | 2 | 3 | 4 | N/A |
|---|-----|---|---|----|-----|
| 8. How to safely store hazardous materials. | | | | | |
| 9. Are hazardous materials stored properly on job sites? | YES | | | NO | |
| 10. Are proper storage facilities available from battalion or camp assets to store hazardous materials? | YES | | | NO | |
| 11. Have you read the QC plan for your project? | YES | | | NO | |
| 12. Do you know who your Safety Petty Officer is? | YES | | | NO | |
| 13. Do you know who your QC Petty Officer is? | YES | | | NO | |
| 14. Do you feel job site cleanliness is an important safety concern? | YES | | | NO | |
| 15. Do you feel daily safety lectures are effective? | YES | | | NO | |
| 16. Do you know where to find MSDS sheets? | YES | | | NO | |
| 17. Do you know how many people must be First Aid/CPR certified on a job site? | YES | | | NO | |
| 18. Do you know what the EM-385 and 29CFR1926 are? | YES | | | NO | |
| 19. Do you feel the safety color of the month is effective in preventing electrical safety mishaps? | YES | | | NO | |
| 20. Is feedback from field QC reports an effective tool in planning and executing your project? | YES | | | NO | |
| 21. Have you attended safety or QC training? | YES | | | NO | |
| If so, what was the name of the course? _____ | | | | | |

F. Tools and Equipment - This section deals with the maintenance and accountability of tools and equipment.

- | | | | | | |
|--|-----|---|---|----|-----|
| 1. How to perform a tool kit inventory. | 1 | 2 | 3 | 4 | N/A |
| 2. How to requisition new tools. | 1 | 2 | 3 | 4 | N/A |
| 3. How to perform first echelon equipment maintenance. | 1 | 2 | 3 | 4 | N/A |
| 4. Do you feel equipment maintenance is adequate? | YES | | | NO | |

Thank you for your time and effort in answering these questions.

APPENDIX C

QUESTION	MEAN	ST. DEV.
TRAINING		
Do formal schools provide adequate training for your assigned duties?	1.69	0.81
Do your current duties provide adequate on-the-job training?	2.03	0.80
Do you feel on-the-job training is an effective training method?	1.48	0.69
Do SCBT's provide adequate training for your assignments?	2.09	0.80
Are PAR's an effective way to document on-the-job training?	2.55	0.90
Are training Saturday's a valuable training method?	2.92	0.94
Are homeport projects an effective way to get on-the-job training?	2.18	0.97
Does the Regiment provide adequate:		
Military Training?	1.89	0.69
ABFC Training?	1.95	0.74
A. MANDAY ESTIMATING		
How to calculate the Production Efficiency Factor (PEF) for a job site.	2.31	0.94
The difference between a PEF and a Delay Factor.	2.27	1.02
How to fill out a time card.	1.35	0.63
How to use the availability factor for your job site.	2.12	0.87
How to calculate Mandays from workdays.	1.54	0.81
B. PROJECT PLANNING		
Understand the difference between a Master Activity and a Construction Activity.	1.50	0.75
How to complete a Construction Activity Summary Sheet.	1.67	0.91
Understand the difference between Free Float and Total Float.	2.18	1.01
How to read Plans & Specs.	1.44	0.70
How to update as-built drawings.	1.77	0.94
How to Resource Level your project.	2.24	0.99
How to read a Bar Chart.	1.71	0.89
How to read a Precedence Schedule.	1.66	0.88
The difference between a Level I, II, & III Bar Chart.	1.94	0.98
The purpose of an "S" Curve on a Bar Chart.	2.53	1.00
Completing a Two Week Window from your Level III.	2.19	1.01
Working with Microtracks Computers.	2.74	1.06
Develop Rebar Schedule or Concrete Forming Plan.	2.42	1.12
	% YES	% NO
Is adequate time set aside for project planning?	55%	45%
Is it worth the time and effort to plan and estimate projects?	86%	14%
Are computers an effective tool for project planning?	87%	13%
Are 9-Folder Project Packages a useful tool?	81%	19%
Have you received schooling in project planning?	39%	61%
C. PROJECT CONTROLLING		
How to complete a STIRREP feeder.	2.66	0.99
How to calculate an activity's percent completion.	2.32	1.00
How to complete a Field Adjustment Request (FAR).	2.14	1.09
	% YES	% NO
Are construction schedules (two-week windows) usually followed?	65%	35%
D. MLO OPERATIONS		
How to fill out a 1250-1 chit.	1.38	0.68
How to conduct a BM/MFO bounce.	1.82	1.00
The purpose of the 45 day material plan.	1.81	0.96

The difference between an Add-On and a Reorder.	1.66	0.90
How to compare your job site BM with MLO.	1.86	1.04
The difference between priority A, B, and C request chits.	1.87	0.95
How to track long-lead items with MLO.	2.16	0.99
What items are typically long-lead items.	2.12	0.96
How to read a PCR/PSR.	2.14	0.98
How to complete an Add-On request.	1.99	0.95
	% YES	% NO
Do you know how much your portion of the project costs?	54%	46%
Know your Estimate At Completion (EAC)?	53%	47%
Do you compare your job site BM's with MLO periodically?	70%	30%
Are job site BM's effective in project planning and execution?	87%	13%
Have you received schooling in MLO Operations?	6%	94%
E. SAFETY/QC		
Safety requirements for your job.	1.31	0.58
Accident reporting procedures.	1.47	0.67
What information is contained on Material Safety Data Sheets (MSDS).	1.48	0.69
What QC testing requirements are for your job.	1.79	0.88
What safety information is required to be posted on a job site.	1.50	0.72
Have you read your project safety plan.	1.66	0.93
How to fill out an injury report.	1.53	0.70
How to safely store hazardous materials.	1.53	0.74
	% YES	% NO
Are hazardous materials stored properly on job sites?	86%	14%
Are proper storage facilities available from battalion or camp assets to store HAZMAT?	76%	24%
Have you read the QC plan for your project?	66%	34%
Do you know who your Safety Petty Officer is?	92%	8%
Do you know who your QC Petty Officer is?	88%	12%
Do you feel job site cleanliness is an important safety concern?	98%	2%
Do you feel daily safety lectures are effective?	78%	22%
Do you know where to find MSDS sheets?	92%	8%
Do you know how many people must be First Aid/CPR qualified on a job site?	39%	61%
Do you know what the EM-385 and 29CFR 1926 are?	51%	49%
Do you feel the safety color of the month is effective in preventing electrical safety mishaps?	83%	17%
Is feedback from field QC reports an effective tool in planning and executing your project?	86%	14%
Have you attended safety training?	24%	76%
F. TOOLS AND EQUIPMENT		
How to perform a tool kit inventory.	1.14	0.46
How to requisition new tools.	1.34	0.65
How to perform first echelon equipment maintenance.	1.61	0.89
	% YES	% NO
Do you feel equipment maintenance is adequate?	81%	19%