A QUALITY MANAGEMENT EVALUATION

OF THE GRADUATE EDUCATION PROCESS

FOR OCEAN ENGINEERS IN THE CIVIL ENGINEER CORPS

A Report on a Major Subject

by

William Anthony Oster

Submitted for partial fulfillment of the requirements for the degree of

MASTER OF ENGINEERING

Texas A&M University

Major Subject: Ocean Engineering

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ABSTRACT

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The purpose of this report is to evaluate the quality of graduate education required for Ocean Facilities Program (OFP) officers in the Civil Engineer Corps (CEC) of the United States Navy. For the purpose of this report, quality is defined as meeting or exceeding the needs and expectations of OFP customers while maintaining professional integrity. The OFP serves as the Navy's experts for ocean, coastal, and underwater engineering, in providing their customers with capabilities for the research and development, planning and design, construction and installation, maintenance and repair, and re-utilization and disposal of facilities and systems attached to or resting upon the seafloor and shore-based hyperbaric facilities. Toward this mission, the OFP requires prospective officers to complete a master's degree in ocean engineering in sixteen months (four semesters) at one of five eligible universities. The OFP periodically reviews the quality of education received and, as necessary, adjusts the educational skill requirements (ESRs) that guide an officer's education plan. The purpose of this report is to describe the results of an evaluation that employs a rational sequencing of a quality management tool commonly known as quality function deployment (QFD) to align the graduate education process with the foreseeable, prioritized customer needs. The prioritized customer needs were determined by distributing questionnaires to all officers in the OFP. Statistical analyses of numerical data and judgmental analysis of professional opinions resulted in conclusive evidence defining the design requirements necessary to provide high quality graduate education. Recommendations necessary to implement the processes required to achieve the final delivery system are suggested.

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LIST OF EXHIBITS

INTRODUCTION

A. The Ocean Facilities Program. The Ocean Facilities Program (OFP) is that program within the Naval Facilities Engineering Command (NAVFAC) which has the mission to provide the responsive capability for the research and development, planning and design, construction and installation, maintenance and repair, and reutilization and disposal of facilities and systems attached to or resting upon the seafloor and shore-based hyperbaric facilities. The OFP is staffed by military and civilian personnel; however, the focus of this report is on the graduate education of only the Civil Engineer Corps (CEC) naval officers in the OFP. The vision statement for the OFP expresses the intent to serve as the Navy's expert for ocean, coastal, and underwater engineering. Toward that mission, NAVFAC assigns CEC OFP officers to staff billets in support of principal customers at key naval commands. The officer, then, is the host commands' "expert" for ocean engineering.

Officers are especially chosen from within the CEC for acceptance into the OFP. Upon acceptance, they are sent to complete a master's degree in ocean engineering at one of several universities. In completing the master's degree, the officer is guided in course selection by engineering skill requirements (ESRs). ESRs prescribe the essential skills required of a graduate ocean engineer and are required by the Naval Postgraduate School. Typically, courses are taken to satisfy ESRs on a one-for-one basis. Student adherence to ESR requirements is monitored by NAVFAC. Current ESRs for ocean engineering are provided as Appendix A. Upon completion of the master's degree, the officers are then required to qualify as a basic diving officer at a naval training facility.

B. Objectives. The writer intends to employ the principles of quality management in identifying the graduate education system design requirements for Navy CEC officers in the OFP. These design requirements will best prepare the officers to meet the needs and expectations of OFP customers. The design requirements will be arrayed as ESRs from which curriculums can be proposed (by others). In addition, such an array lends itself well toward validating the current ESRs. The conclusions and recommendations of this report are intended for use by the Assistant Commander for Ocean Facilities. The present study identifies and prioritizes customer needs and translates those needs into design requirements. This necessitates continuing work at the processor (NAVFAC) level to coordinate with the suppliers to the system to determine optimum curricula for OFP master's degree candidates.

C. Literature Review. Extensive literature is available on the subject of quality management. The writer has found considerable information regarding the topics of quality management and quality function deployment (QFD) including its inception, introductory concepts, and practical applications to common business. Brocka and Brocka (1992) have compiled a very informative introduction to quality management including its history, an introduction to the "masters," and implementation dynamics. Sullivan et al. (1988) were especially useful having introduced QFD concepts, processes, and applications. A good example of applied QFD can be found in Hauser and Clausing (1988). Bradburn and Sudman (1988) include a very comprehensive guide for information-gathering techniques, survey word choice and length, response probabilities, and respondent tendencies. Hunt's (1992) work details survey compilation. Samson (1992) introduces the "IPO," the fundamental quality management model. Guidance on frequency of evaluation can be found in Gopalakrishnan et al. (1992). NAVFAC publications and Ocean Facilities Program (OFP) Total Quality Leadership Initiatives provide the framework for defining the mission. Hayes' (1991) work was extremely useful in designing the survey introduction and response formats and in selecting word choice and the presentation of questions.

QUALITY MANAGEMENT

A. Background. Quality management can be defined as:

"Systematically and continuously improving quality of products, service, and life using all available human and capital resources.

or,

An organization-wide problem-solving and process-improving methodology.

or,

A system of means to economically produce goods or services that satisfy customer requirements," (Brocka and Brocka et al., 1992).

Quality management can be viewed as:

"...both a philosophy and a set of guiding principles that represent the foundation of a continuously improving organization, all the processes within the organization, and the degree to which present and future needs of customers are met." (Brocka and Brocka et al., 1992).

It includes the integration of all employees, suppliers, and customers with the corporate environment.

Numerous pedagogues are commonly followed when implementing quality management. A summary of seven of the more famous masters and their hallmarks follows (Brocka and Brocka, 1992).

- Philip B. Crosby is associated with his "Fourteen Steps."
- W. Edwards Deming has developed his "Fourteen Points," "Twelve Obstacles," and "Seven Deadly Diseases."
- Joseph M. Juran is noted for his "Trilogy."
- Armand V. Feigenbaum has stated for his "Three Steps to Quality," "Four Deadly Sins," and "Nineteen Steps to Quality Improvement."
- Tom Peters presents "Nine Aspects of Excellent Companies" and "Peters' Prescription for Management Evolution."
- Genichi Taguchi is associated with "Quality Philosophy."
- Kaoru Ishikawa is noted for both "Quality Philosophy" and his "Seven Tools."

All of the masters can be said to have developed in the twentieth century. But there are historical roots in Sun-Tzu, Aesop, and Socrates. Besides providing a fundamental philosophy for quality management, the masters also provide guidance in management dynamics, organizing, planning, self-examination, group techniques, and statistical tools, some to a lesser degree than others.

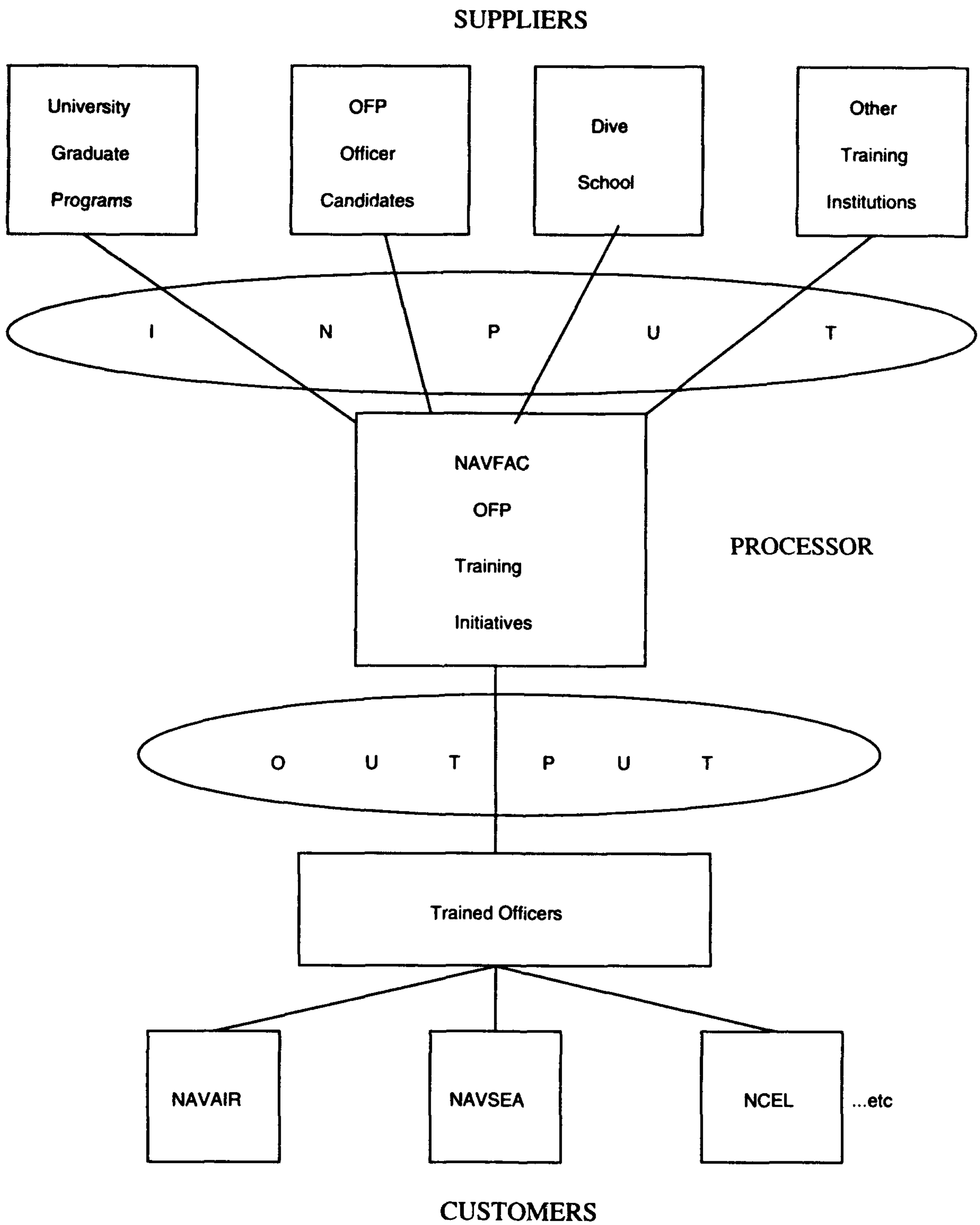
As shown above, the masters have identified specific approaches to quality management. But their foundations are similar and can be summarized as containing the following eight components (Brocka and Brocka, 1992) :

- Organizational vision
- Barrier removal
- Communication
- Continuous evaluation
- Continuous improvement
- Customer/vendor relationships
- Empowering the worker
- Training

B. The Model. For the purpose of this report, quality is defined as meeting or exceeding the needs and expectations of customers while maintaining professional integrity, Samson (1992). If an organization is to provide quality as defined, it must first determine who their customers are. The customers of particular concern for the purposes of this report are the primary staff to which OFP officers are assigned. Exhibit 1 portrays the model used in establishing the boundaries necessary to determine organizational relationships. Understanding the model is essential both to understand the relationship between the contributors and to appreciate the application of the writer's work to the process. The model is based on the Supplier/Processor/Customer input-output process. In this instance, the Ocean Facilities Program of NAVFAC is the processor. The processor takes input from suppliers in the form of prospective OFP officers and combines it with input from educational institutions such as university graduate programs, dive school, and perhaps other sources. The processor ultimately delivers an output, an educated OFP officer, to its customers in an effort to meet the needs of those customers.

Second, for the processor (formerly the organization) to be fully responsive to the needs of these customers, it must know and understand what those needs are. Many tools and techniques are available with which to determine the needs and expectations of customers. This report adapts the tool known as quality function deployment (QFD).

Exhibit 1.
Input-Output Model for Supplier/Processor/Customer.

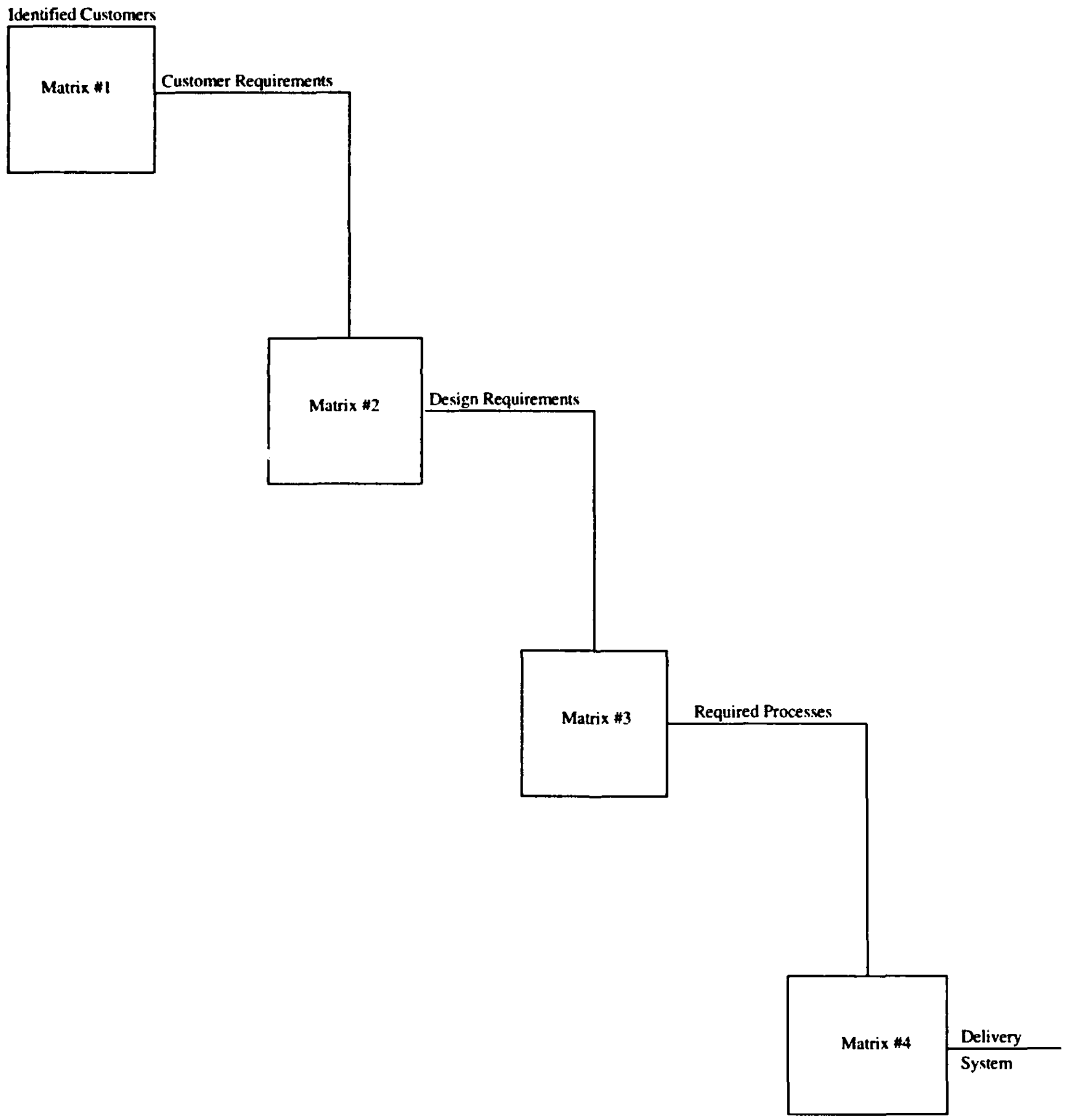


C. Quality Function Deployment. QFD was developed in Japan by Akao. Don Clausing of MIT is given credit for introducing QFD to U. S. industry (Sullivan, 1988). It identifies goals from the end users' point of view and diffuses these goals upstream through the production processes. QFD is heralded as the most complete methodology for planning to meet customer requirements, Conti (1989). QFD is policy management traditionally using matrix charts and binary tables to evaluate interaction of the means with company objectives as opposed to Management-by-Objective which establishes objectives and then evaluates performance by measuring the results (Sullivan, 1988). Analyses that begin with the company processes tend to produce goals based on cost criterion and do not provide a strong stimulus to identify with the market. When a process fails to meet requirements, "downstream" processes must make up for it thus, adding inefficiencies to downstream processes (Conti, 1989). QFD recognizes that not everything can, nor should, be achieved; the focus is on those characteristics that are most strongly linked to customer satisfaction (Brown, 1991). Thus, QFD focuses on the means as opposed to measuring performance "after-the-fact." The results become an outcome of the means and, therefore, are a measure of how well policy management is working (Sullivan, 1988).

QFD emphasizes the use of highly traceable procedures and graphical displays to drive all phases of product or service deployment without stifling the voice of the customer (Brown, 1991). In general, the voice of the customer is determined and transformed into design parameters defining the product or service being offered. Relationships are then established through correlation matrices with rating factors assigned in an effort to develop a product that meets the customer's stated and implied needs and expectations. It is of paramount importance that value be judged from the customer's point of view.

A series of four characteristic matrices may be employed in tracking the design process from customer needs and expectations to production requirements. See Exhibit 2. In a QFD matrix, "whats" comprise the vertical rows and are transformed into "hows" which comprise horizontal columns. The representation gives the appearance of a house and is commonly known as a "house of quality." The matrix created by this array allows for a correlation between the "whats" and the "hows". Furthermore, a triangular matrix correlating the "hows" is added putting the "roof" on the house of quality. The "hows" of the matrix then become the "whats" of the next matrix and the procedure is continued until the delivery system is defined. The first matrix identifies customers by priority and the technical requirements that satisfy the customers' needs. These needs are expressed in the language of the customers. The next matrix identifies the design requirements necessary to satisfy the technical requirements prioritized in the first matrix. It is in this second matrix that the needs expressed in the language of the customers are translated into the "technical" language of the designer. The third matrix identifies the processes required to meet the design requirements prioritized in the second matrix. The final matrix defines the delivery system best suited to providing the required processes. Although this report does not employ the use of QFD matrices, these four significant steps guide the development of the final recommendations and conclusions. Instead, response data is presented in the form of charts to lend the assistance of a graphical display important to QFD analyses. This follows QFD sequencing to tie the desired delivery system to customer needs and expectations. An example of a similar application of QFD can be found in Hauser and Clausing (1988).

Exhibit 2.
QFD Correlation Matrices.



QFD also emphasizes a cross-functional team framework (Brown, 1991). Toward the end of getting cross-functional input, the writer, as the investigator, a committee member from the ocean engineering area, a committee member from the civil engineering quality management area, a committee member from the Department of Naval Sciences, and the counsel of the Assistant Commander for Ocean Facilities, NAVFAC have provided input into this study.

THE SURVEY

A. Designing the Survey. Polls and surveys have become an essential part of our political lives and are ingrained in our media and the business world (Bradburn and Sudman, 1988). Businesses (organizations) conduct market research which is essentially research-gathering activities that enable them to match the needs and preferences of the market with the products and services they provide (Bradburn and Sudman, 1988). Do respondents tell the truth? Research shows that the answer is yes, if they know it (Bradburn and Sudman, 1988). Also, for a number of reasons respondents do not tend to lie about their opinions (Bradburn and Sudman, 1988). A survey that interrogates the entire population is defined as a census (Bradburn and Sudman, 1988) which is indeed the case for this report. Numbers calculated using an entire population are called parameters, not statistics which are derived from a sample of a population (Hayes, 1991). A copy of the survey is provided as Appendix B.

Surveys should be limited to twelve pages without causing problems for "motivated" respondents (Bradburn and Sudman, 1988). Although mail surveys have limitations, they can provide useful data if valid addresses are known, the respondents are known, the respondents have loyalty to a common group, and the respondents are educated and thus better able to complete a survey of this nature (Bradburn and Sudman, 1988). All of the above criteria are true for this survey.

A survey generally requires attention to three significant attributes: the introduction, the response format, and the questions (Bradburn and Sudman, 1988). The introduction provides a brief explanation of the purpose(s) of the survey and interest for completing the survey. It also explains how the data will be used, and especially when determining customer needs and expectations, it should encourage cooperation with the customer in completing the survey (Hayes, 1991).

For the majority of the survey, a bi-polar continuum response format was used which allows the respondent to respond in varying degrees to each question (Hayes, 1991). This allows the respondent to express a degree of agreement rather than a yes/no restriction and aids significantly in prioritizing customer requirements. Research shows that from a statistical perspective, scales with five response options have more reliability than scales with two response options while still allowing for determination of positive/negative responses. Furthermore, reliability seems to level off after five suggesting minimal incremental utility of using more than five response options (Lissitz and Green, 1975). The present survey used four response options. The survey also included some checklist and short answer questions to determine background information about the respondent and respondent opinions.

It is important to include all possible examples for a response category or topic. Some of the response categories or topical areas may overlap and judgment is required to prevent unnecessary duplication. Furthermore, generating the response categories and topical areas may be done independently o: simultaneously (Hayes, 1991). In this case, a basic framework existed in the form of current ESRs around which additional topics were generated to present a list of skills that could logically be presumed to be of use or necessity to the OFP officer in the performance of his/her duties.

After the categories and topics have been identified, the items must be carefully selected for presentation in the questionnaire. The most critical element in surveys is the formulation of the questions that make up the survey instrument (Bradburn and Sudman, 1988). Guidelines for the questions are that they be concise, not contain a double negative, be neutral, be unambiguous, appear relevant to the objective of the survey, and contain only one thought (Hayes, 1991). In the case of this survey, section one is designed to provide background information on the respondent and to query opinions that are independent of customer satisfaction and more pertinent to the graduate education process than the curriculum. Section two recapitulates the ESRs for the navy's ocean engineering graduate education curriculum. Section three expands on topics specific to graduate institution ocean engineering curriculums. Section four addresses topics that are not specific to ocean engineering and may not have been addressed thoroughly enough in section two. Section five provides the respondent the opportunity to indicate skills that the survey may have overlooked or omitted completely. Lastly, section six provides the respondent the opportunity to express opinions or offer advice on any facet of the entire graduate education process.

PROCEDURE

A. Identifying the Customer. Before the voice of the customer can be obtained, the customer must first be identified. OFP officers are assigned to significant OFP customers and one can identify the customers by identifying commands to which the officers are assigned. Several OFP officer assignments serve more than one customer. Initially, one might want to survey all of the customers of the OFP, i.e., survey the commands to which the OFP officers are assigned. Doing so would require the investigator to translate all customer requirements (as communicated in the "customer's" language) into design criteria in the "designer's" language. Proceeding in this manner would pose three significant difficulties to analyzing the data. First, it would not include any input from the OFP officer serving the customer and that officer is expected to be the customer's expert for ocean engineering. Second, it would require that the investigator translate customer requirements directly into curriculum which is a skill better served by graduate institutions. And third, research on human judgment suggests that people are poor judges as to what information they think they use (Hayes, 1991). This puts the customer at a distinct disadvantage suggesting that their judgment would be even less reliable when evaluating what information their ocean engineering expert (their staff OFP officer) uses.

Therefore, it was decided that the OFP officers would be surveyed instead of the commands to which OFP officers are assigned. This is an improvement over surveying the commands to which OFP officers are assigned. First, input from the OFP officers is specifically included. Second, the OFP officer can be queried in the language of the designer thus minimizing errors that could be caused by translating customer needs from the customer's language to the designer's. And besides, the objective of this report is to evaluate the quality of graduate education required for OFP officers to meet or exceed customer needs and expectations, not to determine the customer's needs and expectations. The customer's needs and expectations are unquestionably known by the OFP officers, and it is incumbent upon those officers to translate those needs and expectations into the language of ocean engineers on a daily basis.

B. Soliciting the Voice of the Customer. After the survey was prepared and approved, both a letter of endorsement and a mailing list of OFP officers were obtained from the Assistant Commander for Ocean Facilities. A copy of the letter of endorsement was attached to each survey. A survey was mailed to the home address of each OFP officer who had completed both graduate school and basic diving officer training, forty surveys in all. Home addresses were chosen because of the nature of some of the respondents' assignments. After three weeks, follow-ups were conducted on all officers who had not yet responded. Research shows that one may expect at best a 70% response provided that follow-ups are conducted (Bradburn and Sudman, 1988).

C. Obtaining the Voice of the Customer. As the surveys were returned, they were cross-referenced with the respondent. This was necessary in order to determine which respondents would require follow-ups. Thereafter, the information in the survey was recorded anonymous of the respondent. The returned survey was also classified as to whether or not it was from an entry-level officer. An entry-level officer is one in his or her first assignment as an OFP officer or at an assignment that officers in their first tour are traditionally sent. This classification was made to investigate any difference between skills required of entry-level officers and those required of the entire population. Responses from entry-level officers were then recorded as such.

The short-answer responses from survey sections one, five, and six were simply collected and examined for similarity, trends, etc. The numerical value answers from sections one through four were carefully tabulated. After all responses were received, a mean value for each sub-topic was computed followed by a mean value and standard deviation for each topical area. Appendix C contains all of the numerical data and statistical values for survey sections two, three, and four. The purpose of finding the standard deviation of the topical area was to establish a method of evaluating the sub-topics within the topical area. Mean values for the sub-topics were compared to the mean and standard deviation of the topical area to determine their relative value. Sub-topics with means greater or less than the standard deviation from the topical area mean were noted for later evaluation. An example calculation is provided below with Exhibit 3, Example #1. Note that items 10 through 15 are sub-topics of the topical area which is ESR #5. Also note that items 10a, b, c, and d are also sub-topics. Of course for a topic consisting of only two sub-topics, addressing only the topic mean and standard deviation can disguise the fact that sub-topic means may be significantly higher or lower. An example is provided as Example #2 in Exhibit 3.

D. Prioritizing the Voice of the Customer. QFD prescribes that customers be prioritized. Thus, priority of customer requirements for numerous customers can be derived from individual customer priority. However, NAVFAC does not have an order of priority for OFP customers. All customers are equally important and warrant the assignment of a full-time OFP officer. Instead, priority of skill requirements is obtained from the value responses as demonstrated in Exhibit 3. After calculations were completed for all topical areas in survey sections two, three, and four, the topical areas in each section were ranked in descending order according to their topical area mean for both the entry-level and the entire respondent groups. Brief notations were made during this process to identify relatively high and low sub-topics and sub-topics that were perhaps misrepresented by their topical area mean. This resulted in a hierarchy of skills essential to the duties of an OFP officer.

At this point, all sub-topics and topical areas can be evaluated with respect to each other. In some cases, topics could be combined. For example, ESR #3 and Geotechnical Site Investigation from survey section four were combined. In another case, skill requirements were redundant with skills obtained at basic diving officer training.

Exhibit 3.
Example Calculations.

Example #1. Survey section II, ESR #5: Entry-level.

Sub-topic	Response values	Total	Mean	*Δ
10. Oceanography:				
a. chemical	3,2,3,2,2,3,2,4,2,2,2,3,3	33	2.54	-0.34
b. biological	2,2,3,2,2,2,2,3,2,2,3,3,2	30	2.31	-0.57
c. physical	4,3,3,4,2,3,3,4,2,3,3,3,3	40	3.08	0.20
d. geological	2,3,3,3,2,3,4,4,2,3,4,3,3	39	3.00	0.12
11. Sea water Properties.	3,3,3,3,2,3,3,4,2,3,2,3,3	37	2.85	0.03
12. Currents.	4,3,3,4,3,3,3,4,2,4,4,4,3	44	3.38	0.50
13. Tides.	4,3,3,4,3,3,4,4,2,4,3,4,3	44	3.38	0.50
14. Meteorological conditions.	2,3,3,3,3,3,2,4,2,4,3,3,3	38	2.92	0.04
15. Predicting operational...	2,3,3,4,3,2,2,2,2,2,2,3,2	32	2.46	-0.42
Summary:	Topic Total	337	2.88	
	Standard Deviation	+/- 0.38		
	Mean +/- Std. Dev.	2.50 - 3.26		

Relative highs: sub-topics 12 and 13.
Relative lows: sub-topics 10b and 15.

Example #2. Survey section II, ESR #7: Entry-level.

Sub-topic	Response values	Total	Mean	*Δ
18. Hydrodynamics.	4,3,3,3,3,3,3,4,2,3,3,3,2	39	3.00	0.27
19. Fluid...scaled...	2,3,3,3,3,2,2,2,2,2,2,3,3	32	2.46	-0.27
	Topic total	71	2.73	
	Standard deviation	+/- 0.38		
	Mean +/- Std. Dev.	2 .35 - 3.11		

No relative highs or lows as defined by standard deviation but it is obvious that sub-topics 18 and 19 are disguised by the topical area mean of 2.73.

Next, all skills from survey sections two, three, and four were ranked in descending order on the basis of not only the topical area mean but also in consideration of relatively high and low sub-topics. This resulted in over twenty-five skills for both the entry-level and entire respondent groups. This would appear to be too many skills to satisfy in the four semesters allotted for completion of a masters' degree in ocean engineering. Before design requirements can be proposed, boundaries and limitations need to be established.

E. Boundary Conditions. It is important to note here that an officer is limited to four semesters in completing a master's degree in ocean engineering. This necessitates a basis for prioritizing skill requirements so as to maximize the time and effort spent earning a degree. First, most courses represent three credit hours. Certainly, some courses earn four credit hours and some earn only two. But the majority earn three credit hours. Second, assuming studies are begun in the fall, one might expect a student to complete twelve courses during a school schedule consisting of three semesters per year: fall, spring, and summer. It is reasonable to assume that a student could typically carry four courses in the first fall semester, three in the spring, two in the summer, and three the following fall. The decreased number of courses in the last three semesters allow for the student to both complete credit hours toward his or her engineering report or research project and provide time for physical conditioning in preparation for basic diving officer training.

Next, skills with a topical area mean or sub-topic mean of less than 3.00 were eliminated. (This cutoff was arrived at after several iterations.) A mean of 3.00 suggests that the majority of the respondent group (OFP officers) requires at least a basic understanding of the topic to effectively serve their customer(s).

F. System Design Requirements. A system design can now be proposed. Two assumptions in designing the system must be understood. First, it is assumed that the officer completes the master's degree before completing basic diving officer training. Otherwise, more time is available to the student since he or she does not have to prepare for dive school. Second, it is assumed that the student begins graduate work in the fall semester at a university operating on the semester system (three semesters per year). The design may have to be revised to accommodate universities operating on the quarter system (four quarters per year).

Proposed system design requirements for both the entry-level and entire respondent groups were then developed. This is the limit of the objectives of this report.

G. Continuing Actions. Given the design requirements proposed by this report and continuing with the QFD application, it would be necessary to take the next two steps to identify both the required processes and the delivery system best suited to achieving the design requirements. Identifying required processes might include identifying or developing specific courses to satisfy the skills specified by the design requirements. Identifying the delivery system might finally develop a curriculum that satisfies required processes. Both steps are beyond the scope of this report but recommendations are suggested.

RESULTS

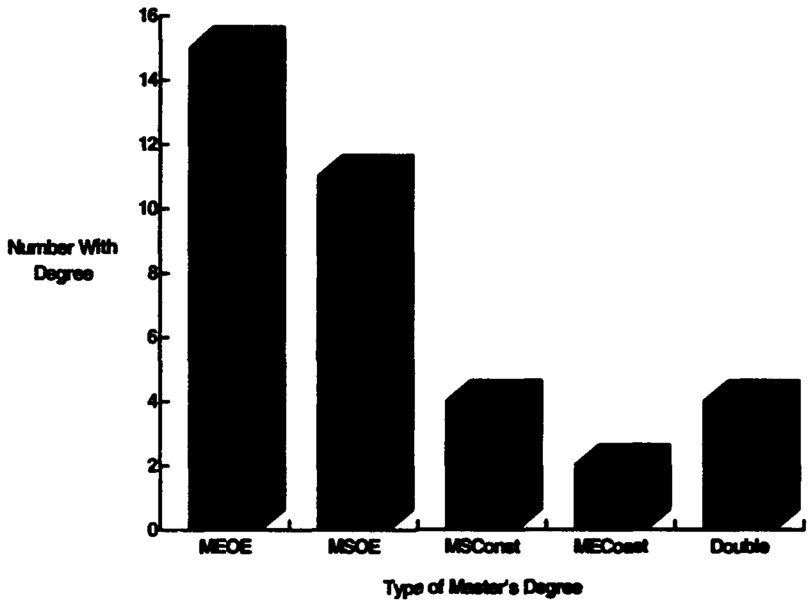
A. Prelude. This report should not be misconstrued as an evaluation of the quality of education provided by any one university. The data represent the experience and opinions of twenty-eight naval officers who attended seven different universities for master's degrees. This discussion and pursuant conclusions are drawn entirely from survey results. Twenty-eight surveys were returned of the forty that were mailed out, a 70% response rate. Of those that responded, twelve were entry-level officers. Of the twelve that did not respond, two were entry-level. Care has been taken to point out response trends for both entry-level and entire respondent groups. The validity of the final results depends on the quality of the entire chain of events from the design of the survey through the data collection phase to the final tabulation and interpretation of the data (Hayes, 1991).

B. Presentation of Results by Section. In that the survey was presented in a series of sections, so will the analysis by presented.

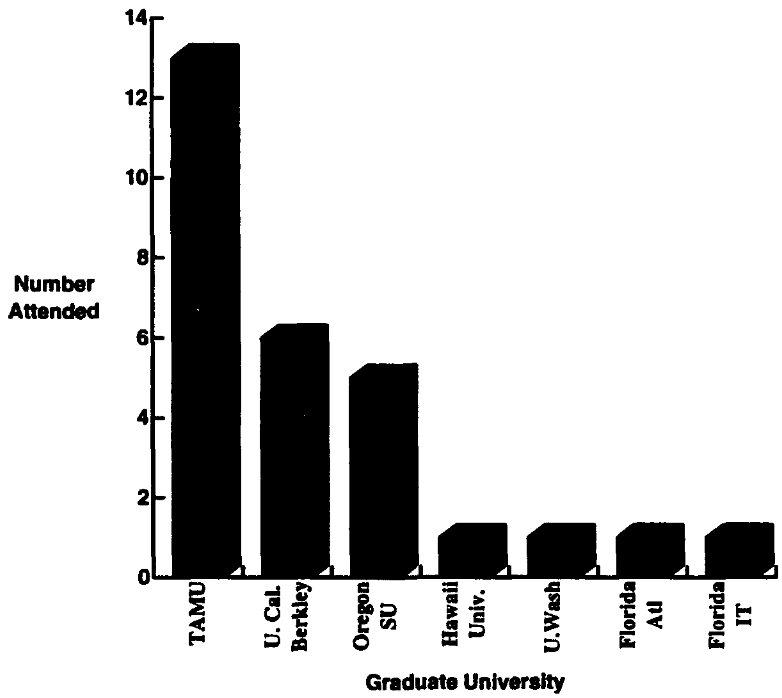
1. Section I: Background Information. A summary is provided as Exhibit 4. A large majority (93%) of the respondents hold master's degrees in ocean engineering. The remainder include master's degrees in construction engineering and coastal engineering. Five respondents noted that the graduate university they attended allowed for completion of a double degree, with the second degree consistently construction engineering. Texas A&M, University of California at Berkeley, and Oregon State represent the significant sources for master's degrees.

Exhibit 4.
Graduate Degree History.

4a. Degrees Held

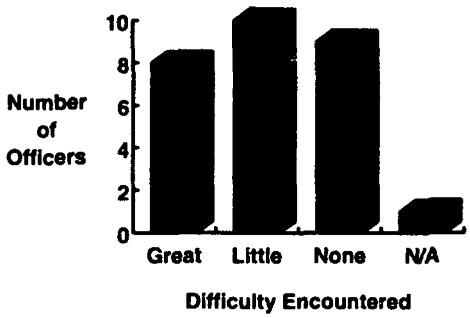


4b. Graduate Universities Attended



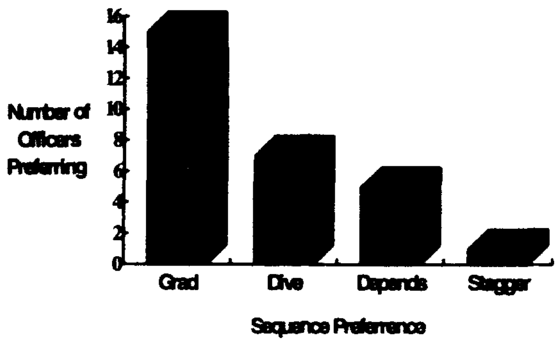
The respondents were about evenly split with respect to the degree of difficulty they encountered in obtaining a research topic. Eight had great difficulty and nine had no difficulty. Ten respondents had some measure of difficulty. And one had no difficulty since his university did not require the completion of a thesis or major report. The reasons for arriving at a final topic range from their selection of a topic by the availability of grant money to having their topic selected for them by their primary advisor. But the predominant reasons include a topic of interest to the student, a topic of interest to their primary advisor or committee, facilities availability, relevance to their first assignment in the OFP, and sense of purpose or opportunity to do field work and gain hands-on experience. Exhibit 5 summarizes.

Exhibit 5.
Degree of Difficulty in Obtaining a Research/Report Topic.



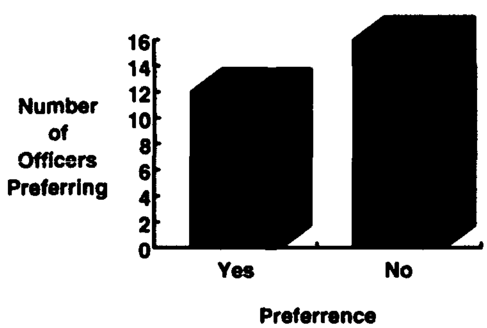
A majority (fifteen) recommended that future OFP officers should complete graduate school before attending dive school. But a significant number (seven) suggested that the sequence is not necessarily important and it may be more advantageous to treat each officer conditionally depending upon his or her location and rotation date when entering the program. Initial assignment (i.e., entry-level customer) should also be considered since several respondents indicated that it is essential to attend dive school immediately before being assigned to a diving-related billet. See Exhibit 6 below for a summary. An important fact to be aware of is that prospective OFP officers must pass preliminary medical and physical qualifications before acceptance into the OFP and assignment to graduate studies in ocean engineering. If, after completion of graduate studies, an officer is found to be unqualified for diving, his or her skills as an ocean engineer can still be used by the CEC in shorefront facilities management albeit to a lesser degree than one who is a certified Navy diver.

Exhibit 6.
Preference in School Sequence.



A majority (sixteen) did not concur with the suggestion that OFP officers conduct research toward their master's degree at a federal laboratory or research facility (as opposed to at a university). They cited a convincing number of reasons. Some of the more prominent reasons against include: it suggests a costly graduate education process in excess of sixteen months; research should be conducted at a university under the supervision of an advisor; universities are a better place from which to expose students to "new ideas"; and OFP officers are expected to be leaders not researchers. Some favorable arguments of note include: the Navy can benefit by expanding the number of researchers it has toward Navy research interests; and it would allow the student more time for research which is why students are sent to graduate institutions in the first place. See Exhibit 7 for a summary.

Exhibit 7.
Concurrence With Research at a Federal Research Facility.



With respect to what courses taken as a graduate student were found to be most beneficial, a wide array of skills is represented indicative of the breadth of knowledge required of the OFP officer. The responses are loosely categorized by current ESR and ranked by frequency of response and summarized in Exhibit 8. The purpose of this question was to provide a means to validate the prioritization of skills in survey sections two, three, and four. But three of the respondents (11%) did not answer this question and, therefore, the data is not conclusive.

Exhibit 8.
Courses Taken as a Graduate Student Found to be Most Beneficial as an OFP Officer.

Topical Area (ESR)	Frequency of Response
ESR #5:	
• Wave Mechanics/Theory	11
• Physical Oceanography	4
• Linear Waves	2
• Random Waves	1
• Islands and Oceans	1
ESR #6:	
• Coastal Engineering	7
• Shore Protection Manual	2
• Coastal Sediment Processes	2
• Coastal Processes	2
• Scour	1
• Coastal Structures	1
• Beach Sedimentation Flow/Processes	1
ESR #2:	
• Dynamics of Ocean Structures	4
• Design, Construction and Maintenance of Marine Structures	3
• Reliability-based Design Criteria for Marine Structures	3
• Finite Element Analysis	3
• Harbor Design	1
• Dynamic Load and Structural Analysis	1
ESR #9:	
• Project Management	3
• Acoustics	2
• Naval Architecture	2
• Systems Engineering	1
• Stability Analysis of Ocean Vessels	1
• Diving and Life Support Technology	1
• Aerospace/Hydrospace Technology	1
• Basic Electronics	1

Exhibit 8. (continued)

ESR #8:

- Advanced Concrete Construction 2
- Offshore Construction 2
- Management of Harbor, Coastal and Offshore Construction Projects 1
- Strategic Issues in Engineering and Construction 1
- Productivity Improvement 1
- Ports and Harbors 1

ESR #3:

- Marine Foundation Engineering 3
- Advanced Soil Mechanics 2
- Engineering Geology 1
- Geotechnical Engineering 1

ESR #7:

- Wave Hydrodynamics 2
- Hydrodynamics 1

ESR #1:

- Wind/Wave Forces on Marine Structures 2

ESR #4:

- Sea Water Corrosion Processes 2

ESR #10:

- Computers in Architecture 1

ESR #12:

- Business Management 1

ESRs #11 and #13:

- No response.

OTHER:

- Ocean Engineering Vehicles 2
- Arctic Ocean Engineering 3
- California Geography 1
- Fluid Dynamics 2
- Ocean Engineering Seminar 1
- Marketing of International Construction Projects 1
- Dynamics of Marine Vehicles 1
- Management (TQL, etc.) 1
- Time-Series Analysis 1
- Introduction to Ocean Engineering 1
- Steel Design 1

Similarly, the responses concerning which courses the officers would like to have taken but did not take indicate a wide array as shown by Exhibit 9. The responses are loosely categorized by current ESR and ranked by frequency of response. This question was also included for the purpose of validating skill requirements identified in other sections but three of the respondents (11%) did not answer this question and, therefore, the data is not conclusive.

Exhibit 9.

Courses That Respondents Would Like to Have Taken at Graduate School But Did Not.

Topical Area (ESR)	Frequency of Response
ESR #9:	
• Underwater Acoustics	5
• Hyperbaric Systems Structures/Piping Design/Installation	4
• Construction Management	3
• Instrumentation Engineering	2
• Diving Life Support	1
ESR #8:	
• Offshore Construction and Equipment	3
• Construction Oriented Courses (Steel, Concrete, Foundations)	2
• Construction Techniques in the Ocean and Coastal Environment	2
• Undersea Cable Systems	1
• Repair and Maintenance of Facilities	1
• Practical Underwater Work Courses	1
ESR #2:	
• Mooring Design	3
• Computer Aided Structural Design/Analysis	2
• Harbor Planning and Design	1
• Offshore Structural Mechanics/Dynamics	1
• Pier Design	1
• Finite Elements	1
ESR #3:	
• Seafloor Soil Mechanics	3
• Pile and Foundation Design	1
ESR #4:	
• Corrosion Engineering	4
ESR #12:	
• Business: Finance and Advertising	3
ESR #6:	
• Coastal Engineering	1
• Beach Erosion and Shoreline Stabilization	1

Exhibit 9. (continued)

ESR #5:	
• Oceanography	1
ESR #11:	
• Upper Level Writing	1
ESRs 1, 7, 10, and 13:	
• Not represented	
OTHER:	
• Vehicles for Deep Ocean Engineering	2
• Environmental Engineering	1
• Business Law	1
• Marine Animal Interest in Man-made/-placed Objects	1
• Management Theory	2
• Total Quality Management	1

2. Section II: Skills Assessment/Validation. The questions from this section were developed entirely from the current ESRs. The purpose of this section was to assess the validity of the current ESRs. Exhibit 10 provides a summary of entry-level responses to this section of the survey. It includes the relative rank of the ESRs, means of the ESRs (topical areas), and general comments about relatively high or low scoring sub-topics. Exhibit 11 provides a similar summary for the entire respondent group.

Exhibit 10.
Response Summary of ESRs for Entry-Level Officers.

Rank	Mean	ESR (Topical Area)	Sub-Topic Comments
1.	3.51	ESR #12 (Communications)	"Oral communications" mean = 4.0 "Written communications" mean = 4.0
2.	3.41	ESR #4 (Corrosion)	"Types of materials and their engineering properties" mean = 3.46
3.	3.37	ESR # 8 (Ocean Construction)	"...fixed facilities" mean = 3.23
4.	3.17	ESR # 11 (Financial Management)	
5.	3.15	ESR # 3 (Geotechnical)	"Using seafloor...requirements" mean = 3.38
6.	3.10	ESR #6 (Coastal Engineering)	"Coastal processes including storm surge" mean = 2.85

Exhibit 10. (continued)

Rank	Mean	ESR (Topical Area)	Sub-Topic Comments
7.	3.06	ESR #1 (Environmental Effects)	"Measurement of seismic activity" mean = 2.23 "Application to the design of facilities...seismic activity" mean = 2.46
8.	2.95	ESR #9 (Unrelated subtopics)	"Principles of naval architecture" mean = 2.54 "Instrumentation engineering" mean = 2.92 "Principles of underwater acoustics" mean = 2.92 "Systems engineering" mean = 3.00 "Construction project/program management" mean = 3.46
9.	2.88	ESR #5 (Oceanography)	"Biological oceanography" mean = 2.31 "Predicting operational...wave theory" mean = 2.46 "Chemical oceanography" mean = 2.54 "Currents" and "Tides" mean = 3.38
10.	2.85	ESR #10 (Data Processing)	
11.	2.73	ESR #7 (Hydromechanics)	"Hydrodynamics" mean = 3.00
12.	2.72	ESR #2 (Design Methods)	"...Finite difference models" mean = 2.46 "The principles of fatigue mechanics... design of ocean facilities" mean = 2.92

Exhibit 11.

Response Summary of ESRs for All OFP Officers.

Rank	Mean	ESR (Topical Area)	Sub-Topic Comments
1.	3.57	ESR #12 (Communications)	"Oral communications" mean = 4.00 "Written communications" mean = 4.00
2.	3.51	ESR # 8 (Ocean Construction)	"...mooring systems" mean = 3.63 "...fixed facilities" and "...pipelines" means = 3.40
3.	3.46	ESR #4 (Corrosion)	"Principles of corrosion" mean = 3.43
4.	3.43	ESR # 11 (Financial Management)	
5.	3.22	ESR # 3 (Geotechnical)	"Using seafloor...requirements" mean = 3.37
6.	3.17	ESR #6 (Coastal Engineering)	"Coastal processes including storm surge" mean = 2.97 "Determining the effects...storm surge" mean = 3.03
7.	3.12	ESR #1 (Environmental Effects)	"Measurement of seismic activity" mean = 2.30 "Applicatiom to the design of facilities...seismic activity" mean = 2.70
8.	3.07	ESR #10 (Data Processing)	
9.	3.06	ESR #9 (Unrelated sub-topics)	"Principles of naval architecture" mean = 2.70 "Construction project/program management" mean = 3.63
10.	3.00	ESR #5 (Oceanography)	"Biological oceanography" mean = 2.53 "Predicting operational...wave theory" mean = 2.67 "Chemical oceanography" mean = 2.70 "Currents" and "Tides" means = 3.43
11.	2.83	ESR #7 (Hydromechanics)	"Hydrodynamics" mean = 3.17
12.	2.67	ESR #2 (Design Methods)	"The principles of fatigue mechanics... design of ocean facilities" mean = 3.03

3. Section III: General Topics. The questions from this section were developed entirely from general ocean engineering topics. The purpose of this section was to determine what skills specific to the ocean engineering curriculum were most important to the OFP officer. Exhibit 12 provides a summary of entry-level responses to this section of the survey. It includes the relative rank of the general topics, means of the general topics (topical areas), and comments about relatively high or low scoring sub-topics. Exhibit 13 provides a similar summary based on the responses of the entire respondent group.

Exhibit 12.
Response Summary of General Ocean Engineering Topics for Entry-Level Officers.

Rank	Mean	General Topic	Sub-Topic Comments
1.	3.25	#4 (Life Support/Diving Tech)	"Diving physiology" mean = 3.42 "Remotely operated vehicles" mean = 3.08
2.	3.19	#3 (Design of Ocean Facilities)	"Design of structures, equipment, and systems for the ocean" mean = 3.33
3.	2.99	#9 (Coastal Engineering)	"Effects of waves on ocean facilities" mean = 3.25 "Design of breakwaters/jetties" mean = 3.25 "Wave forecasting" mean = 2.75
4.	2.97	#14 (Marine Foundations)	"Settlement and bearing capacity analysis of offshore locations" mean = 2.83. Remaining sub-topics regarding pile driving analyses have means of 3.08 and 3.00
5.	2.90	#6 (Ocean Vehicle Dynamics)	"Behavior of facilities in waves" mean = 3.00
6.	2.85	#1 (Underwater Acoustics)	"Acoustic transducers and arrays" mean = 3.08 "Design and prediction of SONAR systems" mean = 2.58 "Propagation of underwater sound" mean = 2.92

Exhibit 12. (continued)

Rank	Mean	General Topic	Sub-Topic Comments
7.	2.78	#8 (Wave Mechanics)	"Nonlinear wave theories" mean = 2.42 "Wave properties in shoaling waters" mean = 3.08 "Linear wave theories" and "Application of wave theory to engineering problems" means = 2.92
8.	2.75	#10 (Dynamics of Offshore Facilities)	"Functional design of offshore facilities" mean = 3.08 "Wave forces" mean = 2.92
9.	2.75	#15 (Marine Dredging)	Has no sub-topic mean greater than 2.83
10.	2.56	# 5 (Arctic Offshore Engineering)	Has no sub-topic mean greater than 2.67
11.	2.56	#13 (Estuary Hydrodynamics)	Has no sub-topic mean greater than 2.58
12.	2.54	#12 (Coastal Sediment Processes)	"Sediment properties and size distributions" and "Inlet stability" means = 2.92
13.	2.50	#11 (Hydromechanics)	Has no sub-topic mean greater than 2.58
14.	2.42	#16 (Computational Fluid Mechanics)	
15.	2.40	#2 (Principles of Naval Architecture)	
16.	2.38	#7 (Dynamics of Fluid-Solid Interaction)	
17.	2.33	#17 (Fluid Mechanic Modeling)	

Exhibit 13.

Response Summary of General Ocean Engineering Topics for All OFP Officers.

Rank	Mean	General Topic	Sub-Topic Comments
1.	3.46	#3 (Design of Ocean Facilities)	"Design of structures, equipment, and systems for the ocean" mean = 3.54
2.	3.43	#4 (Life Support/Diving Tech)	"Diving physiology" mean = 3.68 "Remotely operated vehicles" mean = 3.25
3.	3.21	#14 (Marine Foundations)	
4.	3.13	#6 (Ocean Vehicle Dynamics)	"Behavior of facilities in waves" mean =3.32
5.	3.09	#9 (Coastal Engineering)	"Effects of waves on ocean facilities" mean = 3.43 "Wave forecasting" mean = 2.79
6.	3.08	#10 (Dynamics of Offshore Facilities)	"Structural dynamics for time and frequency domain simulations" mean = 2.75
7.	2.99	#8 (Wave Mechanics)	"Wave spectral analysis" mean = 2.71
8.	2.92	#1 (Underwater Acoustics)	"Design and prediction of SONAR systems" mean = 2.61 "Propagation of underwater sound" mean = 2.92
9.	2.82	# 5 (Arctic Offshore Engineering)	
10.	2.79	#11 (Hydromechanics)	"General conservation laws" and "Flow past a body of any shape" means = 2.96
11.	2.69	#12 (Coastal Sediment Processes)	"Sediment properties and size distributions" mean = 3.07 "Movement of material by the sea" mean = 2.96 "Sediment tracing" mean = 2.29
12.	2.67	#2 (Principles of Naval Architecture)	"Load line and classification systems" mean = 2.43
13.	2.61	#15 (Marine Dredging)	
14.	2.61	#13 (Estuary Hydrodynamics)	

Exhibit 13. (continued)

Rank	Mean	General Topic	Sub-Topic Comments
15.	2.54	#16 (Computational Fluid Mechanics)	
16.	2.52	#7 (Dynamics of Fluid-Solid Interaction)	
17.	2.46	#17 (Fluid Mechanic Modeling)	

4. Section IV: Non-Traditional Topics: The questions from this section were developed from twenty-four topics that might be considered useful to the OFP officer but are not generally included in ocean engineering curriculum. Examples are "Financial Management" and "Composites." The twenty-four topics were grouped into twelve topical areas as indicated in Exhibit 14. The purpose of this survey section was to determine a hierarchy of non-ocean engineering skills useful to the OFP officer. Exhibit 15 provides a summary of entry-level responses to this section of the survey. It includes the relative rank of the topical areas, means of the topical areas, and general comments regarding relatively high- or low- scoring sub-topics. Exhibit 16 provides a similar summary of the entire respondent group.

Exhibit 14.
Collection of Nontraditional Topics Into Topical Areas.

#1. Construction Management
- Construction practices
- Construction scheduling
- Construction resources
- International construction contracting
- Construction engineering management
- Construction law

#2. Composites
- Principles of composite materials
- Testing composite materials
- Designing with composite materials

#3. Human Engineering
- Engineering man-machine interfaces
- Human factors engineering

#4. Math Applications
- Engineering data analysis
- Statistics in research
- Methods in time-series analysis

#5. Systems Design
- Preliminary system design
- Computer-aided design
- Safety engineering in facilities design

#6. Power Systems

#7. Financial Management

#8. Professional Engineering Ethics and Practice

#9. Environmental Control of Oil and Hazardous Materials

#10. Geotechnical Site Investigation

#11. Mechanical Vibrations

#12. Ocean Research and Operational Techniques

Exhibit 15.
Response Summary of Nontraditional Topics for Entry-Level Officers.

Rank	Mean	Nontraditional Topic	Sub-Topic Comments
1.	3.19	#1 (Construction Management)	"International construction contracting" mean = 2.58
2.	3.17	#7 (Financial Management)	
3.	3.17	#12 (Ocean Research and Operational Techniques)	
4.	3.08	#8 (Professional Engineering Ethics and Practice)	
5.	3.08	#10 (Geotechnical Site Investigation)	
6.	3.08	#6 (Mechanical Vibrations)	
7.	2.97	#5 (Systems Design)	"Preliminary system design" mean = 2.83 "Computer-aided design" mean = 3.00 "Safety engineering in design" mean = 3.08
8.	2.92	#4 (Math Applications)	"Methods in time-series analysis" mean = 2.58 "Statistics in research" mean = 3.17 "Engineering data analysis" mean = 3.00
9.	2.83	#9 (Environmental Control of Oil and HazMats)	
10.	2.79	#3 (Human Engineering)	
11.	2.67	#6 (Power Systems)	
12.	2.53	#2 (Composites)	

Exhibit 16.

Response Summary of Nontraditional Topics for All OFP Officers.

Rank	Mean	Nontraditional Topic	Sub-Topic Comments
1	3.40	#7 (Financial Management)	
2.	3.32	#8 (Professional Engineering Ethics and Practice)	
3.	3.30	#1 (Construction Management)	"International construction contracting" mean = 2.68
4.	3.18	#10 (Geotechnical Site Investigation)	
5.	3.11	#9 (Environmental Control of Oil and HazMats)	
6.	3.07	#12 (Ocean Research and Operational Techniques)	
7.	3.05	#5 (Systems Design)	"Preliminary system design" mean = 2.93
8.	2.99	#4 (Math Applications)	"Methods in time-series analysis" mean = 2.64 "Statistics in research" mean = 3.00 "Engineering data analysis" mean = 3.32.
9.	2.82	#3 (Human Engineering)	
10.	2.82	#6 (Mechanical Vibrations)	
11.	2.68	#2 (Composites)	
12.	2.64	#6 (Power Systems)	

5. Section V: Unsolicited Customer Requirements. The purpose of this section of the survey was to determine any skills required of the OFP officer that may not have been already addressed. A summary of responses to this section is given in Exhibit 17. The responses range from TQL (for total quality leadership, the Navy's quality management initiative) to instrumentation engineering. The responses include topics consistent with the higher ranking topical areas from survey sections two, three, and four. Furthermore, it includes significant emphasis on both a familiarity with practical applications and leadership and management. It also includes skills that cannot be provided by graduate institutions such as Navy manning practices. One respondent wrote :

> "The OFP officer must be a technically competent manager who can translate fleet requirements to engineering/research requirements and vice versa; manage a project timely, within budget, and to meet mission requirements; be able to relate to the unique circumstances of the underwater environment; and develop sound engineering solutions to engineering problems."

Exhibit 17.
<u>Response Summary of Unsolicited Customer Requirements.</u>

- Better working knowledge of gadget/technical components engineering
- Focus on unique skills a CEC officer can bring to Ocean Engineering: ocean construction, shore-based hyperbaric facilities, mooring/cables/pipeline systems, seafloor interaction
- TQL (The Navy's quality management initiative)
- Organizational dynamics (leadership)
- Oral and written communications
- Navy manning practices
- Navy PPBS
- Networking
- Experience!!
- <u>All</u> CEC officers should receive some training in shorefront facility maintenance.
- Underwater acoustics: signal processing methods
- Finance
- Hyperbaric design, operation and maintenance
- Personnel management
- Practical engineering solutions geared toward logistics in the ocean engineering environment
- Safety and certification
- "No failure" engineering

6. Section IV: CEC Ocean Engineer Opinions. The purpose of this section of the survey was to query the OFP officer on any topic or issue regarding the graduate education process that may not have been addressed. A summary of the responses to this section is provided as

Exhibit 18. Some of the more notable responses include the requirement for the OFP officer to possess a basic understanding of many different topics as opposed to specializing in one topic, the necessity to maintain physical readiness throughout graduate school in order to pass the rigorous physical entrance exam to dive school, and advice that students find a topic for research quickly given the short time provided to complete the master's degree.

Exhibit 18.
Response Summary of CEC Ocean Engineer Opinions.

- Attend graduate school with other OFP students
- Students should be visited by officers already in the OFP
- Students should attend the OFP conference.
- OFP officers need a basic understanding of many different topics; therefore, students should expose themselves to as broad a spectrum as possible and can learn the details later if and when required.
- Keep masters degrees practical; theory is for PhDs
- Don't go to dive school unprepared for the physical readiness test!
- Consult local ...[NAVFAC commands/offices]... for projects
- Draw on a range of universities to improve diversity and educational backgrounds
- Expect increase in harbor facilities maintenance and repair and support of amphibious operations
- Find a major professor and a small project with a well defined scope early
- Universities need to better explain degree and project requirements.
- Value added in combining other curriculums with OE (geotechnical, environmental)
- MBA or Communications courses may have been a better choice.
- Math learned was never used and skills are now lost.
- OE students should pass the PE while at graduate school.
- Graduate school is designed to gain/refine OE skills, management can be learned on the job.
- Students need to become conversant with design engineers and the fleet and be capable of conducting a "sanity check" on proposals.
- Need to include Underwater Construction Team Basic or an underwater construction course from Naval Construction Training Center with the training process
- Haven't solved an equation since I left graduate school
- Need ocean as well as construction courses and that is why UCal Berkeley is perfect: too bad for controlled enrollment
- It is best to have a good knowledge of many things rather than an outstanding knowledge of only a few things.
- Most of a career is spent on project management as opposed to actual engineering
- Most of our focus is on repair/maintenance of existing facilities and little/none on design of new and offshore: due to the effects of wave action/currents/corrosion
- For LTjg's and Ensigns in early dive billets, it would be better to send them to dive school first and graduate school after completion of their first tour.
- The fear of specializing prevents us from being true specialists!

C. Analysis of Results. The results of survey sections I, V, and VI leave little room for analysis. Pertinent discussions are included with the conclusions of the report. The results of survey sections II, III, and IV require some discussion before presenting the final conclusions. The analysis is divided into two subsections: the first addresses the responses from the entry-level officers and the second addresses the responses of all OFP officers.

1. As stated earlier, a "cutoff" was established in that skills for consideration in the system design requirements should have a mean of at least 3.00. This is one way of making the best of an alresdy compressed process. Lowering the cutoff increases the quantity of skills for inclusiion in the system design requirements and raising the cutoff decreases that quantity. The cutoff of 3.00 was arrived at iteratively. Another investigator might have reason to raise or lower the cutoff and arrive at a different solution.

With a cutoff of 3.00, twenty-one topical areas and numerous sub-topics are presented for consideration. But some topical areas and sub-topics can be combined while others can be eliminated for duplication. It is during this phase that judgemental decisions can influence the process more than any other phase and the investigator has endeavored to be completely objective; nevertheless, it is conceivable that another investigator might develop different system design requirements.

For example, ESR #1 can be divided into one section concerning measurement of environmental effects which can then be combined with ESR #5 which emphasizes oceanography, a topic which is greatly concerned with environmental measurements. The second section of ESR #1 concerns the ability to apply environmental effects to the design of flexible and rigid structures which can be combined with coastal engineering and design of ocean facilities topics.

ESR #9 is composed of seven distinctly different ocean engineering topics and it appears to be a "catch-all" ESR. Naval architecture, hyperbarics design, and instrumentation engineering topics can all be eliminated with means less than 3.00. Acoustics can be combined with the same general topic from survey section III. Project management can be combined with the construction management topics in survey section IV. Marine engineering can be combined with coastal engineering and/or design of ocean facilities topics. And systems engineering remains as a solitary topic.

General topic #3, coastal engineering, can be combined with identical topic ESR #6.

General topic #1, underwater acoustics, has a mean less than 3.00. But if sub-topic regarding the design and prediction of SONAR systems is discounted with a mean of 2.58, the topic mean is very close to 3.00 and should be included with the system design requirements. A similar analysis can be made for general topic #8 regarding wave mechanics in that, if the subtopics regarding nonlinear wave theories and wave spectral analysis are discounted, the topic mean is very close to 3.00.

Nontraditional topics #7 and #10 are duplications of ESRs #11 and #3, respectively, and can be eliminated.

The remaining skills can then be arrayed as shown in Exhibit 19. Exhibit 19 presents twenty-one skills in descending order of priority and, thus, summarizes the system design requirements for a graduate education system designed to meet the needs and expectations of the customers served by entry-level officers. Exhibit 19 also provides one recommended solution for satisfying the system design requirements. A total of fifteen topics are presented for completion during graduate school and one solution would be to require that the first nine be met and give the officer the choice of completing at least three of the remaining six. Ten of the twelve current ESRs are represented in this solution suggesting that they are serving well.

2. Nearly identical comments can be made for the analysis of the entire respondent group. Similarly, a cutoff of 3.00 was established resulting in twenty-five topical areas and five subtopical areas for consideration in the system design requirements. Topical areas can be manipulated the same as for the entry-level respondent group. The only significant changes are more topics to be considered for inclusion in the system design requirements and the topic means are higher than those for the entry-level respondent group.

The skills are arrayed in Exhibit 20. Exhibit 20 presents twenty-seven skills in descending order of priority and, thus, summarizes the system design requirements for a graduate education system designed to meet the graduate education skills required of OFP officers. Exhibit 20 also provides one recommended solution for satisfying the system design requirements. A total of seventeen topics are presented for completion during graduate school and one solution would be to require that the first seven be met and give the officer the choice of completing at least five of the remaining ten. All twelve of the current ESRs are represented in this solution suggesting that they are serving well.

Exhibit 19.
System Design Requirements for Entry-Level Officers.

A. Requirements are presented in decreasing order of priority based on the topic/sub-topic mean.
B. Refer to Exhibits 10,12, and 15 if additional topics are required.
C. Current ESRs 2, 10, and sub-topics of 9 are excluded from these requirements.
D. "Coursework" indicates that the requirement should be met by completing a specific course.
E. "Satisfied in general coursework" indicates that the requirement can be met without completing a specific course.

Priority	Requirement	Recommended Solution
1.	ESR #12, Communications	Coursework.
2.	ESR #4, Corrosion	Coursework.
3.	GT #3, Life Support and Diving Technology	Satisfy at basic diving officer training.
4.	ESR #8, Ocean Construction Practices	NCTC Port Hueneme.
5.	GT #3, Design of Ocean Facilities	Coursework.
6.	NTT #1, Construction Management	Coursework
7.	ESR #11, Financial Management	Coursework.
8.	NTT #8, Ocean Research and Operational Techniques	Coursework.
9.	ESR #3, Seafloor Geotechnics	Coursework
10.	ESR #6, Coastal Engineering	Coursework.
11.	NTT #4, Statistics in Research	Satisfied in general coursework.
12.	ESR #5, Oceanography	Coursework.
13.	NTT #8, Professional Engineering Ethics and Practice	Coursework.
14.	NTT #6, Mechanical Vibrations	Could be included with coursework in design of ocean facilities.
15.	GT #1, Underwater Acoustics	Coursework.
16.	GT #8, Wave Mechanics	Coursework.
17.	ESR #7, Hydromechanics	Coursework.
18.	NTT #4, Engineering Data Analysis	Satisfied in general coursework.
19.	NTT #5, Computer Aided Design	Satisfied in general coursework.
20.	ESR #9, Systems Engineering	Coursework.
21.	GT #14, Marine Foundation Engineering	Coursework.

Exhibit 20.

System Design Requirements for All OFP Officers.

A. Requirements are presented in decreasing order of priority based on the topic/sub-topic mean.
B. Refer to Exhibits 11, 13, and 16 if additional topics are required.
C. All of the current ESRs are represented although some sub-topics are excluded.
D. "Coursework" indicates that the requirement should be met by completing a specific course.
E. "Satisfied in general coursework" indicates that the requirement can be met without completing a specific course.

PriotityRequirement	Recommended Solution
1. ESR #12, Communications	Coursework.
2. ESR #8, Ocear · ˜onstruction Practices	NCTC Port Hueneme.
3. ESR #4, Corrosion	Coursework.
4. GT #3, Design of Ocean Facilities	Coursework.
5. ESR #11, Financial Management	Coursework.
6. GT #3, Life Support and Diving Technology	Satisfy at basic diving officer training.
7. NTT #8, Professional Engineering Ethics and Practice	Coursework.
8. NTT #4, Engineering Data Analysis	Satisfied in general coursework.
9. NTT #1, Construction Management	Coursework
10. ESR #3, Seafloor Geotechnics	Coursework
11. GT #14, Marine Foundation Engineering	Coursework.
12. ESR #6, Coastal Engineering	Coursework.
13. ESR #9, Systems Engineering	Coursework.
14. ESR #7, Hydromechanics	Coursework.
15. NTT #5, Safety Engineering in Design	Could be included with coursework in design of systems engineering
16. GT #6, Ocean Vehicle Dynamics	Coursework.
17. GT #8, Wave Mechanics	Coursework.
18. NTT #9, Environmental Control of Oil and and Hazardous Materials	Civil Engineer CorpsOfficer School
19. GT #10, Dynamics of Offshore Facilities	Coursework.
20. NTT #5, Computer Aided Design	Satisfied in general coursework.
21. NTT #8, Ocean Research and Operational Techniques	Coursework.
22. ESR #10, Data Processing	Satisfied in general coursework.
23. ESR #9, Hyperbarics design	Self-study.
24. ESR #2, Fatigue/fracture mechanics	Could be included with coursework in design/dynamics of ocean facilities.
25. GT #1, Underwater Acoustics	Coursework.
26. ESR #5, Oceanography	Coursework.
27. NTT #4, Statistics in Research	Satisfied in general coursework.

CONCLUSIONS

1. CEC OFP officers practice in a broad field of ocean engineering. This should preclude specialization by a student in any one topical area in favor of a system designed for exposure to as many topical areas as possible within prescribed limits. Furthermore, this should quell any suspicion that OFP officers should pursue Construction Management/Engineering degrees.

2. The current ESRs do not entirely provide OFP officers with the skills necessary to meet or exceed the needs and expectations of OFP customers in the foreseeable future. First, they are not prioritized. In the event an officer has to choose between satisfying one of two skills because of schedule conflicts for example, the choice cannot be made based on a hierarchy of the skills. Second, they exclude topics shown to provide necessary skills. Professional engineering ethics and practice, ocean research and operational techniques, and diving physiology are examples of skills found to be important to both respondent groups and are not addressed by the current ESRs. Last, they include skills shown to be of lesser priority. Measurement of seismic activity, principles of naval architecture, and biological and chemical oceanography are examples of skills found to be of lesser importance to both respondent groups and are addressed by the current ESRs. This is not to say that the current ESRs are ineffective. Of the twelve current ESRs, ten encompass a majority of the skills that entry-level officers require and all encompass a majority of the skills that all OFP officers require. However, improvements to the current ESRs could be made in an effort to better meet the needs and expectations of OFP customers.

3. OFP officers should complete graduate school before attending basic diving officer training, extenuating circumstances aside. The majority of OFP assignments require an ocean engineer who can dive rather than a diver who is also an ocean engineer. Some circumstances to the contrary include officers entering the OFP with a predetermined assignment to a billet that primarily requires diving skills, and officers that are out of cycle (for whatever reason) such that time would be better spent at dive school rather than waiting six months for a fall graduate school assignment.

4. Students experience unnecessary difficulty in arriving at a research/report topic. This is based on the responses to the survey indicating that nearly one-third (eight) of the respondents had great difficulty arriving at a topic.

5. Students should not conduct their research at a federal research facility such as Navy Research Lab, Waterways Experiment Station, Navy Experimental Dive Unit, etc. unless the Navy is willing to invest the inevitable additional time and money necessary to meet the logistical requirements of such a venture. Due to the number of positive responses to this proposal (twelve or nearly forty percent), however, it might be worthwhile to look at assignment to such a facility as a follow-on assignment out of graduate school (i.e., an entry-level assignment).

RECOMMENDATIONS

1. Revise the OFP ESRs. If the focus of graduate education is to satisfy the needs of the customers that will be served by entry-level officers, then institute the system design requirements of Exhibit 19. Otherwise, institute the system design requirements on Exhibit 20. It is the writer's opinion that if one embraces the principles of quality management, then one must also commit to long-term objectives. Therefore, Exhibit 21 (which follows) is a proposed revision to the current ESRs. It includes the hierarchy of skills developed in this report and excludes sub-topics from the current ESRs found to be of lesser importance. Note that the proposed changes to the current ESRs also do not satisfy all the skills required. We have seen that it is not possible in four semesters to meet all skill requirements and a cutoff was established at 3.00. Topics and sub-topics with means less than the cutoff were excluded from the ESRs in order to arrive at a list of skills that could reasonably be met in four semesters of graduate study.

   An alternative worth considering is developing a system designed to satisfy the needs and of the advanced OFP officers (i.e., those who are not entry-level officers). This would require a true commitment to the future. A system for advanced officers could be developed with the data provided in this report. The only reason it has not been considered in this report is that the idea of designing a graduate education system to satisfy customer needs four to six years after completion of graduate studies did not appear desirable at the onset of this investigation.

2. Continue with the practice of sending future OFP officers first to graduate school and subsequently to dive school except as indicated by unusual circumstances.

3. Do not send officers to a research facility to complete their research/project. However, enough positive interest was expressed that this venture should not be completely disregarded. In the event the time and money can be allotted and specific criteria can be established, it could prove beneficial to both the officer and the Navy.

4. Develop a program that will assist the officer in arriving at a meaningful research/report topic in an expeditious manner. Such a program does exist in general for all CEC officers in graduate school regardless of degree specialty. But the responses suggest that more assistance is needed.

5. Periodically continue the process of updating customer requirements. Perhaps a fixed interval of 2-3 years could be established or as significant events dictate.

Exhibit 21.

Proposed ESRs for OFP Officers.

ESR #1. Proficiency in oral and written communications and the ability to identify, research, and recommend alternatives to various engineering problems for presentation to both technical and non-technical managers. A thesis or major report is required to satisfy the latter half of this requirement. The topic selected must be applicable to ocean engineering problems found in the Navy or extend knowledge in a particular engineering area.

ESR #2. Understanding the types of marine materials, their engineering properties, principles of corrosion, and the techniques of cathodic protection for ocean facilities.

ESR #3. Understanding of ocean facilities design including design of structures, equipment, and systems for the ocean; environmental, logistical, and reliability requirements; safety engineering in facilities design; application of the principles of fatigue and fracture mechanics; and a familiarity with computer-aided design.

ESR #4. Understanding of and ability to apply business and financial accounting principles. Preference is for a business school elective for this requirement.

ESR #5. Basic understanding of professional engineering ethics and practices including value judgments, risk assessment, and ethical considerations related to engineering decisions.

ESR #6. Understanding of ocean construction practices, resources, scheduling, engineering management, and law including methods and limitations of working in the offshore environment on fixed and floating facilities, pipelines, cables, and mooring systems.

ESR #7. Basic understanding of seafloor sediment and rock including types and properties, site investigation, sampling, and testing.

ESR #8. Basic understanding of marine foundation engineering and the ability to use this knowledge to conduct settlement and bearing capacity analysis of off-shore locations, determine facility and foundation anchoring requirements, conduct pile driving analysis, and conduct analysis of axially and laterally-loaded piles and sheet piles.

ESR #9. Basic understanding of coastal processes including shallow water wave theory, storm surge, tides, and other physical factors which affect the static and dynamic coastal geomorphology and sediment transport. Basic understanding of coastal engineering including: the environmental effects of wind, currents, and waves on coastal facilities; design of breakwaters and jetties, design of harbors and ship channels; diffusion and spreading of pollutant discharge; and oil spill and pollutant containment and collection

Exhibit 21. (continued)

ESR #10. Basic understanding of systems engineering including systematic approaches for the application of technology to engineering requirements and the planning, organization, development, and management of highly complex systems.

ESR #11. Basic understanding of hydromechanics including fluid flow behavior and resistance determination.

ESR #12. Basic understanding of dynamics of ocean vehicles including stability and motion of immersed and floating vehicles, maneuverability and control, behavior of facilities in waves, and design considerations leading to motion reduction.

ESR #13. Basic understanding of ocean wave mechanics including the application of wave theory to engineering problems, linear wave theories, and wave properties in shoaling waters.

ESR #14. Basic understanding of dynamics of offshore facilities including structural dynamics for time and frequency domain simulations, wind and current interaction, wave forces, and functional design of offshore facilities.

ESR #15. Basic understanding of ocean research and operational techniques including technical, operational and legal aspects; planning and execution; and shipboard equipment parameters.

ESR #16. Basic understanding of underwater acoustics including propagation of underwater sound, acoustic transducers and arrays, and noise in the ocean environment.

ESR #17. Basic understanding of the classical branches of physical and geological oceanography including a thorough understanding of sea water properties, currents, tides, and meteorological conditions. Includes a basic understanding of contemporary measurement techniques for environmental parameters of wind, currents, and waves.

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Appendix A.
Educational Skill Requirements.

1. Ability to measure and apply the environmental effects of wind, current, waves, and seismic activity to the design of flexible and rigid structures.

2. Working knowledge of design methodologies for ocean structures, including finite element and difference models, modal analysis, and general quasi-static analysis. Application of the principles of fatigue and fracture mechanics to the design of ocean facilities.

3. Working knowledge of seafloor sediment and rock, including types and properties, sampling, and testing, and ability to use this knowledge to determine facility foundation and anchoring requirements.

4. Understanding of the types of marine materials, their engineering properties, principles of corrosion, and the techniques of cathodic protection for ocean facilities.

5. Working knowledge of the classical branches of physical, geological, biological, and chemical oceanography, including a thorough understanding of sea water properties, currents, tides, and meteorological conditions, and ability to predict operational and extreme environmental conditions through the application of advanced probability analysis of wave spectra and classical wave theories.

6. Understanding of coastal processes including shallow water wave theory, storm surge, tides, and other physical factors which affect the static and dynamic coastal geomorphology and sediment transport. Ability to determine the effect on structures, shore lines, and harbors.

7. Working knowledge of hydrodynamics including fluid flow behavior, resistance determination, and modeling facility behavior under scaled conditions.

8. Working knowledge of ocean construction practices including methods and limitations of working in the offshore environment on fixed and floating facilities, pipelines, cables, and mooring systems.

9. Basic knowledge of the principles of underwater acoustics, naval architecture, marine engineering, project and program management, systems engineering, hyperbarics design, and instrumentation engineering.

10. Basic understanding of data processing and compute: .-chniques for application to engineering problems encountered in work situations.

11. Working knowledge of and ability to apply business and financial accounting principles. Preference is for a business school elective for this requirement.

12. Proficiency in oral and written communications and ability to identify, research, and recommend alternatives to various engineering problems for presentation to both technical and non-technical managers.

13. A thesis or major report is required for the degree. The topic selected must be applicable to ocean engineering principles found in the Navy or extend knowledge in a particular technical engineering area.

Engle (1992)

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
200 STOVALL STREET
ALEXANDRIA, VA 22332-2300

IN REPLY REFER TO

01 Jul 93

FIRST ENDORSEMENT on LT Oster memo of 28 Jun 93

From: CAPT A. M. Parisi, CEC, USN
To: Ocean Facilities Program Officers

Subj: OCEAN FACILITIES PROGRAM GRADUATE EDUCATION QUESTIONNAIRE

1. We normally review the Educational Skill Requirements on a regular basis by asking you what you think of them and what changes you would make. Bill Oster is taking a TQL approach which will give us a much better insight on post graduate education.

2. Please take a few minutes from your busy schedule to complete the questionnaire and return it to Bill. Your effort will help us improve the products and services we provide to our customers.

A. M. PARISI
Assistant Commander
for Ocean Facilities

Copy to:
LT Oster

MEMORANDUM 28Jun93

From: LT(SCW) W. A. Oster, Ocean Engineering Graduate Student, Civil Engineering Department, Texas A&M University, College Station, TX 77843
To: Ocean Facilities Program Officers
Via: CAPT A. M. Parisi, Assistant Commander for Ocean Facilities, NAVFACENGCOM

Subj: OCEAN FACILITIES PROGRAM GRADUATE EDUCATION QUESTIONNAIRE

Encl: (1) Questionnaire

1. My project is entitled, "A Quality Management Evaluation of the Graduate Education Process for Ocean Engineers in the U. S. Navy." It involves identifying the future needs of the Ocean Facilities Program and developing a system that provides future OFP officers with the skills to satisfy those needs. Throughout the evaluation, a quality management tool known as quality function deployment (QFD) will be used to focus on "customers" of the process (those impacted by it) and to prioritize the system requirements and meet customer needs and expectations. I have developed the enclosed questionnaire and ask that you complete it and return it to me at the above address not later than 30 July so that I can complete my project. (The questionnaire should take about 40 minutes to complete.)

2. Similar evaluations have been done in the past in updating and validating the educational skill requirements (ESRs) for ocean engineers in the CEC. In this instance, a quality management approach will be used to evaluate the entire graduate education process. The questionnaire is designed to obtain your input concerning those skills necessary for the performance of your duties in the foreseeable future. These skills will be accumulated, prioritized, and translated into a graduate education system designed to best meet the needs of our customers. Therefore, it is important to respond in consideration of your customers, those who directly benefit from your services and drive your workload. If you are not currently assigned to an operational billet (1103P-coded), then please complete the questionnaire with respect to your estimate of the skills required in the future based on your experience in the OFP.

3. I ask that you take care to distinguish those skills required of you from those skills required of your unit/staff. The difference needs to be clear to accurately develop a graduate education system for ocean engineers in the CEC.

4. The information gathered will be held in strict confidence and used solely for the project. Duplication on my behalf of any opinions you express will be without reference to their source. Your sincere responses are paramount in developing a graduate education process that will prepare OFP officers for the future.

5. I encourage you to retain a copy of your response for future reference and to call me if you have any questions. I can be reached at 409-845-0272(DWH) or -776-0096(AWH). I'll be very grateful for your assistance in this project.

W. A. Oster

OFP GRADUATE EDUCATION QUESTIONNAIRE

- The questionnaire is divided into six sections of different format. Some questions may seem redundant but subtle differences are important in analyzing the data.
- Please remember to focus on the skills required of your billet and to faithfully represent the needs of your customer(s).
- Please take the time for careful and deliberate answers and use additional sheets as necessary.

I. BACKGROUND INFORMATION

1. What degrees do you hold and from what schools?
   Degree University Discipline

2. To which billets in the ocean facilities program have you been assigned during your career?

3. Which did you complete first, graduate school or dive school?

4. Please comment briefly with regard to future OFP officers which school you think should be completed first and why.

5. What difficulty did you have in selecting a research topic for your master's degree?
   Great / Little / None

6. For what reason(s) did you choose your research topic?

7. What is your opinion of a graduate education process that would entail coursework at a university followed by research at a facility such as NCEL, WES, NEDU, NRL, etc.?

8. Please indicate which courses you have taken as a graduate student that you have found to be most beneficial to you as a CEC ocean engineer.

9. Please indicate which courses you would like to have taken (but did not) as a graduate student that you now realize would have been beneficial to you as a CEC ocean engineer.

10. Are you currently assigned to an 1103P-coded billet? Yes/No

The legend for the remainder of the questionnaire is:

No Opinion	None	Basic Understanding	Working Knowledge
1	2	3	4

Circle the number that you feel best represents the degree of aptitude required in the performance of your duties.

II. SKILLS ASSESSMENT/VALIDATION

- The following list of educational skills is presented for you to rank. Please evaluate with respect to your billet requirements in the foreseeable future.

1. Measurement of:
   a. wind 1 2 3 4
   b. currents 1 2 3 4
   c. waves 1 2 3 4
   d. seismic activity. 1 2 3 4

2. Application to the design of facilities of the environmental effects of:
   a. wind 1 2 3 4
   b. currents 1 2 3 4
   c. waves 1 2 3 4
   d. seismic activity. 1 2 3 4

3. Design methodologies for ocean facilities including:
   a. finite element models 1 2 3 4
   b. finite difference models 1 2 3 4
   c. modal analysis 1 2 3 4
   d. general quasi-static analysis. 1 2 3 4

4. The principles of fatigue mechanics applied to the design of ocean facilities. 1 2 3 4

5. Seafloor sediment and rock:
   a. types and properties 1 2 3 4
   b. sampling and testing. 1 2 3 4

6. Using seafloor geotechnical knowledge to determine facility foundation and/or anchoring requirements. 1 2 3 4

7. Types of marine materials and their engineering properties. 1 2 3 4

8. Principles of corrosion. 1 2 3 4

9. Techniques of cathodic protection for ocean facilities. 1 2 3 4

No Opinion	None	Basic Understanding	Working Knowledge
1	2	3	4

10. Oceanography:
    a. chemical 1 2 3 4
    b. biological 1 2 3 4
    c. physical 1 2 3 4
    d. geological. 1 2 3 4

11. Seawater properties. 1 2 3 4

12. Currents. 1 2 3 4

13. Tides. 1 2 3 4

14. Meteorological conditions. 1 2 3 4

15. Predicting operational and extreme environmental conditions through the application of advanced probability analysis to wave spectra and classical wave theory. 1 2 3 4

16. Coastal processes including:
    a. shallow water wave theory 1 2 3 4
    b. storm surge 1 2 3 4
    c. tides 1 2 3 4
    d. sediment transport. 1 2 3 4

17. Determining the effect on facilities, shorelines and harbors of:
    a. shallow water wave theory 1 2 3 4
    b. storm surge 1 2 3 4
    c. sediment transport. 1 2 3 4

18. Hydrodynamics. 1 2 3 4

19. Fluid flow under scaled conditions. 1 2 3 4

20. Ocean construction practices including methods and limitations of working in the offshore environment on:
    a. fixed facilities 1 2 3 4
    b. floating facilities 1 2 3 4
    c. pipelines 1 2 3 4
    d. cables 1 2 3 4
    e. mooring systems. 1 2 3 4

No Opinion	None	Basic Understanding	Working Knowledge
1	2	3	4

21. Principles of underwater acoustics. 1 2 3 4

22. Principles of naval architecture. 1 2 3 4

23. Principles of marine engineering. 1 2 3 4

24. Construction project/program management. 1 2 3 4

25. Systems engineering. 1 2 3 4

26. Hyperbaric design. 1 2 3 4

27. Instrumentation engineering. 1 2 3 4

28. Data processing and computer techniques with respect to engineering problems encountered in work situations. 1 2 3 4

29. Oral communications. 1 2 3 4

30. Written communications. 1 2 3 4

31. The application of engineering economics including:
    a. procurement and amortization of capital investments 1 2 3 4
    b. operations, maintenance and salvage costs 1 2 3 4
    c. benefit-cost analyses. 1 2 3 4

III. GENERAL TOPICS ANALYSIS

- Please assess the future requirement of the following topics and sub-topics.

1. Underwater acoustics:
    a. propagation of underwater sound 1 2 3 4
    b. acoustic transducers and arrays 1 2 3 4
    c. noise in the ocean environment 1 2 3 4
    d. design and prediction of sonar systems. 1 2 3 4

2. Principles of naval architecture:
    a. ship geometry and hydrostatics 1 2 3 4
    b. load line and classification systems 1 2 3 4
    c. concept of intact and damaged stability 1 2 3 4
    d. resistance and propulsion of waterborne craft. 1 2 3 4

No Opinion	None	Basic Understanding	Working Knowledge
1	2	3	4

3. Design of ocean facilities:
   a. design of structures, equipment and systems for the ocean 1 2 3 4
   b. environmental requirements 1 2 3 4
   c. logistical requirements 1 2 3 4
   d. reliability requirements. 1 2 3 4

4. Life support and diving technology:
   a. behavior of compressed gases 1 2 3 4
   b. diving physiology 1 2 3 4
   c. breathing apparatus design 1 2 3 4
   d. decompression theory 1 2 3 4
   e. hyperbaric facility design 1 2 3 4
   f. pressure vessel design 1 2 3 4
   g. remotely operated vehicles. 1 2 3 4

5. Arctic offshore engineering:
   a. sea ice formation and properties 1 2 3 4 5
   b. sea ice mechanics and forces 1 2 3 4
   c. application to design. 1 2 3 4 5

6. Dynamics of ocean vehicles:
   a. stability and motion of immersed and floating vehicles 1 2 3 4
   b. maneuverability and control 1 2 3 4
   c. behavior of facilities in waves 1 2 3 4
   d. design considerations leading to motion reduction. 1 2 3 4

7. Dynamics of fluid-solid interaction:
   a. hydroelasticity 1 2 3 4
   b. hydrostatic divergence 1 2 3 4
   c. flow-induced vibrations and instability 1 2 3 4
   d. compliant surfaces. 1 2 3 4

8. Ocean wave mechanics:
   a. application of wave theory to engineering problems 1 2 3 4
   b. linear wave theories 1 2 3 4
   c. nonlinear wave theories 1 2 3 4
   d. wave properties in shoaling waters 1 2 3 4
   e. wave spectral analysis 1 2 3 4

No Opinion	None	Basic Understanding	Working Knowledge
1	2	3	4

9. Coastal engineering:
   a. effects of waves on coastal facilities 1 2 3 4
   b. design of breakwaters/jetties 1 2 3 4
   c. design of harbors/ship channels 1 2 3 4
   d. diffusion/spreading of pollutant discharge 1 2 3 4
   e. wave forecasting 1 2 3 4
   f. oil spill/pollutant containment/collection. 1 2 3 4

10. Dynamics of offshore facilities:
   a. structural dynamics for time and frequency domain simulations 1 2 3 4
   b. wind and current interaction 1 2 3 4
   c. wave forces 1 2 3 4
   d. functional design of offshore facilities. 1 2 3 4

11. Hydromechanics:
   a. general conservation laws (Euler, Navier-Stokes) 1 2 3 4
   b. potential flow 1 2 3 4
   c. flow past a body of any shape 1 2 3 4
   d. lift for a slender body 1 2 3 4
   e. source and vortex distribution 1 2 3 4
   f. boundary layer theory 1 2 3 4
   g. viscous flow. 1 2 3 4

12. Coastal sediment processes:
   a. sediment properties and size distributions 1 2 3 4
   b. fluvial sediment transport equations 1 2 3 4
   c. movement of material by the sea 1 2 3 4
   d. littoral drift 1 2 3 4
   e. inlet stability 1 2 3 4
   f. moveable bed models 1 2 3 4
   g. sediment tracing. 1 2 3 4

13. Estuary hydrodynamics:
   a. tidal dynamics for estuaries 1 2 3 4
   b. determination of mean velocities in estuaries 1 2 3 4
   c. determination of circulation patterns. 1 2 3 4

14. Marine foundation engineering:
   a. settlement and bearing capacity analysis of off-shore locations 1 2 3 4
   b. pile driving analysis 1 2 3 4
   c. analysis of axially- and laterally-loaded piles and sheet piles. 1 2 3 4

No Opinion	None	Basic Understanding	Working Knowledge
1	2	3	4

15. Marine dredging:
   a. dredge pump selection 1 2 3 4
   b. pump and system characteristics 1 2 3 4
   c. types of dredges and dredging equipment 1 2 3 4
   d. deep ocean dredging 1 2 3 4
   e. design of disposal methods for dredged material 1 2 3 4
   f. environmental effects of dredging 1 2 3 4
   g. sediment transport in pipes. 1 2 3 4

16. Computational fluid mechanics. 1 2 3 4

17. Fluid mechanic modeling. 1 2 3 4

IV. NON-TRADITIONAL TOPICS ANALYSIS

- Please evaluate as in sections II and III above.

1. Preliminary system design. 1 2 3 4

2. Computer-aided design. 1 2 3 4

3. Professional engineering ethics and practice. 1 2 3 4

4. Construction practices. 1 2 3 4

5. Construction scheduling. 1 2 3 4

6. Construction resources. 1 2 3 4

7. International construction contracting. 1 2 3 4

8. Principles of composite materials. 1 2 3 4

9. Testing composite materials. 1 2 3 4

10. Power systems. 1 2 3 4

11. Financial management. 1 2 3 4

12. Engineering data analysis. 1 2 3 4

No Opinion	None	Basic Understanding	Working Knowledge
1	2	3	4

13. Environmental control of oil and hazardous materials. 1 2 3 4

14. Construction engineering management. 1 2 3 4

15. Geotechnical site investigation. 1 2 3 4

16. Engineering man-machine interfaces. 1 2 3 4

17. Human factors engineering. 1 2 3 4

18. Mechanical vibrations. 1 2 3 4

19. Safety engineering in facilities design. 1 2 3 4

20. Ocean research and operational techniques. 1 2 3 4

21. Statistics in research. 1 2 3 4

22. Construction law. 1 2 3 4

23. Designing with composite materials. 1 2 3 4

24. Methods in time-series analysis. 1 2 3 4

V. UNSOLICITED CUSTOMER REQUIREMENTS

- This section is intended to be an unformatted deliberation of skills required by your primary customers that may not have been addressed in the previous sections. In addition, please indicate the level of proficiency required according to the legend.

VI. CEC OCEAN ENGINEER OPINIONS

- This final section is an opportunity for you to comment on any aspect of the graduate education process not addressed in this questionnaire or to elaborate on any of your above responses. The graduate education process, for this purpose, is defined as beginning with applications to universities through to completion of the master's degree.

Appendix C.
Responses to Survey Sections II, III, andIV.

Response column E indicates responses from entry-level officers.
Response column NE indicates responses from all other officers.
Entry Total Summary includes responses from entry-level officers only.
Entire Total Summary includes responses from all officers.

Section II.

		Response							
		1		2		3		4	
ESR	Ques	E	NE	E	NE	E	NE	E	NE
# 1	1a.	0	0	1	2	8	9	3	6
	1b.	0	0	1	1	4	7	7	9
	1c.	0	0	1	1	4	6	1	10
	1d.	3	3	4	7	5	5	0	2
	2a.	0	0	3	4	6	8	3	5
	2b.	0	0	1	2	5	5	6	10
	2c.	0	0	1	2	6	5	5	10
	2d.	2	0	4	6	5	7	1	4

Summary:	Entry	Total	318	Mean	3.06	Standard Deviation	0.47
	Entire	Total	751	Mean	3.12	Standard Deviation	0.43

		Response							
		1		2		3		4	
ESR	Ques	E	NE	E	NE	E	NE	E	NE
# 2	3a.	0	1	3	4	8	12	1	0
	3b.	1	2	4	5	7	10	0	0
	3c.	0	3	3	4	8	9	0	0
	3d.	1	3	3	4	7	8	1	2
	4.	1	0	2	1	6	13	3	3

Summary:	Entry	Total	174	Mean	2.72	Standard Deviation	0.17
	Entire	Total	395	Mean	2.67	Standard Deviation	0.22

Appendix C.
Responses to Survey Sections II, III, andIV.

Response column E indicates responses from entry-level officers.
Response column NE indicates responses from all other officers.
Entry Total Summary includes responses from entry-level officers only.
Entire Total Summary includes responses from all officers.

		Response							
		1		2		3		4	
ESR	Ques	E	NE	E	NE	E	NE	E	NE
# 3	5a.	1	0	1	2	7	9	3	6
	5b.	1	0	2	3	6	7	3	7
	6.	0	0	1	2	6	7	5	8

Summary:	Entry	Total	123	Mean	3.15	Standard Deviation	0.20
	Entire	Total	290	Mean	3.22	Standard Deviation	0.13

		Response							
		1		2		3		4	
ESR	Ques	E	NE	E	NE	E	NE	E	NE
# 4	7.	0	0	1	2	5	5	6	10
	8.	0	0	2	1	3	7	7	9
	9.	0	0	2	1	3	6	7	10

Summary:	Entry	Total	133	Mean	3.41	Standard Deviation	0.04
	Entire	Total	311	Mean	3.46	Standard Deviation	0.02

		Response							
		1		2		3		4	
ESR	Ques	E	NE	E	NE	E	NE	E	NE
# 5	10a.	0	0	7	5	4	10	1	2
	10b.	0	0	8	6	4	10	0	1
	10c.	0	0	2	1	7	10	3	6
	10d.	0	0	3	2	6	11	3	4
	11.	0	0	3	2	8	10	1	5
	12.	0	0	1	1	5	7	6	9
	13.	0	0	1	1	5	7	6	9
	14.	0	0	3	6	7	7	2	4
	15.	0	0	7	5	4	10	1	2

Summary:	Entry	Total	337	Mean	2.88	Standard Deviation	0.38
	Entire	Total	809	Mean	3.00	Standard Deviation	0.33

Appendix C.
Responses to Survey Sections II, III, andIV.

Response column E indicates responses from entry-level officers.
Response column NE indicates responses from all other officers.
Entry Total Summary includes responses from entry-level officers only.
Entire Total Summary includes responses from all officers.

		Response							
		1		2		3		4	
ESR	Ques	E	NE	E	NE	E	NE	E	NE
# 6	16a.	0	0	2	1	7	9	3	7
	16b.	0	0	3	3	8	10	1	4
	16c.	0	0	2	1	5	9	5	7
	17a.	1	0	2	1	6	11	3	5
	17b.	0	0	3	4	6	9	3	4
	17c.	0	0	2	2	6	7	4	8

Summary:	Entry	Total	282	Mean	3.10	Standard Deviation	0.15
	Entire	Total	665	Mean	3.17	Standard Deviation	0.13

		Response							
		1		2		3		4	
ESR	Ques	E	NE	E	NE	E	NE	E	NE
# 7	18.	0	0	1	1	9	10	2	6
	19.	0	3	7	4	5	8	0	2

Summary:	Entry	Total	71	Mean	2.73	Standard Deviation	0.38
	Entire	Total	170	Mean	2.83	Standard Deviation	0.47

		Response							
		1		2		3		4	
ESR	Ques	E	NE	E	NE	E	NE	E	NE
# 8	20a.	0	0	2	2	5	4	5	11
	20b.	0	0	1	0	5	6	6	11
	20c.	0	0	3	2	3	5	6	10
	20d.	0	0	2	1	3	4	7	12
	20e.	0	0	2	0	3	4	7	13

Summary:	Entry	Total	219	Mean	3.37	Standard Deviation	0.10
	Entire	Total	526	Mean	3.51	Standard Deviation	0.10

Appendix C.
Responses to Survey Sections II, III, andIV.

Response column E indicates responses from entry-level officers.
Response column NE indicates responses from all other officers.
Entry Total Summary includes responses from entry-level officers only.
Entire Total Summary includes responses from all officers.

		Response							
		1		2		3		4	
ESR	Ques	E	NE	E	NE	E	NE	E	NE
# 9	21.	0	0	3	4	7	9	2	4
	22.	1	1	4	2	6	13	1	1
	23.	0	0	2	2	8	13	2	2
	24.	0	0	2	1	2	2	7	14
	25.	1	0	3	1	4	10	4	6
	26.	1	0	4	2	5	8	2	7
	27.	1	1	2	4	7	8	2	4

Summary:	Entry	Total	268	Mean	2.95	Standard Deviation	0.28
	Entire	Total	643	Mean	3.06	Standard Deviation	0.29

		Response							
		1		2		3		4	
ESR	Ques	E	NE	E	NE	E	NE	E	NE
#10	28.	1	1	2	2	7	6	2	8

Summary:	Entry	Total	37	Mean	2.85	Standard Deviation	N/A
	Entire	Total	92	Mean	3.07	Standard Deviation	N/A

		Response							
		1		2		3		4	
ESR	Ques	E	NE	E	NE	E	NE	E	NE
#11		0	0	3	0	3	6	5	10

Summary:	Entry	Total	38	Mean	3.17	Standard Deviation	N/A
	Entire	Total	96	Mean	3.43	Standard Deviation	N/A

Appendix C.
Responses to Survey Sections II, III, andIV.

Response column E indicates responses from entry-level officers.
Response column NE indicates responses from all other officers.
Entry Total Summary includes responses from entry-level officers only.
Entire Total Summary includes responses from all officers.

		Response							
		1		2		3		4	
ESR	Ques	E	NE	E	NE	E	NE	E	NE
#12	29.	0	0	0	0	0	0	12	17
	30.	0	0	0	0	0	0	12	17
	31a.	0	0	2	2	7	7	3	8
	31b.	0	0	1	0	8	5	3	12
	31c.	0	0	2	1	7	4	3	12

Summary:	Entry	Total	228	Mean	3.51	Standard Deviation	0.45
	Entire	Total	546	Mean	3.57	Standard Deviation	0.40

Section III.

		Response							
		1		2		3		4	
GT	Ques	E	NE	E	NE	E	NE	E	NE
#1	1a.	0	0	3	3	6	7	2	6
	1b.	0	0	2	4	6	8	3	4
	1c.	0	0	4	4	5	7	2	5
	1d.	0	1	5	5	5	9	1	1

Summary:	Entry	Total	137	Mean	2.85	Standard Deviation	0.21
	Entire	Total	327	Mean	2.92	Standard Deviation	0.21

		Response							
		1		2		3		4	
GT	Ques	E	NE	E	NE	E	NE	E	NE
#2	2a.	0	0	6	4	5	8	0	4
	2b.	1	2	5	5	5	8	0	1
	2c.	1	0	4	3	6	9	0	4
	2d.	0	0	6	3	5	11	0	2

Summary:	Entry	Total	115	Mean	2.40	Standard Deviation	0.04
	Entire	Total	299	Mean	2.67	Standard Deviation	0.16

Appendix C.
Responses to Survey Sections II, III, andIV.

Response column E indicates responses from entry-level officers.
Response column NE indicates responses from all other officers.
Entry Total Summary includes responses from entry-level officers only.
Entire Total Summary includes responses from all officers.

		Response							
		1		2		3		4	
GT	Ques	E	NE	E	NE	E	NE	E	NE
#3	3a.	0	0	1	1	6	3	4	12
	3b.	1	0	1	0	6	4	3	12
	3c.	1	0	1	0	5	6	4	10
	3d.	1	0	1	1	5	5	4	10

Summary:	Entry	Total	153	Mean	3.19	Standard Deviation	0.10
	Entire	Total	387	Mean	3.46	Standard Deviation	0.06

		Response							
		1		2		3		4	
GT	Ques	E	NE	E	NE	E	NE	E	NE
#4	4a.	0	0	2	0	4	3	5	13
	4b.	0	0	2	0	3	2	6	14
	4c.	0	0	3	0	4	9	4	7
	4d.	0	0	2	0	4	4	5	12
	4e.	0	0	2	0	5	10	4	6
	4f.	0	0	2	0	6	10	3	6
	4g.	0	0	2	1	7	8	2	7

Summary:	Entry	Total	273	Mean	3.25	Standard Deviation	0.12
	Entire	Total	673	Mean	3.43	Standard Deviation	0.18

		Response							
		1		2		3		4	
GT	Ques	E	NE	E	NE	E	NE	E	NE
#5	5a.	0	0	6	2	3	13	0	1
	5b.	0	0	4	1	7	13	0	2
	5c.	0	0	6	3	5	9	0	4

Summary:	Entry	Total	92	Mean	2.56	Standard Deviation	0.10
	Entire	Total	237	Mean	2.82	Standard Deviation	0.07

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Responses to Survey Sections II, III, andIV.

Response column E indicates responses from entry-level officers.
Response column NE indicates responses from all other officers.
Entry Total Summary includes responses from entry-level officers only.
Entire Total Summary includes responses from all officers.

		Response							
		1		2		3		4	
GT	Ques	E	NE	E	NE	E	NE	E	NE
#6	6a.	0	1	3	1	7	7	1	7
	6b.	0	1	3	2	7	6	1	7
	6c.	0	0	2	1	7	7	2	8
	6d.	0	1	3	1	6	7	2	7

Summary:	Entry	Total	139	Mean	2.90	Standard Deviation	0.08
	Entire	Total	351	Mean	3.13	Standard Deviation	0.13

		Response							
		1		2		3		4	
GT	Ques	E	NE	E	NE	E	NE	E	NE
#7	7a.	1	3	5	2	5	9	0	2
	7b.	1	4	6	2	4	8	0	2
	7c.	1	2	5	2	5	9	0	3
	7d.	0	3	6	3	5	8	0	2

Summary:	Entry	Total	114	Mean	2.38	Standard Deviation	0.08
	Entire	Total	282	Mean	2.52	Standard Deviation	0.07

		Response							
		1		2		3		4	
GT	Ques	E	NE	E	NE	E	NE	E	NE
#8	8a.	0	0	1	2	10	7	0	7
	8b.	0	0	2	3	8	9	1	4
	8c.	0	0	6	3	5	12	0	1
	8d.	0	0	1	3	8	6	2	7
	8e.	1	1	3	3	7	10	0	2

Summary:	Entry	Total	167	Mean	2.78	Standard Deviation	0.27
	Entire	Total	418	Mean	2.99	Standard Deviation	0.19

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Responses to Survey Sections II, III, andIV.

Response column E indicates responses from entry-level officers.
Response column NE indicates responses from all other officers.
Entry Total Summary includes responses from entry-level officers only.
Entire Total Summary includes responses from all officers.

		Response							
		1		2		3		4	
GT	Ques	E	NE	E	NE	E	NE	E	NE
#9	9a.	0	0	1	1	7	5	3	10
	9b.	0	0	2	3	5	8	4	5
	9c.	0	0	4	3	5	10	2	3
	9d.	0	0	4	1	6	10	1	5
	9e.	0	1	4	4	7	8	0	3
	9f.	0	0	2	2	9	9	0	5

Summary:	Entry	Total	215	Mean	2.99	Standard Deviation	0.21
	Entire	Total	518	Mean	3.09	Standard Deviation	0.21

		Response							
		1		2		3		4	
GT	Ques	E	NE	E	NE	E	NE	E	NE
#10	10a.	1	0	5	2	5	12	0	2
	10b.	1	0	3	2	7	6	0	8
	10c.	1	0	2	2	5	3	3	11
	10d.	0	0	1	1	8	8	2	7

Summary:	Entry	Total	132	Mean	2.75	Standard Deviation	0.30
	Entire	Total	345	Mean	3.08	Standard Deviation	0.25

		Response							
		1		2		3		4	
GT	Ques	E	NE	E	NE	E	NE	E	NE
#11	11a.	0	0	4	1	7	11	0	4
	11b.	1	0	5	1	5	13	0	2
	11c.	1	0	2	1	8	11	0	4
	11d.	1	1	5	3	5	10	0	2
	11e.	1	1	4	3	6	10	0	2
	11f.	1	0	5	3	5	11	0	2
	11g.	2	0	3	1	6	13	0	2

Summary:	Entry	Total	210	Mean	2.50	Standard Deviation	0.12
	Entire	Total	547	Mean	2.79	Standard Deviation	0.13

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Responses to Survey Sections II, III, andIV.

Response column E indicates responses from entry-level officers.
Response column NE indicates responses from all other officers.
Entry Total Summary includes responses from entry-level officers only.
Entire Total Summary includes responses from all officers.

		Response							
		1		2		3		4	
GT	Ques	E	NE	E	NE	E	NE	E	NE
#12	12a.	0	0	3	1	7	11	1	4
	12b.	2	2	6	3	3	10	0	1
	12c.	1	0	3	2	6	10	1	4
	12d.	1	0	4	3	5	10	1	3
	12e.	0	1	3	4	7	9	1	2
	12f.	2	3	6	3	3	8	0	2
	12g.	4	3	4	4	3	8	0	1

Summary:	Entry	Total	213	Mean	2.54	Standard Deviation	0.34
	Entire	Total	528	Mean	2.69	Standard Deviation	0.30

		Response							
		1		2		3		4	
GT	Ques	E	NE	E	NE	E	NE	E	NE
#13	13a.	2	1	2	4	6	10	1	1
	13b.	1	2	5	4	4	9	1	1
	13c.	1	1	4	4	5	10	1	1

Summary:	Entry	Total	92	Mean	2.56	Standard Deviation	0.05
	Entire	Total	219	Mean	2.61	Standard Deviation	0.06

		Response							
		1		2		3		4	
GT	Ques	E	NE	E	NE	E	NE	E	NE
#14	14a.	0	0	2	1	9	6	0	9
	14b.	0	0	2	2	7	6	2	8
	14c.	0	0	2	2	7	7	2	7

Summary:	Entry	Total	107	Mean	2.97	Standard Deviation	0.13
	Entire	Total	270	Mean	3.21	Standard Deviation	0.04

Appendix C.
Responses to Survey Sections II, III, andIV.

Response column E indicates responses from entry-level officers.
Response column NE indicates responses from all other officers.
Entry Total Summary includes responses from entry-level officers only.
Entire Total Summary includes responses from all officers.

		Response							
		1		2		3		4	
GT	Ques	E	NE	E	NE	E	NE	E	NE
#15	15a.	0	1	4	7	5	6	2	2
	15b.	0	2	4	6	5	7	2	1
	15c.	0	1	4	5	5	8	2	2
	15d.	0	1	7	10	4	4	0	1
	15e.	0	1	4	7	6	6	1	2
	15f.	0	1	4	5	6	6	1	4
	15g.	0	1	4	6	5	6	2	3

Summary:	Entry	Total	231	Mean	2.75	Standard Deviation	0.15
	Entire	Total	512	Mean	2.61	Standard Deviation	0.14

		Response							
		1		2		3		4	
GT	Ques	E	NE	E	NE	E	NE	E	NE
#16	16a.	1	2	6	3	4	10	0	1

Summary:	Entry	Total	29	Mean	2.42	Standard Deviation	N/A
	Entire	Total	71	Mean	2.54	Standard Deviation	N/A

		Response							
		1		2		3		4	
GT	Ques	E	NE	E	NE	E	NE	E	NE
#17	17a.	1	2	6	3	4	11	0	0

Summary:	Entry	Total	28	Mean	2.33	Standard Deviation	N/A
	Entire	Total	69	Mean	2.46	Standard Deviation	N/A

Appendix C.
Responses to Survey Sections II, III, andIV.

Response column E indicates responses from entry-level officers.
Response column NE indicates responses from all other officers.
Entry Total Summary includes responses from entry-level officers only.
Entire Total Summary includes responses from all officers.

Section IV.

		Response							
		1		2		3		4	
NTT	Ques	E	NE	E	NE	E	NE	E	NE
#1	4.	0	0	2	1	3	3	6	12
	5.	0	0	2	1	3	4	6	11
	6.	0	0	3	1	3	5	5	10
	7.	0	1	5	6	4	5	2	4
	14.	0	0	3	1	2	3	6	12
	22.	0	0	2	5	6	6	3	5

Summary:	Entry	Total	230	Mean	3.19	Standard Deviation	0.31
	Entire	Total	555	Mean	3.30	Standard Deviation	0.36

		Response							
		1		2		3		4	
NTT	Ques	E	NE	E	NE	E	NE	E	NE
#2	8.	1	1	3	2	7	10	0	3
	9.	1	3	3	2	7	10	0	1
	23.	1	0	6	3	4	12	0	1

Summary:	Entry	Total	91	Mean	2.53	Standard Deviation	0.17
	Entire	Total	225	Mean	2.68	Standard Deviation	0.13

		Response							
		1		2		3		4	
NTT	Ques	E	NE	E	NE	E	NE	E	NE
#3	16.	0	2	4	4	6	6	1	4
	17.	0	1	4	4	7	6	0	5

Summary:	Entry	Total	67	Mean	2.79	Standard Deviation	0.06
	Entire	Total	158	Mean	2.82	Standard Deviation	0.05

Appendix C.
Responses to Survey Sections II, III, andIV.

Response column E indicates responses from entry-level officers.
Response column NE indicates responses from all other officers.
Entry Total Summary includes responses from entry-level officers only.
Entire Total Summary includes responses from all officers.

		Response							
		1		2		3		4	
NTT	Ques	E	NE	E	NE	E	NE	E	NE
#4	12.	0	0	2	0	7	7	2	9
	21.	0	0	3	4	8	10	0	2
	24.	0	1	5	4	6	10	0	1

Summary: Entry Total 105 Mean 2.92 Standard Deviation 0.30
Entire Total 251 Mean 2.99 Standard Deviation 0.34

		Response							
		1		2		3		4	
NTT	Ques	E	NE	E	NE	E	NE	E	NE
#5	1.	1	1	3	0	5	13	2	2
	2.	0	0	2	0	7	14	2	2
	19.	0	1	2	1	6	8	3	6

Summary: Entry Total 107 Mean 2.97 Standard Deviation 0.13
Entire Total 256 Mean 3.05 Standard Deviation 0.11

		Response							
		1		2		3		4	
NTT	Ques	E	NE	E	NE	E	NE	E	NE
#6	10.	0	2	4	3	7	10	0	1

Summary: Entry Total 32 Mean 2.67 Standard Deviation N/A
Entire Total 74 Mean 2.64 Standard Deviation N/A

		Response							
		1		2		3		4	
NTT	Ques	E	NE	E	NE	E	NE	E	NE
#7	11.	0	0	3	0	3	6	5	10

Summary: Entry Total 38 Mean 3.17 Standard Deviation N/A
Entire Total 96 Mean 3.43 Standard Deviation N/A

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Responses to Survey Sections II, III, andIV.

Response column E indicates responses from entry-level officers.
Response column NE indicates responses from all other officers.
Entry Total Summary includes responses from entry-level officers only.
Entire Total Summary includes responses from all officers.

		Response							
		1		2		3		4	
NTT	Ques	E	NE	E	NE	E	NE	E	NE
#8	3.	0	0	4	3	3	2	4	11

Summary:	Entry	Total	37	Mean	3.08	Standard Deviation	N/A
	Entire	Total	93	Mean	3.32	Standard Deviation	N/A

		Response							
		1		2		3		4	
NTT	Ques	E	NE	E	NE	E	NE	E	NE
#9	13.	0	0	3	1	8	9	0	6

Summary:	Entry	Total	34	Mean	2.83	Standard Deviation	N/A
	Entire	Total	87	Mean	3.11	Standard Deviation	N/A

		Response							
		1		2		3		4	
NTT	Ques	E	NE	E	NE	E	NE	E	NE
#10	15.	0	0	2	2	7	8	2	6

Summary:	Entry	Total	37	Mean	3.08	Standard Deviation	N/A
	Entire	Total	89	Mean	3.18	Standard Deviation	N/A

		Response							
		1		2		3		4	
NTT	Ques	E	NE	E	NE	E	NE	E	NE
#11	18.	0	2	3	2	8	12	0	0

Summary:	Entry	Total	37	Mean	3.08	Standard Deviation	N/A
	Entire	Total	79	Mean	3.82	Standard Deviation	N/A

		Response							
		1		2		3		4	
NTT	Ques	E	NE	E	NE	E	NE	E	NE
#12	20.	0	1	3	1	8	11	0	3

Summary:	Entry	Total	38	Mean	3.17	Standard Deviation	N/A
	Entire	Total	86	Mean	3.07	Standard Deviation	N/A