NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

AN EXPLORATORY STUDY OF THE UNITED STATES NAVAL ACADEMY ENGINEERING CURRICULUM

by

Michael T. O'Reilly

June 2007

Thesis Co-Advisors: Susan P. Hocevar
Linda D. Mallory

Approved for Public release; distribution is unlimited.

THIS PAGE INTENTIONALLY LEFT BLANK

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington DC 20503.

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE June 2007	3. REPORT TYPE AND DATES COVERED Master's Thesis

4. TITLE AND SUBTITLE An Exploratory Study of the United States Naval Academy Engineering Curriculum	5. FUNDING NUMBERS
6. AUTHOR(S) Michael T. O'Reilly	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING /MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A	10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.	12b. DISTRIBUTION CODE

13. ABSTRACT (maximum 200 words)

The purpose of this study is to quantitatively assess Naval Academy graduates' perceptions of two aspects of their undergraduate education as engineering majors: 1) the extent to which their undergraduate education is relevant to their current profession, and 2) their level of preparedness as a result of their engineering education. The Accreditation Board of Engineering and Technology (ABET) identifies eleven 'student learning outcomes' that are utilized as the basis for assessing relevance and preparedness. Baseline data is established for engineering graduates of the Naval Academy between the years of 1985 – 2005. In addition to the general analysis, graduates are grouped for comparison and analysis according to status (civilian and military), job type (technical and non-technical) and according to their particular undergraduate majors. The results indicate high levels of both applicability and preparedness for most of the eleven skills. Recommendations for future engineering program improvements are offered.

14. SUBJECT TERMS Naval Academy; Engineering; Accreditation; ABET; Education	15. NUMBER OF PAGES 105
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL

NSN 7540-01-280-5500 Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18

THIS PAGE INTENTIONALLY LEFT BLANK

Approved for public release; distribution is unlimited.

AN EXPLORATORY STUDY OF THE UNITED STATES NAVAL ACADEMY ENGINEERING CURRICULUM

Michael T. O'Reilly
Lieutenant, United States Navy
B.S., United States Naval Academy, 2001

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN LEADERSHIP AND HUMAN RESOURCE DEVELOPMENT

from the

NAVAL POSTGRADUATE SCHOOL
June 2007

Author: Michael T. O'Reilly

Approved by: Dr. Susan P. Hocevar
Co-Advisor

Dr. Linda D. Mallory
Co-Advisor

Dr. Robert N. Beck
Dean, Graduate School of Business and Public Policy

THIS PAGE INTENTIONALLY LEFT BLANK

ABSTRACT

The purpose of this study is to quantitatively assess Naval Academy graduates' perceptions of two aspects of their undergraduate education as engineering majors: 1) the extent to which their undergraduate education is relevant to their current profession, and 2) their level of preparedness as a result of their engineering education. The Accreditation Board of Engineering and Technology (ABET) identifies eleven 'student learning outcomes' that are utilized as the basis for assessing relevance and preparedness. Baseline data is established for engineering graduates of the Naval Academy between the years of 1985 – 2005. In addition to the general analysis, graduates are grouped for comparison and analysis according to status (civilian and military), job type (technical and non-technical) and according to their particular undergraduate majors. The results indicate high levels of both applicability and preparedness for most of the eleven skills. Recommendations for future engineering program improvements are offered.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

I. INTRODUCTION 1
A. BACKGROUND 1
B. PURPOSE 1
C. RESEARCH QUESTIONS AND METHODOLOGY 2
D. BENEFITS OF THE STUDY 3
E. ORGANIZATION OF THE STUDY 4

II. LITERATURE REVIEW 5
A. INTRODUCTION 5
B. ABET HISTORY 5
C. DEVELOPMENT OF EC2000 6
D. PROGRAM OUTCOMES 8
E. CHOOSING OUTCOME INDICATORS 11
F. EVALUATION 14
G. BEST PRACTICES FOR SURVEY IMPLEMENTATION 17
H. ACCREDITATION AT OTHER INSTITUTIONS 19
I. OTHER METHODS OF EVALUATING LEARNING OUTCOMES 21
J. DESIGN TECHNIQUES FOR COURSES THAT SATISFY ABET ...22
K. ETHICS IN ENGINEERING EDUCATION 23
L. SUMMARY 24

III. METHODOLOGY 25
A. INTRODUCTION 25
B. SITE OF STUDY 26
C. INSTRUMENTATION 27
D. PROCEDURE 31
E. SAMPLE 33
F. ANALYSIS 37

IV. DATA ANALYSIS 39
A. ENTIRE SAMPLE: APPLICABILITY VS. PREPAREDNESS 39
B. EFFECTS OF APPLICABILITY ON PREPAREDNESS 41
C. PAIRED DIFFERENCES FOR ENGINEERING SKILLS 43
D. EFFECTS OF JOB TYPE ON PERCEIVED PREPAREDNESS 46
E. EFFECTS OF MAJOR ON PERCEIVED PREPAREDNESS 47
F. PREPARATION FOR ADVANCED EDUCATION 47
G. RELATIONSHIP BETWEEN CAREER AND EDUCATION 49
H. CIVILIAN/MILITARY: INDEPENDENT SAMPLE T-TEST RESULTS 50
1. Overall Feeling of Preparedness 50
2. Preparedness in Applicable Engineering Related Skills 51
3. Technical vs. Non-Technical: Do Civilians Differ from Military? 53

I. CIVILIAN/MILITARY: PAIRED SAMPLES T-TEST RESULTS ..55

V. SUMMARY, CONCLUSION AND RECOMMENDATIONS 59
A. SUMMARY 59
B. CONCLUSION 60
1. Civilian / Military Comparison 63
C. RECOMMENDATIONS AND LIMITATIONS 64

APPENDIX A: GRADUATE PERFORMANCE ASSESSMENT SURVEY 67

APPENDIX B: SAMPLE DESCRIPTIVE STATISTICS 83

LIST OF REFERENCES 87

INITIAL DISTRIBUTION LIST 91

LIST OF TABLES

Table 1: Criterion 3 Program Outcomes.....9
Table 2: Mapping Survey Questions to ABET Criterion 3 "Program Outcomes".....29
Table 3: Likert Scale Values and Corresponding Meanings..30
Table 4: Major.....33
Table 5: Graduation Year.....35
Table 6: Civilian / Military Status.....35
Table 7: Sample Mean Values for Applicability and Preparedness.....39
Table 8: How Well USNA Degree Prepared Graduates in Skill Areas Applicable to Current Work.....42
Table 9: Mean Differences Between 'Preparedness' and 'Applicability'.....44
Table 10: How Well did Major Prepare for Current Career? (Technical vs. Non-Technical).....46
Table 11: How Well did Major Prepare for Current Career?..47
Table 12: Feeling of Preparedness for Advanced Education..48
Table 13: "How Well did Major Prepare for Current Career" (Civilians Only).....50
Table 14: How Well did Major Prepare for Current Career? (Civilian / Military).....51
Table 15: How well USNA Degree Prepared Graduates in Skill Areas Applicable to Current Profession....52
Table 16: How well did Major Prepare for Current Career? (Technical vs. Non-technical for Civilian Respondents).....54
Table 17: How well did Major Prepare for Current Career? (Technical vs. Non-technical for Military Respondents).....54
Table 18: Paired Sample T-Test (Mean Differences for Civilian/Military).....56
Table 19: Highest Military Rank Achieved.....83
Table 20: Warfare Community.....83
Table 21: Job Description (Military).....84
Table 22: Job Description (Civilian).....84
Table 23: Job Level (Civilian).....85

THIS PAGE INTENTIONALLY LEFT BLANK

ACKNOWLEDGMENTS

Foremost I would like to thank my advisors, Dr. Susan Hocevar and Dr. Linda Mallory, for their enormous effort and support throughout this endeavor. In particular, I would like to thank Dr. Mallory for her expertise and guidance on all matters related to the quantitative data analysis, as well as her positive encouragement over the past year. I would like to thank Dr. Hocevar for her constructive feedback and thoughtful perspective, as well as her expertise in research technique. Both advisors added tremendous value to this thesis at every turn, and I could not have completed it without their help, support and guidance. I would also like to thank my wife, Rachael, for her support and patience with me throughout this entire endeavor.

THIS PAGE INTENTIONALLY LEFT BLANK

I. INTRODUCTION

A. BACKGROUND

The primary purpose of the United States Naval Academy is to provide graduates who then serve as junior officers in the U.S. Navy and Marine Corps. A significant emphasis of the development of midshipmen is on their undergraduate education. Graduates are awarded both a commission into the Navy or Marine Corps and a Bachelor of Science degree. On average, more than a third of each graduating class will have majored in one of eight different engineering fields.

Following graduation, graduates serve for a minimum of five years on active duty in one of many different warfare communities within the Navy or Marine Corps. Many remain on active duty well past this minimum commitment, and others move on to careers within the civilian workforce. Regardless of where the Naval Academy graduates end up going, or what they end up doing, it is important to understand how their undergraduate education has impacted their careers since graduation.

B. PURPOSE

There are several purposes to this study. The primary purpose is to determine the extent to which Naval Academy graduates who majored in engineering believe their undergraduate education to be relevant to their current profession. This portion of the study uses the Accreditation Board of Engineering and Technology (ABET) ‘student learning outcomes,’ which are a set of 11 engineering related skills

or abilities (ABET, 2005, p. 1) as the basis for assessing relevance. The primary goals are: (a) to determine the extent to which Naval Academy graduates believe these skills are relevant to their current profession, and (b) to examine how well graduates believe they were prepared in these areas through their undergraduate education.

Another purpose of the study is to establish a good body of baseline data about engineering majors who have graduated from the Naval Academy. Data are collected from 21 graduating classes, between the years of 1985 and 2005. This is the first time that information (feedback) has been gathered from Naval Academy graduates that provides insight into how they view their undergraduate engineering education. With this in mind, the survey was designed to gather a broad base of data about what professions or jobs graduates are currently doing and how their undergraduate education has factored into their careers.

The data received are rich for exploration and meaningful comparison. A portion of this study focuses on comparing graduates who are still in an active duty military status to graduates who have transitioned to the civilian work force, with regard to how they view their engineering education. Comparisons are also made between graduates in technical and non-technical careers, as well as across the eight different engineering majors available to Naval Academy students.

C. RESEARCH QUESTIONS AND METHODOLOGY

The primary research question is: Utilizing ABET’s accreditation criteria for the Naval Academy’s engineering

program as a means of measurement, to what extent do graduates believe that their undergraduate education in engineering is applicable to their professional lives, and how do they judge their level of preparation? Some secondary research areas entail comparisons between civilian and military respondents, as well as between technical and non-technical jobs.

This is a quantitative study. As one of the purposes of the study is to develop broad - spectrum baseline data, some of the analysis is devoted to descriptive statistics that illustrate interesting trends or highlight areas that may be rich for meaningful comparisons. Most of the analysis uses comparisons between group means, conducted utilizing paired sample and independent sample t-tests and analysis of variance tests (ANOVA). These tests focus on respondents' answers to questions concerning the applicability of and preparation achieved through their undergraduate engineering education. Again, the civilian and military groups are compared; and contrasts are made across the engineering fields.

D. BENEFITS OF THE STUDY

There are several possible benefits to this study. The primary benefit is the establishment of baseline data about engineering graduates of the Naval Academy over the past 20 years, which can be useful in several ways. It gives leaders at the Naval Academy information they can in turn provide to the Accreditation Board for Engineering and Technology, as one of the requirements for accreditation renewal. More importantly, it provides information that can be used as a tool for engineering program improvement at the Naval

Academy, by identifying program strengths and weaknesses. This study enables leaders at the Naval Academy to assess how well we are preparing graduates, from an educational perspective, for their professional lives in the Navy, Marine Corps, and beyond.

E. ORGANIZATION OF THE STUDY

The study is organized into five chapters. Chapter I is an introduction and a brief explanation of the study. Chapter II provides a literature review of information relevant to the history and background of ABET and the development of their 'learning outcomes,' an overview of approaches to program evaluation, the accreditation practices of other universities, and survey implementation practices. Chapter III provides and in depth look at the research methodology used, along with a description of the site of the study and the survey instrument that is utilized. Some descriptive statistics characterizing the sample are also presented in chapter three. Chapter IV is dedicated to data analysis. Chapter V provides the results of the study along with some discussion of the implications associated with the results. Chapter V also discusses some of the limitations of the study, and ends with recommendations for further research. Finally, the appendices include the survey instrument in its entirety, along with frequencies and descriptive statistics for the data set that will be useful for further research.

II. LITERATURE REVIEW

A. INTRODUCTION

This chapter begins with a detailed history of the Accreditation Board for Engineering and Technology (ABET) and describes the recent development of ABET's current accreditation standards, known as Engineering Criteria 2000 (EC2000). These criteria were developed in response to both the evolving demands of the engineering profession and advancements in the realm of evaluation. The discussion then turns to the specific aspect of EC2000 that is addressed in this study, namely Criterion 3, or Program Outcomes Assessment. After defining the Criterion 3 outcomes, this chapter addresses ways in which to choose outcome indicators.

The chapter then addresses the concept of program evaluation, with specific emphasis on survey implementation and utilization as a tool to conduct a program evaluation. Additional methods of evaluation are briefly discussed, with emphasis on the evaluation of learning outcomes. The chapter continues with a discussion about accreditation practices at various universities and colleges, as well as design techniques for courses that satisfy the ABET accreditation criteria. The chapter concludes with a brief discussion of teaching ethics as part of engineering curricula.

B. ABET HISTORY

The Accreditation Board for Engineering and Technology (ABET) Web site provides historical background for the

organization (ABET, 2007). ABET (originally named the Engineers Council for Professional Development, or ECPD) was founded in New York in 1932, as a composite of seven engineering societies that covered all the major engineering fields. From the beginning, the organization focused on the guidance, training, education and recognition of both engineering students and academic institutions. The ECPD developed into an accreditation society almost immediately following its inception, and in 1980 adopted the official name ABET in order to reflect this emphasis on accreditation.

ABET has grown to include 28 professional societies and accredits more than 2700 programs at more than 550 colleges and universities, including seven programs at the United States Naval Academy. These include Aerospace, Electrical, Mechanical and Systems Engineering, accredited since 1970, Naval Architecture and Ocean Engineering, accredited in 1972, and Computer Science in 1987 (ABET, 2007).

Following a lengthy development period, ABET adopted a revolutionary approach to accreditation with its implementation of Engineering Criteria 2000 (EC2000). Enacted in 1997, EC2000 has allowed ABET to shift its focus during accreditation procedures to “what is learned rather than what is taught” (ABET, 2007).

C. DEVELOPMENT OF EC2000

By the end of the 20th century, the curricula of engineering education had evolved from a focus on engineering practice and application toward a focus on mathematics, engineering theory and applied science (Prados,

Peterson & Lattuca, 2005). As a result, a gap began to develop between the skill demands of practicing engineers in the industrial workforce and the skills that engineering education was providing to students. Prados, et al (2005) explain that, with continuing trends toward globalization and advancements in the information technology area, many employers began to recognize that sound technical skills alone would not dictate success within the profession. In particular, employers reported the need for young engineers to gain proficiency in communication skills, quality assurance, leadership and participation in teams and work groups, commitment to continuous education and learning, innovative thinking and creativity.

Until the development of EC2000, ABET's accreditation criteria focused on quantitative measurement of engineering program inputs, such as number of faculty members or seat time (number of hours per student) in a particular subject. These criteria, while relevant and easy to measure and apply universally, did not address some of the engineering skills and many of the general management skills associated with success in the profession. ABET evaluators spent their time number crunching and auditing programs, rather than providing qualitative professional assessment. Not until the early 1990's did ABET realize that their strict adherence to measurement of program inputs had made them partially responsible for the widening rift between the needs of the engineering practice and the outcomes of engineering educational programs. After a substantial review process, ABET released the new EC2000 (Engineering Criteria 2000), which shifted emphasis away from standardized compliance to

program input requirements and toward and emphasis on defining program objectives and learning outcomes (Prados, Peterson & Lattuca, 2005).

EC2000 was piloted at five different institutions in 1996 and 1997. Following the pilot run, EC2000 became optional for the three-year period from 1998 – 2000. During this time, institutions could volunteer to be evaluated using the new criteria, or continue to use the traditional ABET criteria. The number of institutions that chose to utilize the EC2000 criteria increased from 21% in 1998 to 83% in 2000(Prados, Peterson & Lattuca, 2005).

D. PROGRAM OUTCOMES

EC2000 divides the criteria for program accreditation into eight different areas that are listed in order below, as found on ABET's official Website (ABET Commission, 2006, pp. 1-3):

Criterion 1: Students

Criterion 2: Program Educational Objectives

Criterion 3: Program Outcomes Assessment

Criterion 4: Professional Component

Criterion 5: Faculty

Criterion 6: Facilities

Criterion 7: Institutional Support and Financial Resources

Criterion 8: Program Criteria

Feedback from graduates is a vital component of an engineering program review when attempting to satisfy

Criterion 3, “Program Outcomes Assessment.” According to Criterion 3, ABET requires that an institution be able to produce, assess and document the achievement of designated “skills, knowledge and behaviors” (ABET, 2005, p. 1) that a student should achieve by the time of graduation. These skills, knowledge and behaviors are further categorized as items ‘a’ through ‘k,’ listed below in Table 1:

Table 1: Criterion 3 Program Outcomes

a	an ability to apply knowledge of mathematics, science and engineering
b	an ability to design and conduct experiments, as well as to analyze and interpret data
c	an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
d	an ability to function on multi-disciplinary teams
e	an ability to identify, formulate and solve engineering problems
f	an understanding of professional and ethical responsibility
g	an ability to communicate effectively
h	the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context
i	recognition of the need for, and ability to engage in life-long learning
j	a knowledge of contemporary issues
k	an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

An important aspect of ABET’s EC2000 is that it shifts focus from an emphasis on program inputs to a focus on program outcomes. For our purposes, it may be useful to define program inputs, processes, outputs and outcomes, and

emphasize the difference between outputs and outcomes. Rogers (2000) provides useful definitions of these terms. Inputs are those things that are brought into an engineering program by students (test scores, credentials, competencies), faculty (credentials, experience, values) and the institution itself (facilities, equipment, resources). Processes focus on what the institution does to exert influence on and work with inputs. These include student choice of major and courses, faculty teaching load and class size, and institutional procedures and governance. Outputs can be seen as the quantitative, concrete results of the processing of inputs. These include grades, retention and employment statistics. Outcomes, on the other hand, are less tangible. They are the knowledge, skills, attitudes, values and behaviors that a student develops as the result of having gone through the educational program (Rogers, 2000).

Rogers (2000) also illustrates the increased level of difficulty when an institution moves from classroom assessment to program assessment. The problems lie with the degree of complexity, time span, level of specificity, accountability, level of faculty buy-in and cost (Rogers, 2000). Evaluating an entire engineering program is more complex than evaluating a course, because the desired outcomes are combined across the entire spectrum of the curriculum. It takes much more time to evaluate a program, because a student must be allowed to complete the program in its entirety. Program assessment is less specific in nature, and it is hard to assign accountability for success or failure to individuals within the program. Finally, program assessment is much more costly in terms of time, money and resources.

E. CHOOSING OUTCOME INDICATORS

Periodically, the U.S. Naval Academy's Engineering department must "renew" the accreditation of its entire program. The process is run by the Accreditation Board of Engineering and Technology (ABET); it requires a thorough review of the program from many different aspects, one of which is an assessment of ABET's "student learning outcomes." While there are several ways to evaluate these outcomes, the evaluation method most relevant to this study is feedback from graduates. In their responses to a survey distributed in the fall of 2005, graduates had the opportunity to assess the value of their undergraduate education.

Prior to 2005, there had never been an external evaluation of the U.S. Naval Academy's Engineering program analyzing feedback from graduates. With ABET's new "student learning outcomes" as a basis for this study, the intention is to determine to what extent graduates believe these outcomes are or are not applicable to their professional lives and to what degree these learning outcomes were successfully achieved during their four years at the Academy.

ABET is the recognized accreditation source for all of the Engineering programs in the country (Brizendine, 2004). It is a federation of 32 professional and technical societies that has been functioning for more than 70 years. Every six years, an Engineering program that desires accreditation is required to satisfy ABET's criteria and submit the results to an ABET Board of Visitors for approval. Brizendine (2004) tells us that, historically, the

accreditation has been based primarily on the capabilities and the capacities of the program itself. In 1996, however, ABET introduced an entirely new method (in addition to, rather than in place of those already in use) to evaluate the quality of a given Engineering program. This new method requires an evaluation of program outcomes (Felder, Brent, 2003).

ABET's guidelines for measuring outcomes are based on their list of eleven "student learning outcomes" (identified as 'a' through 'k,' see Table 1), which were implemented as part of their Technology Criteria 2000 (Brizendine, 2004). These outcomes are subject to a good deal of interpretation by the Engineering departments of the various institutions, but McGourty, Besterfield-Sacre and Shuman (1998) attempt to provide a way to categorize them. They divide these desired outcomes into three types: cognitive (what we "know"), behavioral (what we "do"), and attitudinal (what we "think" or "feel"). The authors believe these outcomes to be measurable, but they reason that there is no score that can be applied universally to determine passing or failing. McGourty, et al. (1998) believe that the advantage to vague wording of the "learning outcomes" is that it leaves it up to the individual Engineering departments to best define them (and evaluate them) in order to align the outcomes with their unique program needs.

Aft (2002) explains that there are several different ways to evaluate the "student learning outcomes." An Engineering program can conduct an internal self-study, which relies on inputs and feedback from faculty and current students to assess the program. Equally important is the

concept of external assessment methods, which could include the periodic ABET visit or the survey of graduates to evaluate the program. Aft (2002) reasons that a quality program will utilize a variety of methods for both internal and external assessment.

There has been research conducted on how to best implement and evaluate the “student learning outcomes” on an internal level. Specifically, the goal has been to take feedback from faculty, staff and students enrolled in the program and utilize that information to effect positive change. Felder and Brent (2003) tell us that this results in “change from within” in terms of clarified learning objectives, and improvements in instruction and assessment. There have also been studies conducted on successful methods for externally evaluating an Engineering program, as will be discussed later in this chapter.

Scales, Owen, Shiohare and Leonard (1998) assert that evaluation begins when the faculty and staff of a program identify the desired outcomes of a course or program, and then identify which indicators will be used to measure these outcomes. Indicators can be classified in different ways, depending on what is to be measured (i.e., attitudes, behaviors, knowledge, performance) and how it is to be measured (qualitative vs. quantitative), or even by who is doing the measuring (i.e., exit surveys given by the institution, universal FE exams given nationally) (Scales, Owen, Shiohare & Leonard, 1998). Availability of time and financial resources may be the biggest determinant when selecting an indicator.

Scales et al. (1998) identify seven different types of outcome indicators, one of which is alumni surveys. Alumni surveys are advantageous because they are relatively inexpensive to administer, results can be analyzed quickly (if quantitative data are collected), and they allow an institution a way to maintain contact with its graduates. Alumni can provide useful biographical data and feedback concerning the quality and content of their education, and an institution can track how these evaluations change over time (Scales et al., 1998).

Unfortunately, there are also several drawbacks when using alumni surveys. They suffer from low response rates and are not ideal for addressing complex issues, as there is no means to answer respondents' questions if there is an unclear or misunderstood survey question. Similarly, there is no way to guard against untruthful or misleading responses. Thus, alumni surveys are most effective when designed as brief, simple questionnaires (Scales et al., 1998). Overall, Scales et al. (1998) report that in a survey given to the representatives of engineering programs attending the 1997 *Best Assessment Processes in Engineering Education: A Working Symposium* conference, the results indicated that alumni surveys were both highly utilized and believed to be very useful.

F. EVALUATION

Patton (1987) offers an excellent distinction of the differences between formative and summative evaluations. Formative evaluations are conducted in order to allow for program improvement, whereas summative evaluations are utilized to determine overall program effectiveness,

specifically useful when making a determination as to whether a program should continue or not (Patton, 1987). When a program is looking to improve quality, a formative evaluation should be utilized. This allows a program to identify strengths (what is working well) and weaknesses (what processes are in need of improvement). Also central to the idea of formative assessment is the concept of feedback – not only must feedback be continuously given by the evaluator, but that feedback must also be acted upon in such a manner as to improve program quality. In other words, the processes of evaluation and providing feedback themselves become an integral part of continuous improvement of program quality (Patton, 1987).

Patton (1982) further clarifies the distinction between formative and summative evaluation by pointing out that summative evaluation results in a judgment being made about the composite worth or effectiveness of a program. Summative evaluations, in general, tend to focus on program outcomes, and formative evaluations tend to focus on program processes. Patton is quick to point out that there may be some blurring of the lines when deciding exactly what to focus on (process or outcome?), and that the important distinction occurs when deciding on the purpose of the evaluation (Patton, 1982).

Royse, Thyer, Padgett and Logan (2001) discuss the fact that, although many experts believe formative evaluation to be synonymous with process evaluation, this is not necessarily true. The key difference is that a formative evaluation is typically conducted early in the development of a program, whereas a process evaluation can be conducted

at any time, even when the program has ended (Royse et al., 2001). Again, it is important to note that the intention of the evaluation is still program improvement, and to differentiate between process and formative evaluation is simply a question of when the evaluation occurs within the lifetime of the program.

Patton (1987) describes the inherent tradeoffs that are inescapably present when conducting any type of evaluation. Tradeoffs are unavoidable, due to realistic challenges associated with working with constrained resources and time. One particularly relevant tradeoff scenario that Patton addresses is the question of depth versus breadth. Within the confines of constrained resources and time, an evaluator must at some point make decisions about how broad or how deep the evaluation will run. Exploratory studies, Patton says, lend themselves more toward a focus on breadth, which allows for a wide range of baseline data; a focus on depth and detail may be more desirable when evaluating specific experiences or outcomes (Patton, 1987).

Another key consideration in evaluation is units of analysis to be studied. On the topic, Patton (1987) states that “the key factor in selecting and making decisions about the appropriate unit of analysis is to decide what unit it is that you want to be able to say something about at the end of the evaluation” (p. 51). Thus, making choices about which units of analysis will be used during an evaluation can also help to answer questions concerning breadth versus depth.

The process of obtaining a target sample is of great importance in evaluation. Of many different sampling

methods, Patton (1987) provides some insight into one that is of particular importance to this study – criterion sampling. Criterion sampling occurs when all chosen cases "meet some predetermined criterion of importance" (Patton, 1987, p. 56). For example, identifying all graduates of a university who majored in an engineering field would constitute criterion sampling. The purpose, Patton (1987) tells us, is "to be sure to understand cases which are likely to be rich in information," because their information will likely lead evaluators toward program improvement (p. 56).

Patton (1982) also highlights the importance of determining specifically what information is required prior to implementing a survey or questionnaire. He discusses four different types of questions that can be asked, based on what an evaluator wishes to find out: (a)behavior questions inquire about actions (what people do); (b) opinion questions inquire about thoughts (what people think); (c) feeling questions inquire about emotions (what people feel); and (d) knowledge questions inquire about facts (what people know) (1982). For purposes of this study, the focus is primarily on the thoughts and opinions of survey respondents.

G. BEST PRACTICES FOR SURVEY IMPLEMENTATION

Couper, Traugott and Lamias (2001) conducted a study at the University of Michigan to identify some traits of Web – based surveys that can either add to or detract from their effectiveness with respect to response rates and data quality. The authors recognize the growing trend of Web – based survey utilization, and they identify some key

advantages, such as a decrease in turnaround time between questionnaire delivery and response and ease of access to a large population through the Web. The primary focus, however, is on the pros and cons of various types of Web survey design.

In one experiment, the effect of including a progress indicator for the survey respondent was studied. While a larger percentage of respondents completed the survey if they were able to track their progress toward completion, the progress indicator also involved a more complex survey design which led to an increase in survey completion time (Couper et al., 2001). In another experiment, the effects of placing single versus multiple items on a page were studied. When a single item was placed on each page, the survey took longer to complete; when multiple items were placed on each page, response time decreased, but the correlation between answers increased (Couper et al., 2001). The third experiment compared the response rates when respondents were given the option of either entering data in a text field or using the computer's mouse to click on a button. Response rates were significantly higher when respondents could use the mouse to enter all information, rather than entering data into a text field (Couper et al., 2001).

These types of experiments seem to indicate that, when faced with the task of designing and implementing a Web – based survey, the designer will have to make choices based on what type of information they are attempting to retrieve. There will be trade-offs associated with each choice.

Schwarz (1995) tells us that "respondents use features of the questionnaire to determine the meaning of a question

and to generate a useful answer" (p. 161). Regardless of whether it is intended to be unbiased or neutral, there are certain aspects of a survey that force respondents to make interpretations and judgments. For example, the ordering of questions can have an impact or, in the case of a survey that uses a numerical rating scale, the words used to define the extreme high and low values on the scale can influence respondents, as can the numerical values chosen to represent different ratings (Schwarz, 1995). For example, in one experiment conducted by Schwarz (1995), respondents to a survey were statistically much less likely to report a value below the midpoint on a rating scale if the scale ranged from -5 to 5 as opposed to a scale that ranged from 0 to 10.

H. ACCREDITATION AT OTHER INSTITUTIONS

McGourty, Sebastian and Swart (1998) describe the process that one institution, the New Jersey Institute of Technology (NJIT), implemented in order to achieve a comprehensive internal assessment of engineering education. The team at NJIT followed a five-step process to develop their program. The first step, defining objectives, strategies, and outcomes, required the team to identify the students and courses to which the assessment program would apply; then, faculty input (through focus groups and surveys) was used to decide which student learning outcomes would be assessed.

The outcomes chosen align with the outcomes associated with ABET's EC-2000. The second step required the selection of assessment methods, with a focus on reliability, validity, fairness and, perhaps most importantly, choosing only those methods that could provide information useful to

continuous program improvement. Step three was a pilot run of the assessment process; step four was full implementation of the assessment process. The goal of step five was to close the loop on the process by applying the feedback from the assessment toward improvement of both the academic curriculum and the assessment process itself (McGourty, Sebastian & Swart, 1998).

There were four assessment methods chosen by the NJIT team at the start of this program. The process began with a survey given to students prior to beginning a course. The students would then, with help from faculty, maintain a portfolio that tracked their progress through the courses chosen for assessment. A peer assessment tool (the “Student Developer”) allowed students to give feedback to each other throughout the curriculum. Finally, at the end of the course, the faculty would observe and evaluate an oral presentation given by individual students, which would allow faculty to assess student outcomes for the course. Data useful in both assessing student learning and improving program composition were obtained from all methods with the exception of the portfolio, which was deemed to be too laborious for students and faculty and subsequently dropped (McGourty, Sebastian & Swart, 1998).

Regan and Schmidt (1999) outline the evaluation process used by the University of Maryland, College Park, to determine if the “student learning outcomes” are achieved. Their evaluation method, which spanned the time period from entry into the program until five years after graduation, culminated with a survey of graduates to determine if the “student learning outcomes” were applicable in their

professional lives and to what extent those outcomes had been achieved during their undergraduate education. Their results provided them with a source of external feedback that proved to be beneficial when attempting to evaluate the achievement of ABET's student learning outcomes.

I. OTHER METHODS OF EVALUATING LEARNING OUTCOMES

In this section, different methods of assessing learning outcomes are discussed. The majority of the assessment methods were developed specifically with ABET's EC2000 criteria in mind, for use in determining the level to which Criterion Three (See Table 1) was attained.

Christy and Lima (1998) advocate a method of assessing student learning that could possibly be useful as institutions attempt to measure EC2000 Criterion Three, or student learning outcomes. This method involves the use of portfolios maintained by the individual students throughout their time in the engineering program. One section of the portfolio would list course-specific desired goals or outcomes for students. Periodically, the students would evaluate their progress toward mastery of the outcomes, based on self – evaluation of their work in the course.

The intention is to allow the student to take responsibility for their own education; with the help of the portfolio process of documentation and criterion – based self assessment to guide them toward the achievement of the desired outcomes. In a study conducted at Ohio State University, both freshmen and senior engineering students were required to maintain portfolios in one particular

class. 78% of the seniors and 80% of the freshmen reported that the portfolios did in fact enhance their learning experience (Christy & Lima, 1998).

One relatively unexplored method of evaluating the more technical of ABET's learning outcomes is the nationally standardized Fundamentals of Engineering (FE) Exam (Watson, 1998). This eight - hour test covers 15 different areas of technical engineering science, and is administered to graduating engineering students who may wish to continue toward a professional engineering career. While this test could provide some rich data with which to assess student learning, it is rendered ineffective as a measurement tool by several factors. First, the National Council of Examiners for Engineers and Surveyors (NCEES) is bound by privacy and release restrictions. Second, even if NCEES were allowed to furnish test results, the test is taken on a predominantly voluntary basis. Many engineering students never take the exam, and those who do take it tend to be highly motivated (Watson, 1998).

J. DESIGN TECHNIQUES FOR COURSES THAT SATISFY ABET

Shaeiwitz (1998) discusses the important role that classroom assessment can play in the development of a comprehensive program evaluation. In particular, the author discusses the importance of nested feedback loops, in which measurement of outcomes and feedback occur regularly throughout the students' progression through a curriculum. Using the concept of nested feedback loops, engineering programs can benefit from both formative and summative assessment.

In formative assessment, the audience is a particular instructor or faculty member, and the goal is to improve student learning at the course level (Shaeiwitz, 1998). Formative assessments represent short-term feedback loops, where the time passage between measurement and feedback is minimized.

With summative assessment, the goal is to evaluate the effectiveness of the educational curriculum taken as a whole, and the audience is external to the department. Summative assessment evaluates the entire educational process, from beginning to end. Shaeiwitz (1998) believes that a program designed to satisfy ABET's EC2000 criteria will take advantage of nested feedback loops, which provide multiple opportunities for formative assessment and program improvement.

K. ETHICS IN ENGINEERING EDUCATION

Haws (2001) discusses the importance of teaching ethics to engineers, as a way to help students to think divergently. By this, he implies that it is important to gain a broader perspective by looking, through the eyes of a non-engineer, at the potential impacts of decisions on a wide range of people and things. Teaching the Professional Code of Ethics solely by presenting the ethical considerations summarized in that document is insufficient (Haws, 2001). A good understanding of ethical considerations will most likely be achieved through a number of different approaches, including professional codes, humanist readings, theoretical grounding, ethical heuristics, case studies and service learning (actively applying ethics to community-

based projects). Haws (2001) recognizes value in all six of these methods, but favors a combination of theoretical grounding and service learning.

L. SUMMARY

This chapter has covered the history of the Accreditation Board for Engineering and Technology (ABET), highlighting the relatively recent changes that ABET has made to their accreditation criteria. The changes most relevant to this study involve the evaluation of ABET's Criterion Three 'Student Learning Outcomes.' Best practices for choosing and evaluating indicators of these outcomes were explored in detail. This chapter also explored the use of various methods of evaluation, with specific emphasis on surveys as tools for program evaluation. Finally, some background was given concerning accreditation at other institutions.

III. METHODOLOGY

A. INTRODUCTION

There are several purposes to this study. One goal is to establish baseline data about engineering graduates of the United States Naval Academy over the past 20 years. The bulk of the analysis is devoted to an overall assessment of the relevance of engineering education to Naval Academy graduates and the level of preparedness afforded them through their undergraduate education.

Additionally, an attempt is made to explore the differences (if any) that exist between military and civilian graduates of the United States Naval Academy who majored in engineering, with respect to their level of preparedness for their profession and the level of applicability of their undergraduate education to their professional lives. Finally, comparisons are made between graduates in technical and non-technical career fields, as well as across the different engineering majors.

The Accreditation Board for Engineering and Technology (ABET) Criterion Three ‘Student Learning Outcomes’ (See Table 1) provide the basis for all analyses and comparisons, and this chapter provides background information on how the study was conducted. The site of the study, survey instrumentation and implementation procedure, sample description and analysis procedures are all covered in detail.

B. SITE OF STUDY

This study was conducted at the United States Naval Academy in Annapolis, MD. The Naval Academy is a four-year institution whose graduates are awarded both a Bachelor of Science degree and an officer's commission into the Navy or Marine Corps as either ensigns or second lieutenants. The minimum active duty service requirement following graduation is five years; many graduates remain on active duty past the minimum commitment, and many take their education and military experience and join the civilian workforce.

Between the years 1990 – 2005, an average of 1246 men and women were admitted to the Naval Academy each year. During this same time span, an average of 964 men and women graduated and were commissioned into the Navy or Marine Corps each year. The average attrition rate for each incoming class was 22.5%, which means that an average of 77.5% of all men and women admitted to the Naval Academy went on to graduate during this time period (U.S. Naval Academy Institutional Research, 2004).

There are 19 different majors offered at the Naval Academy in areas of Engineering and Weapons, Mathematics and Science, and Humanities and Social Sciences. Selection of major is voluntary, and an average of 35% of each class of Midshipmen will choose to major in an engineering field. For this study, the focus is on graduates who studied in one of eight available engineering majors. In particular, this study deals only with engineering majors who graduated between the years of 1985 – 2005. During this 20 – year time span, a total of 7572 graduates of the Naval Academy majored

in some field of engineering. For purposes of this study, these 7572 graduates are the population.

C. INSTRUMENTATION

The survey instrument is essentially broken up into three distinct sections. The intent is to track information about the professional lives of respondents between the time of their graduation and present, then gather information about the applicability of their undergraduate education to their career and gauge the level of preparation each respondent feels was achieved through their undergraduate education.

The survey (See Appendix A for the complete version) begins with 13 questions designed to gather information about the current professional career status of each respondent. If respondents indicate that they are in an active duty status, they are asked to give information such as warfare community, rank, technical nature of current job and career intentions. If respondents indicate that they are working in the civilian professional workforce, they are asked to provide information such as current title and/or position, name of employer, technical nature of current job and employing organization, and number of years served in current position.

A field of 24 questions was designed for the second section of this survey, with the intention of addressing ABET’s accreditation criteria. Specifically, these questions were developed in order to ascertain:(a) The level of preparedness that each graduate believes was achieved during their undergraduate engineering education with respect to

ABET's Criterion 3 'Program Outcomes' ('a' through 'k'); and (b) The degree to which each of the 'a' through 'k' criteria is relevant to their current positions.

According to Criterion 3, ABET requires that an institution be able to produce, assess and document the achievement of designated "skills, knowledge and behaviors" (ABET, 2005, p. 1) that a student should achieve by the time of graduation. These skills, knowledge and behaviors are further categorized as items "a" through "k": (a) an ability to apply knowledge of mathematics, science and engineering; (b) an ability to design and conduct experiments, as well as to analyze and interpret data; (c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability; (d) an ability to function on multi-disciplinary teams; (e) an ability to identify, formulate and solve engineering problems; (f) an understanding of professional and ethical responsibility; (g) an ability to communicate effectively; (h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context; (i) recognition of the need for, and ability to engage in life-long learning; (j) a knowledge of contemporary issues; and (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

The second section of the survey includes questions that identify the above skills or capabilities and asks respondents to indicate both the level of applicability of

those skills to their professional jobs (12 questions) and the level of preparation in each of those skill areas afforded them by their undergraduate engineering education (12 questions). Respondents were asked to indicate the level of applicability and preparation on a five-point scale, ranging from “Not at all” to “Extremely” applicable or prepared. The table below illustrates the manner in which these 24 questions can be mapped to ABET’s Criterion 3 ”Program Outcomes.“

Table 2: Mapping Survey Questions to ABET Criterion 3 “Program Outcomes”

Survey Question	**Addresses which ABET Criterion 3 “Program Outcome”**
Ability to apply knowledge of math, engineering and science?	a. an ability to apply knowledge of mathematics, science and engineering
Ability to analyze and interpret data?	b. ability to design and conduct experiments, analyze and interpret data
Ability to identify, formulate and solve engineering problems?	e. ability to identify, formulate and solve engineering problems
Ability to design systems, components or processes to meet needs?	c. ability to design a system, component, or process to meet desired needs within realistic constraints
Ability to design and conduct experiments?	b. ability to design and conduct experiments, analyze and interpret data
Ability to use techniques, skills and tools in engineering practice?	k. ability to use the techniques, skills and modern engineering tools necessary for engineering practice
Expectation to be current in technologies related to your current field?	j. a knowledge of contemporary issues
Ability to prepare reports and documents?	g. ability to communicate effectively
Ability to prepare and deliver professional presentations?	g. ability to communicate effectively
Ability to function on multi-disciplinary teams?	d. an ability to function on multi-disciplinary teams
Understanding of ethical and professional responsibility?	f. an understanding of professional and ethical responsibility

Survey Question	Addresses which ABET Criterion 3 "Program Outcome"
	h. broad education needed to understand impact of engineering solutions in global / societal / economic context
Recognition of the need to engage in life-long learning?	h. broad education needed to understand impact of engineering solutions in global / societal / economic context
	i. recognition of need to engage in life – long learning

For each of the 24 questions in the second section of the survey, a five-point Likert scale us utilized. The Likert scale values and corresponding meanings are clarified below in Table 3:

Table 3: Likert Scale Values and Corresponding Meanings

Number in Likert Scale	Corresponding Meaning for 'Preparedness' questions	Corresponding Meaning for 'Applicability' questions
1	Not prepared at All	Not Important at all
2	Somewhat Prepared	Somewhat Important
3	Adequately Prepared	Fairly Important
4	Very well Prepared	Very Important
5	Extremely well Prepared	Extremely Important

In addition to answering specific questions rating the levels of preparedness and applicability of ABET's program outcomes, respondents were also asked several other questions in the second section of the survey that may provide useful feedback when evaluating their undergraduate education. Specifically, respondents were asked to indicate

1. How well their education, in general, prepared them for their career.

2. How many times per year they attend professional conferences.

3. Whether they have attained, or intend to attain advanced engineering licensing (PE licensing).

4. How well prepared they felt for graduate education.

5. The highest level of education that they had attained.

The third and final section of the survey consists of three questions that allowed respondents to provide qualitative feedback about their engineering majors program. Each respondent was asked to provide comments to identify and discuss the most useful and the least useful aspects of their engineering education at the Naval Academy. They were also asked to provide comments or suggestions for improvement of the engineering program at the Naval Academy.

D. PROCEDURE

The design of the survey instrument used for this study was the result of a collaborative effort between the Institutional Research, Planning and Assessment (IR) Department and the Engineering Department faculty at the U.S. Naval Academy. The IR Department, founded in 1992, was designed “for the purpose of evaluating and disseminating institutional data to stimulate positive changes in the admissions and education processes at USNA. IR is the single source of evaluated information on Midshipman and graduate performance” (USNA, 2007).

As benchmarks for the development of this survey, IR and Engineering Department personnel used survey instruments from several other colleges and universities that had recently completed ABET accreditation visits. These institutions, including York College, Johns Hopkins University and Rutgers University, had utilized survey instruments in order to address ABET's new accreditation standards, namely Criterion 3 "Student Learning Outcomes."

The survey developed by USNA (titled the "Graduate Performance Assessment Survey") was web–based. The IR Department obtained e-mail addresses from the Naval Academy Alumni Association for any graduates between the years of 1985-2005 who had majored in engineering. Of the 7572 graduates who fit this description, the Alumni Association had contact information for 4189 of them, as maintaining contact with the Alumni Association is voluntary for all graduates. (This translates into contact information for 55.3% of the stated population.) The e-mail sent to each graduate contained the Website URL where the survey was located; respondents simply needed to 'click' on the URL, open the survey and begin entering data.

The IR Department was responsible for survey administration and data integrity. Following a brief pilot period, which was conducted in order to determine if the survey was complete, accessible and user-friendly, the survey was placed online for a period of one month between February and March of 2006. After the survey was taken offline, the IR Department pulled data from the electronic

responses and dropped them into a spreadsheet, and cleaned the data. The complete survey instrument is located in Appendix A.

E. SAMPLE

The sample for this study is a total of 1068 Naval Academy graduates who majored in engineering between 1985 – 2005. Of the 4189 graduates from this time period for whom contact information was available and to whom the survey was sent, the 1068 respondents yield a response rate of 25.5%.

Within the entire population of 7572 engineering majors from this time period, the 1068 respondents represent 14.1% of the population.

All of the participants in this study were required to indicate their specific field of engineering study. The frequencies for each of the eight majors within USNA's Engineering Department are listed below in Table 4. Of these majors, all are still available for study at the Naval Academy with the exception of Marine Engineering, which was last offered in 1999.

Table 4: Major

Engineering Majors	**Number in Population**	**Percent of Population**	**Number in Sample**	**Percent of Sample**
Aerospace (EAS)	838	11.10%	106	9.90%
Aeronautics (EASA)	505	6.70%	82	7.70%
Electrical (EEE)	590	7.80%	92	8.60%

Engineering Majors	Number in Population	Percent of Population	Number in Sample	Percent of Sample
General (EGE)	1020	13.50%	100	9.40%
Mechanical (EME)	1376	18.20%	210	19.60%
Naval Architecture (ENA)	431	5.70%	63	5.90%
Ocean Engineering (EOE)	873	11.50%	111	10.40%
Systems (ESE)	1684	22.20%	246	23.00%
Marine Engineering (ESP)	255	3.40%	58	5.40%
Total	**7572**	**100%**	**1068**	**100%**

When comparing the population to the sample, all engineering majors, with the exception of aerospace, ocean and general engineering, are slightly over-represented in the sample. The most over-represented major is marine engineering, where 2.0% more of the sample is comprised of marine engineers than is the case within the population. Conversely, the most under-represented major is general engineering; 13.5% of the population majored in general engineering, compared with only 9.4% of the sample (a difference of 4.1%). With the exception of general engineering, the samples of all engineering majors represent the population within a tolerance of 2.0% or better.

For purposes of this study, there is a need to track as much specific biographical information about each of our respondents as possible in order to maximize the opportunities for meaningful comparisons between distinct groups. For example, one focus of this study is on whether graduates are currently in an active duty military status or

a civilian status, and also which particular field of engineering each graduate majored in while attending the Naval Academy. For a list of demographic variables and descriptive statistics, see Appendix B.

Tracking and identification information is made possible by having respondents indicate their alpha code. The alpha code is a unique identification number issued to Midshipmen on the day they report to the Naval Academy, which they maintain until graduation. Alpha codes are not duplicated or reissued regardless of graduation year.

Table 5: Graduation Year

Grad Year	Sample	Percent of Sample
1985 – 1990	321	30.10%
1991 – 1995	272	25.50%
1996 – 2000	270	25.30%
2001 - 2005	205	19.20%
Total	1068	100%

The graduating classes of 1985-1990 are slightly over-represented in our sample, whereas the graduating classes of 2001-2005 are slightly under-represented. There is a good sample distribution across the graduating classes of 1991-2000, which represents approximately 50% of the sample.

Table 6: Civilian / Military Status

Status	Frequency	Percent of Sample
Civilian	546	51.1
Active Duty Military	522	48.9
Total	1068	100.0

This is close to an ideal sample distribution between civilian and military respondents, as a good bit of analysis is conducted with the intent of comparing civilian to active duty military respondents. The sample distribution is roughly equal, with civilian and active duty military both representing about half of the sample.

With few exceptions, all graduates of the Naval Academy are required to accept commissions as either Navy or Marine Corps officers following graduation. Therefore, all respondents served at least one year on active duty. As a general rule, graduates will owe a minimum of 5 years on active duty, although this number frequently changes based on many factors including warfare community, needs of the service, and health status of the service member. All respondents indicated the total amount of time they spent on active duty, which ranged in time from 1 year to 8 years. In the sample, 90.1% of the respondents served between 3 and 5 years on active duty.

Respondents are also asked to indicate the warfare community in which they served (or serve). The vast majority of the sample (81.5%) indicated that they served in one of the four largest unrestricted line warfare communities that are available to Naval Academy graduates, namely naval aviation, surface warfare, submarine warfare and the Marine Corps. Approximately 9% of respondents serve (or served) in the Civil Engineering Corps or as Engineering Duty Officers.

Survey respondents were asked to answer questions in order to provide details as to the nature of their current job. For example, out of 515 active duty military respondents, 69.3% indicated that the nature of their

current job is technical, with the remaining 30.7% indicating that their current job is non-technical.

In contrast, 57.0% of civilian respondents indicated that their current occupation is technical in nature, and 43.0% indicated that their current occupations are non-technical in nature. (To see further information concerning this breakdown between technical and non-technical positions, see Appendix B.)

Civilian respondents were asked to indicate the level of their current position within their current organization, ranging from entry level to senior executive (i.e., President, CEO). Again, a complete description of this breakdown can be found in Appendix B. Of the civilian respondents, 7.4% indicated that they are the Senior Executive of their organization; 40.5% indicated that they work as upper management, and 43.8% indicated that they work as mid-level management. A small percentage (3.3%) indicated that they are currently working at entry level positions.

F. ANALYSIS

The majority of the analysis for this study focuses on the entire population, with an effort being made to determine the level of applicability and preparedness that respondents assign to each of the engineering related skills and abilities. Additional analysis focuses on comparing military and civilian respondents, and also on comparing respondents from differing engineering majors. The portion of the survey instrument that is utilized for comparison analyses are the questions, described earlier in this chapter, modeled after ABET's "Criterion 3" (a – k). These

questions focus on specific student learning outcomes, and allow respondents to comment on levels of applicability of certain skills to their profession and adequacy of preparation attained during undergraduate study.

Independent samples T-tests are conducted in order to compare military and civilian respondents. The goal is to identify statistically significant differences between military and civilian respondents with respect to how they view the applicability of certain engineering related skills to their jobs, and also to identify significant differences in levels of preparation. All significance criteria (for all analyses) will be $p < .05$.

For both civilian and military respondents, paired sample T-tests are conducted in order to determine if there are statistically significant differences between the levels of preparation and the levels of applicability for each of the stated engineering skills. In other words, the paired sample test is used to determine whether respondents within each of the two groups (military or civilian) believed that their level of preparedness for each engineering skill was high or low relative to the perceived level of skill applicability.

Analysis of variance (ANOVA) tests are conducted in order to compare respondents across the nine different engineering majors. Specifically, the ANOVA test is utilized to determine if there is a statistically significant difference between respondents of different engineering majors with regard to how well they feel they were prepared in engineering related skills, or how applicable they believe those skills to be.

IV. DATA ANALYSIS

A. ENTIRE SAMPLE: APPLICABILITY VS. PREPAREDNESS

All respondents were asked to indicate the extent to which they felt that each of 12 different engineering related skills were applicable to their current profession. They were also asked to indicate the extent to which they felt that their undergraduate engineering education had prepared them to perform these engineering related skills. Answers to these questions ranged from 1 (‘Not important at all’ or ‘ Not prepared at all’) to 5 (‘Extremely important’ or ‘Extremely well prepared’). The results for the entire sample are summarized in Table 7.

Table 7: Sample Mean Values for Applicability and Preparedness

Engineering Skill or Ability	**Applicability**		**Preparedness**	
	Mean	**N**	**Mean**	**N**
Apply knowledge of math, engineering and science.	3.84	1037	4.39	1065
Ability to analyze and interpret data.	4.35	1015	4.48	1066
Identify, formulate, and solve engineering problems.	3.09	978	4.27	1065
Design systems, components, or processes to meet needs.	2.97	980	3.79	1063
Design and conduct experiments.	2.34	934	3.78	1062
Use techniques, skills, and tools in engineering practice.	3.03	962	4.07	1060
Expectation to be current in technologies related to your career field.	3.89	1001	3.74	1060
Prepare reports and documents.	4.38	991	4.26	1063
Prepare and deliver professional presentations.	4.48	992	4.11	1062
Function on multi-disciplinary teams.	4.4	982	4.35	1062
Understanding of ethical and professional responsibility.	4.74	964	4.67	1064
Recognition of the need to engage in life-long learning.	4.44	988	4.38	1060

The six skills reported to be most applicable (means > 4.3) to the respondents' current jobs were: "ability to analyze and interpret data;" "prepare reports and documents;" "prepare and deliver professional presentations;" "function on multi-disciplinary teams;" "understanding of ethical and professional responsibility;" and "recognition of the need to engage in life-long learning." Four skills had mean ratings at or below the mid-point rating of 3 for applicability: "Identify, formulate, and solve engineering problems;" "design systems, components, or processes to meet needs;" "design and conduct experiments;" and "use techniques, skills, and tools in engineering practice."

All but three skill areas received ratings >4.0 in terms of how well the degree program prepared them. The highest rated skill area was "understanding of ethical and professional responsibility" (mean = 4.67). The three skill areas with the lowest ratings of preparation were: "design systems, components, or processes to meet needs"; "design and conduct experiments"; and "expectation to be current in technologies related to your current field." It is noteworthy that the first two of these lowest-rated skills also receive the lowest ratings of applicability to their current jobs.

For 6 of the 12 skills, respondents indicated, on average, that their level of preparation met or exceeded the level of ability required in that skill area in their current job or profession. Notably, respondents felt well-prepared to identify, formulate and solve engineering problems; design systems, components, or processes to meet

needs; design and conduct experiments; and use techniques, skills, and tools in engineering practice, yet they did not view these skills as highly relevant to their current positions.

For the other six skills, respondents indicated, on average, that their level of preparation did not meet the level of ability required in that skill area. Notably, respondents felt under-prepared with regard to their ability to prepare reports and documents, and to prepare and deliver professional presentations.

B. EFFECTS OF APPLICABILITY ON PREPAREDNESS

The intention of this section is to examine the results only for the survey respondents who believe that these 12 engineering related skills are applicable to their current job or profession. For those respondents who reported that the skills are applicable, levels of perceived preparedness were analyzed. Those respondents who indicated that a given skill was “not important at all” or “somewhat important” were eliminated from the analysis of each skill category. Only those respondents who indicated that a given skill was “fairly important,” “very important” or “extremely important” were included in this analysis. The results are summarized in Table 8.

Table 8: How Well USNA Degree Prepared Graduates in Skill Areas Applicable to Current Work

Engineering Skill or Ability	PREPAREDNESS	
	MEAN	N
Apply knowledge of math, engineering and science.	4.42	893
Ability to analyze and interpret data.	4.48	944
Identify, formulate, and solve engineering problems.	4.35	616
Design systems, components, or processes to meet needs.	3.94	563
Design and conduct experiments.	3.92	366
Use techniques, skills, and tools in engineering practice.	4.19	567
Expectation to be current in technologies related to your career field.	3.77	841
Prepare reports and documents.	4.28	926
Prepare and deliver professional presentations.	4.1	939
Function on multi-disciplinary teams.	4.36	914
Understanding of ethical and professional responsibility.	4.67	943
Recognition of the need to engage in life-long learning.	4.38	946

All skill categories have preparedness ratings greater than 3.75, and all but three are greater than 4.0. For 6 of the 12 skill categories, more than 900 respondents indicated high levels of applicability: ‘ability to analyze and interpret data;” “prepare reports and documents;” “prepare and deliver professional presentations;” function on multi-disciplinary teams;” “understanding of ethical and professional responsibility;” and “recognition of the need to engage in life-long learning.” Of these six skills, the abilities to “prepare reports and documents” and “prepare and deliver professional presentations” received the lowest ratings for preparedness.

The ‘N’ values themselves are telling in this analysis. Approximately 20% to 50% fewer respondents indicated high

levels of applicability for four of the 12 skill areas (as compared with the other skill categories): “identify, formulate, and solve engineering problems;” “design systems, components, or processes to meet needs;” “design and conduct experiments;” and “use techniques, skills, and tools in engineering practice.” But for those who did feel that these skills were applicable, their perceived levels of preparedness are higher than the overall sample means reported in the previous table.

It is also interesting to note that, in general, as the number of respondents who believed that a given skill was applicable to their current profession increases, the average indication of preparedness for that skill also increases. The largest number of respondents indicated that the skills “understanding of ethical and professional responsibility;” “ability to analyze and interpret data” and “recognition of the need to engage in life-long learning” were applicable to their current jobs, and these skills were also rated highest in terms of preparedness.

C. PAIRED DIFFERENCES FOR ENGINEERING SKILLS

In this section, each of the 12 “preparedness” questions was paired with their corresponding “applicability” questions. A paired samples t-test was conducted in order to determine any significant difference between the level of preparedness and the level of applicability for each of the engineering related skills. The results of the paired samples t-test (using the entire sample) are shown in Table 9.

Table 9: Mean Differences Between ‘Preparedness’ and ‘Applicability’

Engineering Skill or Ability	N	Mean Diff (‘Preparedness’ – ‘Applicability’)	Sig.
Apply knowledge of math, engineering and science.	1062	0.49	0.000
Ability to analyze and interpret data.	1060	0.06	0.099
Identify, formulate, and solve engineering problems.	1057	0.96	0.000
Design systems, components, or processes to meet needs.	1058	0.60	0.000
Design and conduct experiments.	1057	1.00	0.000
Use techniques, skills, and tools in engineering practice.	1054	0.77	0.000
Expectation to be current in technologies related to your career field.	1052	-0.26	0.000
Prepare reports and documents.	1057	-0.22	0.000
Prepare and deliver professional presentations.	1058	-0.47	0.000
Function on multi-disciplinary teams.	1056	-0.17	0.000
Understanding of ethical and professional responsibility.	1056	-0.18	0.000
Recognition of the need to engage in life-long learning.	1054	-0.17	0.000

A positive value for the mean difference indicates that respondents, on average, gave higher ratings to their perceived level of preparedness relative to the rating of applicability. Conversely, a negative value for the mean difference indicates that respondents, on average, gave lower ratings to their perceived level of preparedness relative to the rating of applicability for that skill.

For the skills listed below, the mean difference between the level of preparedness and the level of applicability was positive and statistically significant ($p < .05$). That means that respondents (on average) gave high ratings for preparedness in these skill areas relative to the level of skill applicability:

1. Ability to apply knowledge of math, engineering and science.

2. Ability to identify, formulate and solve engineering problems.

3. Ability to design systems, components or processes to meet needs.

4. Ability to design and conduct experiments.

5. Ability to use techniques, skills and tools in engineering practice.

For the skills listed below, the mean difference between the level of preparedness and the level of applicability was negative and statistically significant ($p < .05$), meaning that respondents (on average) indicated low ratings for preparedness in these skill areas relative to the level of skill applicability:

1. Expectation to be current in technologies related to your current field.

2. Ability to prepare reports and documents.

3. Ability to prepare and deliver professional presentations.

4. Ability to function on multi-disciplinary teams.

5. Understanding of ethical and professional responsibility.

6. Recognition of the need to engage in life-long learning.

D. EFFECTS OF JOB TYPE ON PERCEIVED PREPAREDNESS

All respondents were asked the general question, “How well did your engineering major at USNA prepare you for your current career?” Responses ranged from 1 (‘Not Prepared at All’) to 5 (‘Extremely Well Prepared’). For this section, an independent samples T-test was conducted in order to determine whether respondents who reported that their current job is technical in nature believed that they are better prepared than those who reported that their current job is non-technical in nature. The grouping variable is a binomial variable that indicates whether a respondent’s job is technical or non-technical, and the test variable is the respondents’ rating of their level of preparedness. The results are summarized in Table 10.

Table 10: How Well did Major Prepare for Current Career? (Technical vs. Non-Technical)

Job Description	N	Mean	Std. Dev
Technical	664	4.05	0.867
Non-Technical	388	3.79	1.019

The overall sample mean for this ‘preparedness’ variable is 3.95. The results of the t-test indicate that there is, in fact, a statistically significant difference ($F=25.51$, $p < .05$) between respondents in technical jobs and those in non-technical jobs with regard to how they perceive their level of preparation. In particular, respondents who are in technical jobs give higher ratings to their level of preparation than those who are in non-technical jobs.

E. EFFECTS OF MAJOR ON PERCEIVED PREPAREDNESS

Respondents were asked the general question, “How well did your engineering major at USNA prepare you for your current career?” Responses ranged from 1 (“Not Prepared at All”) to 5 (“Extremely Well Prepared”). A one-way analysis of variance (ANOVA) test was conducted, using the major as the grouping variable and level of preparedness as the test variable. This test was conducted to determine if there was a significant difference in the means between each group. The results are summarized in Table 11.

Table 11: How Well did Major Prepare for Current Career?

Major	**N**	**Mean Value**	**Std. Dev.**
Systems Engineering	245	4.00	0.896
Mechanical Engineering	210	3.90	0.890
Ocean Engineering	111	3.96	0.972
Aerospace Engineering	104	3.91	0.946
General Engineering	100	3.75	0.925
Electrical Engineering	92	4.09	0.898
Aeronautics Engineering	82	4.15	0.904
Naval Architecture	62	3.95	1.093
Marine Engineering	58	3.86	0.999
Total	**1064**	**3.95**	**0.932**

Homogeneity of variance between the major groups was verified to be true, and the results of the ANOVA test indicate that there is no statistically significant difference ($F=1.55$, $p < .05$) between the major groups with respect to how prepared, in general, each group felt.

F. PREPARATION FOR ADVANCED EDUCATION

Respondents were asked to indicate whether or not they had attained any forms of advanced education during the time

since their graduation from the Naval Academy, ranging from partial completion of a graduate degree to the completion of a Doctorate degree. They were also asked to indicate the extent to which they felt that their undergraduate education had prepared them for graduate education. (This question was posed to all respondents, whether they completed further education or not.) To indicate their level of preparation, respondents chose a number between 1 (‘not at all prepared’) and 5 (‘extremely well prepared’). The descriptive statistics for this analysis are shown in Table 12 below. The first column indicates the highest level of education attained, and the mean value indicates the extent to which that group felt prepared for graduate education.

Table 12: Feeling of Preparedness for Advanced Education

EDUCATION LEVEL	**N**	**MEAN**	**STD. DEV.**
PhD or equivalent	29	4.03	0.906
Master's Degree or equivalent	515	4.06	0.914
Some graduate work	114	3.98	0.902
Bachelor's Degree	393	3.74	0.803

A one-way analysis of variance (ANOVA) test was conducted in order to determine whether a significant difference existed between group means. The grouping variable was the highest level of education attained, and the test variable was the level of preparedness for graduate education. The results of this test indicate that there are significant differences ($F=9.89$, $p < .05$) between at least two of these group means.

In order to determine which groups differ, a post hoc LSD test was conducted. The results indicate that those

respondents with a master's degree felt significantly more prepared for graduate education than those respondents who have not furthered their education beyond a bachelor's degree ($p < .05$). Additionally, those respondents who have completed some graduate work felt significantly more prepared for graduate education than those respondents who have not furthered their education beyond their Bachelor's degree ($p < .05$). These results indicate that those who pursue graduate education have a higher perceived preparation than those who have only completed the bachelor's degree.

G. RELATIONSHIP BETWEEN CAREER AND EDUCATION

Civilian respondents were asked to indicate the extent to which their current job is related to their undergraduate engineering education at the Naval Academy. Possible answers were 'Not At All,' 'Somewhat' or 'To a Great Extent.' For the purposes of this specific analysis, these responses were recoded into a new binomial numeric variable, in which those who answered 'Not At All' are classified as having no relationship between undergraduate education and job, and those who answered 'Somewhat' or 'To a Great Extent' are classified as having a relationship between undergraduate education and job.

All respondents were asked the general question, "How well did your engineering major at USNA prepare you for your current career?" Responses ranged from 1 ("Not Prepared at All") to 5 ("Extremely Well Prepared"). An independent samples t-test was conducted in order to determine whether those civilian respondents who felt that their education applied to their current job felt more or less prepared than

those respondents who did not see any relationship between their education and their job. The descriptive statistics for this analysis are displayed in Table 13.

Table 13: “How Well did Major Prepare for Current Career” (Civilians Only)

Job Related to Education?	N	Mean
Related	346	4.06
Not Related	195	3.62

The results of the t-test indicate that there is a significant difference ($t=-4.92$, $p < .05$) between these two groups. Here, those civilian respondents who believed that their job was related to their engineering education felt significantly better prepared for their career than those respondents who report no relationship between job and education.

H. CIVILIAN/MILITARY: INDEPENDENT SAMPLE T-TEST RESULTS

1. Overall Feeling of Preparedness

Respondents were asked the general question, “How well did your engineering major at USNA prepare you for your current career?” Responses ranged from 1 (“Not Prepared at All”) to 5 (“Extremely Well Prepared”). An independent samples t-test was conducted, using a binomial grouping variable that indicates whether respondents are civilian or military, and overall level of preparedness as the test variable. This test was conducted to determine if there was a significant difference in the means for the civilian and

military groups, with respect to their level of perceived overall preparedness. The results are presented in Table 14.

Table 14: How Well did Major Prepare for Current Career? (Civilian / Military)

Status	N	Mean	Std. Dev.
Civilian	543	3.90	0.963
Active Duty Military	521	4.01	0.895

The significance level of the t-test was 0.065. Thus, it cannot be concluded that there is a significant difference ($p < .05$) between the two group means (civilian and military), although there is a significant difference at the $P < .10$ level, with military rating themselves as better prepared than their civilian employed counterparts.

2. Preparedness in Applicable Engineering Related Skills

An independent samples t-test was conducted, using a binomial grouping variable that indicates whether respondents are civilian or active duty military. The test variables were the 12 “preparedness” questions that allowed respondents to indicate their level of preparedness with respect to twelve different engineering related skills.

The intention of this analysis is to examine the responses provided by survey respondents who believe that these engineering related skills are applicable to their current job or profession. With this in mind, those respondents who indicated that a given skill was “not important at all” or “somewhat important” were eliminated from the analysis of each skill category prior to each

independent sample test. Only those respondents who indicated that a given skill was “fairly important,” “very important” or “extremely important” were included in this analysis.

The results of this analysis are summarized in Table 15. For 9 of the 12 engineering related skills, there was no statistically significant difference ($p < .05$) between military and civilian with respect to preparedness. For the ability to “apply knowledge of math and science;” “function on multi-disciplinary teams;” and “understand ethical and professional responsibility,” civilians indicated a higher level of preparedness ($p < .05$).

Table 15: How well USNA Degree Prepared Graduates in Skill Areas Applicable to Current Profession

Engineering Skill or Ability	**Civilian**		**Military**		**t-test sig.**
	Mean	**N**	**Mean**	**N**	
Apply knowledge of math, engineering and science.	4.48	469	4.35	424	**.002**
Ability to analyze and interpret data.	4.52	494	4.44	450	.072
Identify, formulate, and solve engineering problems.	4.37	330	4.32	286	.390
Design systems, components, or processes to meet needs.	3.89	334	4.02	229	.065
Design and conduct experiments.	3.86	220	4.01	146	.122
Use techniques, skills, and tools in engineering practice.	4.22	300	4.14	267	.213
Expectation to be current in technologies related to your career field.	3.75	433	3.80	408	.458
Prepare reports and documents.	4.29	470	4.26	456	.470
Prepare and deliver professional presentations.	4.07	473	4.13	466	.317
Function on multi-disciplinary teams.	4.44	473	4.28	441	**.002**
Understanding of ethical and professional responsibility.	4.74	477	4.60	466	**.000**
Recognition of the need to engage in life-long learning.	4.43	480	4.34	466	.090

3. Technical vs. Non-Technical: Do Civilians Differ from Military?

In an earlier section, an independent samples t-test was conducted in order to determine whether respondents who worked in technical jobs felt differently about their level of preparation than those who worked in non-technical jobs. The results of that analysis indicated that, in general, those in technical jobs felt significantly better prepared ($p < .05$) than those in non-technical jobs.

In this section, the intention is to further this analysis by comparing civilian and military respondents. All respondents were asked the general question, “How well did your engineering major at USNA prepare you for your current career?” Responses ranged from 1 (“Not Prepared at All”) to 5 (“Extremely Well Prepared”).

In the analysis, respondents are first grouped according to whether they are military or civilian. Two independent samples t-tests were conducted (one for the civilian group and one for the military group) in order to determine whether respondents who felt that their current jobs were technical in nature believed that they were better prepared than those who felt that their current job is non-technical in nature. The grouping variable is a binomial variable that indicates whether a respondent’s job is technical or non-technical, and the test variable is the respondents’ rating of their level of preparedness. The results are summarized in Tables 16 and 17.

Table 16: How well did Major Prepare for Current Career? (Technical vs. Non-technical for Civilian Respondents)

Civilian Job Description	N	Mean	Std. Dev.
Technical	308	3.97	0.898
Non-Technical	230	3.81	1.048

Table 17: How well did Major Prepare for Current Career? (Technical vs. Non-technical for Military Respondents)

Military Job Description	N	Mean	Std. Dev.
Technical	356	4.11	0.836
Non-Technical	158	3.77	0.977

For the civilian respondents, the significance of the t-test was 0.055. Thus, it cannot be concluded that a significant difference ($p < .05$) exists between technical and non-technical jobs within the civilian group. Within the active duty military group, however, the significance value was smaller than .0001, indicating that a significant difference does exist between technical and non-technical jobs within the military. In particular, those military respondents who felt that their jobs were technical in nature believed, on average, that they were better prepared for their job due to their undergraduate engineering education. In both cases (civilian and military), the average value for “level of preparedness” was higher for those who believed their jobs to be technical, although the difference is statistically significant only for the military group.

I. CIVILIAN/MILITARY: PAIRED SAMPLES T-TEST RESULTS

For the paired samples t-tests, the cases were split into two categories (civilian and military). Each of the 12 “preparedness” questions were paired with their corresponding “applicability” questions, and the paired samples t-test was conducted in order to determine any significant difference between the level of preparedness and the level of applicability for each of the engineering related skills. For these tests, the N value for the civilian group ranged from 534 to 541, and the N value for the military group ranged from 517 to 521. The results are summarized in Table 18.

All but three differences are significant at the $p < .05$ level. A positive value for the mean difference indicates that respondents, on average, gave higher ratings to their perceived level of preparedness relative to the rating of skill applicability. Conversely, a negative value for the mean difference indicates that respondents, on average, gave lower ratings to their perceived level of preparedness relative to the rating of applicability for that skill.

Table 18: Paired Sample T-Test (Mean Differences for Civilian/Military)

Engineering Skill / Ability	**Mean Difference (Preparedness/Applicability)**	
	CIVILIAN	**MILITARY**
Ability to apply knowledge of math, engineering and science.	0.47	0.51
Ability to analyze and interpret data.	No significant difference	0.2
Ability to identify, formulate and solve engineering problems.	0.94	0.98
Ability to design systems, components or processes to meet needs.	0.27	0.94
Ability to design and conduct experiments.	0.87	1.14
Ability to use techniques, skills and tools in engineering practice.	0.73	0.82
Ability to use technologies related to your career field.	**-0.38**	**-0.13**
Ability to prepare reports and documents.	**-0.38**	No significant difference
Ability to prepare and deliver professional presentations.	**-0.58**	**-0.35**
Ability to function on multi-disciplinary teams.	**-0.29**	No significant difference
Ability to accept ethical and professional responsibility.	**-0.16**	**-0.21**
Importance of engaging in life-long learning.	**-0.15**	**-0.19**

For civilian respondents, there was no significant difference between their level of applicability and their level of preparedness for their ability to apply knowledge of math, engineering and science.

For military respondents, there was no significant difference between their level of applicability and their level of preparedness for the following engineering skills:

1. Ability to prepare reports and documents.

2. Ability to function on multi-disciplinary teams.

For all other paired questions, there were significant differences between the mean values of applicability and preparedness, for both military and civilian respondents.

For the skills listed below, the difference between the level of preparedness and the level of applicability was positive, meaning that respondents (on average) gave high ratings for preparedness in these skill areas relative to the level of skill applicability:

1. Ability to apply knowledge of math, engineering and science.

2. Ability to analyze and interpret data.

3. Ability to identify, formulate and solve engineering problems.

4. Ability to design systems, components or processes to meet needs.

5. Ability to design and conduct experiments.

6. Ability to use techniques, skills and tools in engineering practice.

For the skills listed below, the difference between the level of preparedness and the level of applicability was negative, meaning that respondents, on average, gave low ratings for preparedness in these skill areas relative to the level of skill applicability:

1. Expectation to be current in technologies related to your current field.

2. Ability to prepare reports and documents.

3. Ability to prepare and deliver professional presentations.

4. Ability to function on multi-disciplinary teams.

5. Understanding of ethical and professional responsibility.

6. Recognition of the need to engage in life-long learning.

V. SUMMARY, CONCLUSION AND RECOMMENDATIONS

A. SUMMARY

There were several purposes to this research. The primary purpose was to determine the extent to which Naval Academy graduates who majored in engineering believe their undergraduate education to be relevant to their current profession, utilizing the Accreditation Board of Engineering and Technology (ABET) “student learning outcomes” (ABET, 2005, p. 1) as the basis for assessing relevance. The intention was to assess both the applicability of these particular skills to graduates’ current professions, as well as the perceived levels of preparedness in these skill areas afforded respondents due to their undergraduate education.

A secondary purpose was to draw meaningful comparisons between different groups within the sample. These comparison groups include military and civilian, technical and non-technical jobs, and comparison across the different engineering majors.

A third purpose of this research was to establish a body of baseline data about engineering majors who have graduated from the Naval Academy throughout the past 20 years. The intention was to gather a broad base of data about what professions or jobs graduates are currently doing and how their undergraduate education has factored into their careers.

An overarching goal of this research is to examine the relationship between engineering education at the Naval Academy and the impact that education has on graduates after

they graduate and begin their professional lives. Respondents have provided valuable information and insight based on their personal experience, about what skills have been applicable to their professional lives and how they perceive their level of preparation due to their engineering education. The emphasis is on identifying the strengths of the educational program, as well as identifying potential areas for future improvement.

B. CONCLUSION

Overall, Naval Academy graduates who majored in engineering are generally satisfied with the quality of their undergraduate education. They also feel that what they studied in their engineering program is applicable to what they do today.

For 6 of the 12 engineering related skills or abilities that were analyzed in this research, respondents indicated very high levels of importance to their current work. The six most important skills were: “understanding of ethical and professional responsibility;” “prepare and deliver professional presentations;” “recognition of the need to engage in life-long learning;” “function on multi-disciplinary teams;” and “ability to analyze and interpret data.” All of these skills received ratings of importance between 4.38 and 4.74 (i.e., between “very important” and “extremely important”).

The skills that were rated as least important to respondents were: “design and conduct experiments;” “design systems, components or processes to meet needs;” “use techniques, skills and tools in engineering practice;” and

“identify, formulate and solve engineering problems.” These skills received ratings of importance between 2.34 and 3.09 (i.e., between “somewhat important” and “fairly important”). For all of these skills, respondents (on average) indicated high levels of preparedness relative to the level of applicability for the particular skill.

In general, it seems that respondents gave lower ratings of importance to skills that could be seen as particular to technical work. Respondents gave higher ratings of importance to skills that are more universally applicable.

Respondents felt well prepared for the abilities to “design and conduct experiments” and “identify, formulate and solve engineering problems,” yet reported low ratings for the applicability of these skills to their current job.

Conversely, respondents rated their preparedness low relative to the level of applicability in the skill areas of “expectation to be current in technologies related to current career field;” “ability to prepare and deliver professional presentations;” and ability to “prepare written reports and documents;” “ability to function on multi-disciplinary teams;” “understanding of ethical and professional responsibility” and “recognition of the need to engage in life-long learning.” For these skills, respondents reported high levels of preparedness, but they reported extremely high levels of applicability, especially for the skills related to preparing and delivering presentations and preparing reports and documents.

As could be expected, respondents who indicated that their current job or profession was technical in nature felt

that their undergraduate engineering education had prepared them for their job to a significantly higher degree than those respondents who indicated that their current job or profession was non-technical in nature. This result is not surprising, considering the technical nature of the respondents' undergraduate education.

In general, which of the engineering fields a respondent majored in had no significant effect on how well prepared they felt for their current job due to their undergraduate education. Sample means ranged from 4.15 (aeronautics) to 3.75 (general engineering), with an overall average of 3.95 (i.e., "very well prepared"); however, none of the differences between major groups were statistically significant.

This congruence across majors may be a result of the fact that regardless of which particular field a respondent chose to major in, all were required to take a high percentage of core curriculum courses that are common to all engineering majors. While each major offers many technical courses that are specific to that particular field, there are a large number of common courses that provide all engineering majors with similar technical and engineering related skills.

Respondents who had gone on to either complete a master's degree or begin working on a master's degree felt significantly better prepared for graduate education than those respondents who had not advanced their formal education beyond their bachelor's degree. This result seems to indicate that USNA graduates who majored in engineering underestimate the degree to which they are prepared to

pursue advanced education in the form of a master's program. However, it should be noted that respondents were not asked to provide any specific information about the nature of their master's program.

1. Civilian / Military Comparison

On average, respondents who were still active duty military gave slightly higher ratings to their feelings of preparedness for their current job than those respondents who have transitioned to the civilian work force. The difference between military and civilian was statistically significant at the $p < .10$ level, but not at the $p < .05$ level.

This difference in perceived level of preparedness could be driven in part by the fact that a good deal of the core curriculum offered at the Naval Academy is focused on military – specific education, such as courses in leadership, tactics, military history and navigation. These courses are designed specifically to prepare graduates for the time they will serve as officers in the Navy or Marine Corps.

For 9 of the 12 specified engineering related skills, there was no significant difference between civilian and military respondents with respect to their perceived levels of preparedness. Interestingly, for the three skills where a significant difference did exist, civilians gave higher ratings to their level of preparedness than the military respondents. These skills were "the ability to apply knowledge of math, engineering and science;" "function on

multi-disciplinary teams;” and ”understanding of professional and ethical responsibility.”

With respect to the perceived difference between level of preparedness and the level of applicability of each engineering related skill or ability, there are several notable differences between civilian and military respondents. Civilian respondents gave low ratings of preparedness to the skills of “preparing reports and documents” and “ability to function on multi-disciplinary teams” relative to the level of these skills’ applicability. Military respondents showed no significant difference between preparedness and applicability with respect to these skills.

It is interesting to note that although civilian respondents reported higher levels of preparedness than military respondents with respect to “the ability to function on multi-disciplinary teams,” civilians still felt under-prepared in this skill area, whereas military respondents did not. This can be attributed to civilian respondents that reported much higher levels of applicability (4.72) than military respondents (4.30) for this given skill. For all other skills, there were slight variations between civilian and military respondents, but in general, both groups reported similar results when comparing levels of applicability and preparedness.

C. RECOMMENDATIONS AND LIMITATIONS

One limitation to this study was caused by lack of comprehensive access to Naval Academy graduates who majored in an engineering field. Only those graduates who maintain

current contact information with the Naval Academy Alumni Association were able to be contacted, which certainly degrades the randomness of the sample.

Another limitation is that this research was conducted in an entirely quantitative fashion. There is a large amount of qualitative data that was not analyzed. These data are from the part of the survey instrument that allowed respondents to write their own comments in response to several questions. Respondents were asked to comment on the most useful aspects of their engineering education, the least useful aspects of their engineering education, and finally to offer additional comments or suggestions for improvement of the program. The written answers to these questions will provide a good starting point for a qualitative assessment of the Naval Academy's engineering program, and would be an excellent opportunity for future research.

Overall, the results of this analysis demonstrate that graduates of the Naval Academy who majored in engineering are satisfied with their undergraduate education; they believe that most of what they studied is applicable to what they do now; and that they were well prepared in most areas. Possible areas for program improvement would be to give students more opportunities to learn how to prepare and deliver professional presentations and prepare written reports and documents; these skills will greatly benefit them after graduation. Additional opportunities for students to participate in multi-disciplinary groups, or to work on group projects, will provide them with valuable experience that will be useful to them in their professional careers.

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX A: GRADUATE PERFORMANCE ASSESSMENT SURVEY

USNA ABET GRADUATE SURVEY

Division of Engineering and Weapons

Administered Jan-Feb 2006

Survey flow:

1. Everyone takes the first part of the survey.
2. Only currently active military take the 'active military' part of the survey.
3. All others take the 'non-active military' part of the survey.
4. Everyone takes the last part of the survey.

The next page starts the FIRST PART of the survey.
(Everyone takes this part of the survey.)

Graduate Performance Assessment Survey

Phase I: USNA Engineering Majors Graduates

This survey is intended to collect assessment information regarding each of our engineering programs (majors) at USNA. The information collected via this survey will be analyzed and used by each department to help improve their respective programs in order to best prepare future graduates for their military and professional careers.

You are asked, as a graduate of a USNA engineering program, to provide the following information voluntarily and anonymously. No identifying information will be linked to your responses. Questions regarding the survey may be directed toward Associate Professor Jennifer Waters.

What is your current military duty status?

○	Active Duty (non-reservist)
○	Reservist on Active Duty (>=180 days, Recall or Mobilized)
○	Reservist on Active Duty (<180 days, AT, ADT, or ADSW)
○	Drilling Reservist (SELRES or IRR)
○	Retired (Active or Reserve)
○	Civilian

How many years were you or have you been in active duty status since graduating from USNA?

Select # of Years

Since graduating from USNA, how many years (if any) have you been in a non-active duty status?

Select # of Years

4. What is your current or highest military rank achieved?

○	O-1

○	O-2
○	O-3
○	O-4
○	O-5
○	O-6
○	Flag Rank

Continue

The next page starts the ACTIVE MILITARY PART of the survey.
(Active military only take this part of the survey.)

Graduate Performance Assessment Survey

Phase I: USNA Engineering Majors Graduates

In which community do you serve?

○	Aviation
○	Spec Ops
○	Spec Warfare
○	Subs
○	Surface
○	Restricted Line / Staff Corps: AEDO
○	Restricted Line / Staff Corps: AMDO
○	Restricted Line / Staff Corps: Chaplain Corps
○	Restricted Line / Staff Corps: Civil Engineer Corps
○	Restricted Line / Staff Corps: Engineering Duty
○	Restricted Line / Staff Corps: Human Resources
○	Restricted Line / Staff Corps: Information Professional
○	Restricted Line / Staff Corps: Information Warfare
○	Restricted Line / Staff Corps: Intelligence
○	Restricted Line / Staff Corps: JAG Corps
○	Restricted Line / Staff Corps: Medical Assignments
○	Restricted Line / Staff Corps: METOC
○	Restricted Line / Staff Corps: Public Affairs
○	Restricted Line / Staff Corps: Supply Corps
○	Marine Air
○	Marine Ground
○	Other

Please list any military professional schools you have attended (e.g., flight

school, nuclear power school, TBS, etc.):

Would you assess the nature of your current position as technical or non-technical?

- ○ Technical
- ○ Non-technical

Do you intend to complete a career serving in the military?

- ○ Definitely Yes
- ○ Undecided
- ○ Definitely No

Continue

The next page starts the NON-ACTIVE MILITARY PART of the survey.
(Non-active military only take this part of the survey.)

Graduate Performance Assessment Survey

Phase I: USNA Engineering Majors Graduates

Please answer the following questions regarding your CURRENT PROFESSIONAL (CIVILIAN) EMPLOYMENT:

What is your employment status?

○	Currently employed full-time
○	Currently employed part-time
○	Self-employed
○	Not currently employed, and looking
○	Not currently employed, and not looking
○	Retired full-time

If you are currently employed full or part-time, please complete the following:

Position Title:

Name of Employer:

City/State:

Which of the following choices best describes your employment and employer?

○	Engineering/Technical position in an engineering/technically-based organization
○	Non-technical position in a technically-based organization
○	Technical position in a non-technically based organization
○	Non-technical position in a non-technically-based organization

Which of the following levels best describes your current position?

○	Senior Executive (President, CEO, COO, etc.)
○	Upper Management (Vice President, Director, etc.)
○	Senior Technical/Professional
○	Mid-Level Manager
○	Mid-Level Technical/Professional
○	Entry Level
○	Other

Is your current position related to your major at USNA?

○	To a great extent
○	Somewhat
○	Not at all

How many years have you held your current position?

Select # of Years

Continue

The next page starts the LAST PART of the survey.
(Everyone takes this part of the survey.)

Graduate Performance Assessment Survey

Phase I: USNA Engineering Majors Graduates

Are you willing to be listed in a database for midshipmen to contact regarding caree or other professional information?

○	No
○	Yes - Please give e-mail address or other contact info below. Alternately, if you prefer, you may send an e-mail to: Associate Professor Jennifer Waters, jwaters@usna.edu. Enter your contact information here:

Upon completion of your engineering majors program at USNA, rate your preparation for the following abilities/characteristics:

	Not at all Prepared	Somewhat Prepared	Adequate	Very Prepared	Extreme Prepare
Ability to apply knowledge of math, engineering, and science.	○	○	○	○	○
Ability to analyze and interpret data.	○	○	○	○	○
Ability to identify, formulate, and solve engineering problems.	○	○	○	○	○
Ability to design system, component, or process to meet needs.	○	○	○	○	○
Ability to design and conduct experiments.	○	○	○	○	○
Ability to use techniques, skills, and tools in engineering practice.	○	○	○	○	○
Expectation to be current in technologies related to your career field.	○	○	○	○	○
Ability to prepare reports and documents.	○	○	○	○	○

Ability to prepare and deliver professional presentations.	○	○	○	○	○
Ability to function on multi-disciplinary teams.	○	○	○	○	○
Understanding of ethical and professional responsibility.	○	○	○	○	○
Recognition of need to engage in life-long learning.	○	○	○	○	○

In your current position, how important are the following?

	Not at all Important	Somewhat Important	Fairly Important	Very Important	Extremely Important	Not Applicab
To apply knowledge of math, engineering, and science.	○	○	○	○	○	○
To analyze and interpret data to solve open-ended problems.	○	○	○	○	○	○
To identify, formulate, and solve engineering problems.	○	○	○	○	○	○
To design system, component, or process to meet needs.	○	○	○	○	○	○
To design and conduct experiments.	○	○	○	○	○	○
To use techniques, skills, and tools in engineering practice.	○	○	○	○	○	○
To be current in technologies related to your career field.	○	○	○	○	○	○
To prepare reports and documents.	○	○	○	○	○	○
To prepare and deliver professional presentations.	○	○	○	○	○	○
To function on multi-disciplinary teams.	○	○	○	○	○	○
Ethical and professional responsibility.	○	○	○	○	○	○
To engage in life-long						

learning.	○	○	○	○	○	○

How well did your major at USNA prepare you for your current career?

- ○ Not at all Prepared
- ○ Somewhat Prepared
- ○ Adequate
- ○ Very Prepared
- ○ Extremely Prepared

How often do you attend professional conferences, meetings, symposia, etc.?

- ○ Never
- ○ Once per year
- ○ Between two (2) and five (5) times per year
- ○ More than five (5) times per year

Do you hold a professional engineer's (P.E.) license?

- ○ Yes
- ○ I have passed the FE or EIT exam, and intend to pursue P.E. licensing
- ○ I have passed the FE or EIT exam, but do not intend to pursue P.E. licensing
- ○ No, but I intend to pursue P.E. licensing
- ○ No and do not intend to pursue P.E. licensing

List the professional associations or societies to which you belong:

List any significant technical honors, awards, or patents received:

Whether or not you have attended graduate school, how well do you believe *your majors program* at USNA prepared you for graduate school?

○	Not at all Prepared
○	Somewhat Prepared
○	Adequate
○	Very Prepared
○	Extremely Well Prepared

Indicate the highest degree you have attained:

○	Ph.D. degree or equivalent
○	Master's degree or equivalent
○	Bachelor's degree
○	Some graduate work
○	Other

Please specify each additional degree - including discipline - you have attained since graduating from USNA and the school(s) attended. For example: Ph.D., Mechanical Engineering, University of Maryland; M.S., Systems Engineering, Naval Postgraduate School.

Briefly list the most useful aspect(s) of *your engineering majors program at USNA*:

Briefly list the least useful aspect(s) of *your engineering majors program at USNA*:

Additional comments or suggestions for improvement regarding *your engineering majors program at USNA*:

Please describe any experiences or feedback related to your *academic program* not adequately captured elsewhere in this survey.

Submit Information

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX B: SAMPLE DESCRIPTIVE STATISTICS

Table 19: Highest Military Rank Achieved

Rank	Frequency	Percent
O-1	87	8.1
O-2	107	10.0
O-3	493	46.2
O-4	268	25.1
O-5	108	10.1
O-6	1	0.1
Missing	4	0.4
Total	1068	100.0

Table 20: Warfare Community

Community	Frequency	Percent
Aviation	224	43.5
Submarine Warfare	79	15.3
Surface Warfare	48	9.3
USMC	69	13.4
SPECWAR / SPECOPS	9	1.7
Civ. Eng. Corps / Eng. Duty Officer	46	8.9
Other	40	7.8

Table 21: Job Description (Military)

Job Description	Frequency	Percent
Technical	357	69.3
Non-Technical	158	30.7
Total	515	100.0

Table 22: Job Description (Civilian)

Job Description	Frequency	Percent
Engineering / Technical Position in Engineering / Technically based organization	259	48.0
Non-technical position in Technically based org.	107	19.8
Technical position in Non-Tech. org.	49	9.1
Non-tech position in Non-tech org.	125	23.1
Total	540	100.0

Table 23: Job Level (Civilian)

Level within Organization	Frequency	Percent and Valid Percent	Cumulative Percent
Senior Exec. (President, CEO, COO, CIO, CFO)	40	7.4	7.4
Upper Mngmt (VP, Director)	101	18.7	26.1
Senior technical / Professional	118	21.8	47.9
Mid-level Management	130	24.0	71.9
Mid-level technical / professional	107	19.8	91.7
Entry Level	18	3.3	95.0
Other	27	5.0	100.0
Total	541	100.0	

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF REFERENCES

ABET Engineering Accreditation Commission. (2006, October 28). *Criteria for Accrediting Engineering Programs: Effective for Evaluations During the 2007-2008 Accreditation Cycle,* (E1 11/15/06).

Accreditation Board of Engineering and Technology (2007). *Accredited Programs*. Retrieved March 24, 2007 from http://www.abet.org/schools.asp.

Accreditation Board of Engineering and Technology (2007). *History*. Retrieved March 24, 2007 from http://www.abet.org/history.shtml.

Aft, L. (2002). Evaluating Higher Education Programs in Quality: ASQ Assists ABET. *Quality Progress, 35*(10), 30-31.

Anaya, G. (1999). College Impact on Student Learning: Comparing the Use of Self – Reported Gains, Standardized Test Scores, and College Grades. *Research in Higher Education, 40*(5), 499-516.

Bassis, M. S. (1977, May). The Campus as a Frog Pond: A Theoretical and Empirical Reassessment. *The American Journal of Sociology, 82*(6), 1318-1326.

Bowman, W. R. (1990). Do Engineers Make Better Naval Officers? *Armed Forces and Society*, *16*(2), Winter: 271-286.

Brinzendine, A. L. (2004, November). *What Have We Learned from Recent Experiences with the Accreditation of Engineering Technology Programs Under the New Outcomes Assessment Criteria?* [Slides]. Indianapolis, IN: Assessment Institute.

Cabrera, A. F., Colbeck, C. L., & Terenzini, P. T. (2001). Developing Performance Indicators for Assessing Classroom Teaching Practices and Student Learning: The Case of Engineering. *Research in Higher Education, 42*(3), 327-352.

Christy, A. D., & Lima, M. (1998, April). The Use of Student Portfolios in Engineering Instruction. *Journal of Engineering Education*, 143-148.

Couper, M. P., Traugott, M. W., & Lamias, M. J. (2001). Web Survey Design and Administration. *Public Opinion Quarterly, 65*(2), 230-253.

Dalton, W. K. (Ed.). (1995). *Assessing Student Learning: It Can Be More Than A Survey. Proceedings from the 1995 Frontiers in Education Conference, Session 2c1*, 13-16.

DeLyser, R. R., & Hamstad, M. A. (Eds.). (2000). *Outcomes Based Assessment and a Successful ABET 2000 Accreditation at the University of Denver*. *Proceedings from the 30th ASEE/IEEE Frontiers in Education Conference, Session T1A*, 1-6.

Felder, R. M., & Brent, R. (2003). Designing and Teaching Courses to Satisfy the ABET Engineering Criteria. *Journal of Engineering Education, 92*(1), 7-25.

Haws, D. R. (2001, April). Ethics Instruction in Engineering Education: A (Mini) Meta-Analysis. *Journal of Engineering Education*, 223-229.

McGourty, J., Besterfield-Sacre, M., & Shuman, L. (Eds.). (1998*). ABET's Eleven Student Learning Outcomes (a-k): Have We Considered the Implications? Paper presented to ASEE.* Seattle, Washington.

McGourty, J., Sebastian, C., & Swart, W. (1998, October). Developing a Comprehensive Assessment Program for Engineering Education. *Journal of Engineering Education*, 355-361.

Patton, M. Q. (1982). *Practical Evaluation*. California: Sage Publications.

Patton, M. Q. (1987). *How to Use Qualitative Methods in Evaluation*. California: Sage Publications.

Prados, J. W., Peterson, G. D., & Lattuca, L. R. (2005, January). Quality Assurance of Engineering Education through Accreditation: The Impact of Engineering Criteria 2000 and Its Global Influence. *Journal of Engineering Education*, 165-184.

Regan, T. M., & Schmidt, J. A. (Eds.). (1999). *Student Learning Outcomes: Alumni, Graduating Seniors and Incoming Freshmen. Proceedings of the 29th ASEE/IEEE Frontiers in Education Conference, Session 13a5*, 16-21.

Rogers, G. M. (2000, April). EC2000 and Measurement: How Much Precision is Enough? *Journal of Engineering Education*, 161-165.

Scales, K., Owen, C., Shiohare, S., & Leonard, M. (1998, July). Preparing for Program Accreditation Review Under ABET Engineering Criteria 2000: Choosing Outcome Indicators. *Journal of Engineering Education*, 207-210.

Schneider, S. C., & Niederjohn, R. J. (Eds.). (1995). *Assessing Student Learning Outcomes Using Graduating Senior Exit Surveys and Alumni Surveys. Proceedings from the 1995 Frontiers in Education Conference, Session 2c1*, 1-5.

Schwarz, N. (1995). What Respondents Learn From Questionnaires: The Survey Interview and the Logic of Conversation. *International Statistical Review, 63*(2), 153-177.

Shaeiwitz, J. A. (1998, April). Classroom Assessment. *Journal of Engineering Education*, 179-183.

Strauss, L. C., & Terenzini, P. T. (Eds.) (2005). *Assessing Student Performance on EC2000 Criterion 3.a-k. Proceedings of the 2005 American Society for Engineering Education Annual Conference and Exposition,* 1-12.

Royse, D., Thyer, B. A., Padgett, D. K., & Logan, T. K. (2001). *Program Evaluation: An Introduction* (3rd ed.). Canada: Wadsworth.

United States Naval Academy Institutional Research (2004, November 19). *Midshipmen Strength by Class (As of 30 September 2004)*. Retrieved March 26, 2007 from http://www.usna.edu/IR/restricted/databook/archivedb0304/htmls/sec2midstrength.html.

United States Naval Academy: Institutional Research, Planning and Assessment (2007, January 17). Retrieved March 26, 2007 from http://www.usna.edu/IR.

Volkwein, J. F., Lattuca, L. R., Terenzini, P. T., Strauss, L. C., & Sukhbaatar, J. (2004). Engineering Change: A Study of the Impact of EC2000. *International Journal of Engineering Education, 20*(2), 1-11.

Watson, J. L. (1998, July). An Analysis of the Value of the FE Examination for the Assessment of Student Learning in Engineering and Science Topics. *Journal of Engineering Education*, 305-311.

INITIAL DISTRIBUTION LIST

1. Defense Technical Information Center
   Ft. Belvoir, Virginia

2. Dudley Knox Library
   Naval Postgraduate School
   Monterey, California

3. Nimitz Library
   United States Naval Academy
   Annapolis, Maryland

4. Superintendent
   United States Naval Academy
   Annapolis, Maryland

5. Commandant of Midshipmen
   United States Naval Academy
   Annapolis, Maryland

6. Office of Institutional Research
   United States Naval Academy
   Annapolis, Maryland

7. Professor Susan P. Hocevar, Ph.D.
   Naval Postgraduate School
   Graduate School of Business and Public Policy
   Monterey, California

8. Professor Linda D. Mallory, Ed.D.
   Office of Institutional Research
   United States Naval Academy
   Annapolis, Maryland

9. Lieutenant Michael T. O’Reilly, USN
   Commandant’s Staff
   United States Naval Academy
   Annapolis, Maryland