Is the Postage Worth It?
Lesson Learned From Grad Surveys

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Abstract: The Civil Engineering Department at the Virginia Military Institute has been conducting surveys of their recent graduates and their employers since 1990. This survey was started with the 1986 graduating class and has continued through the 2004 graduating class. This paper discusses the original objectives of the survey, the survey format, changes in the survey method, lessons learned, industry trends in entry level employment skills, curriculum changes and use of a longitudinal survey as an assessment tool. The results of the recent graduates' and employers' surveys and any trends and patterns, which evolved over the 20 graduating classes surveys, are identified and discussed. A review of curriculum changes and the effect on the recent graduates and their employers is included

Introduction and Background Information

In the spring of 1990, engineering faculty members were invited to participate in a program to explore and create innovative assessment tools for VMI engineering programs. A survey of recent graduates, specifically the previous three graduating classes and the employers of these recent graduates, was developed. The graduate and employer surveys were designed to compare VMI's graduates with graduates of other schools during the initial phase of employment and to assess VMI's recent graduates' performance in the work place. The initial surveys were sent to the following groups, (1) the graduate, (2) the employer of the graduate, (3) the faculty of the under graduate, and (4) the graduate school faculty of the graduate. These surveys have been repeated every three years, thereby surveying all graduating class and their employers from 1987 to 2002. A three year time interval was selected to minimize the effect of job training and to give a better indication of entry-level skills and abilities of the VMI graduate. This time period would provide a window on the entry level skills and reflex back on the factors we could influence.

The basic objective of the survey are to: (1) compare recent graduates with other recent graduates, (2) identify the program's strengths and weaknesses, (3) identify the important entry level attributes, (4) detect any trends in the market place for our graduates, (5) identify curriculum changes, (6) measure the impact of a curriculum change, and (7) answer some specific issues in under graduate civil engineering education.

One of the current ABET 2000 assessment requirements is to provide a method to evaluate the performance of graduates and to use this information to improve the civil engineering program and curriculum. The information provided by these surveys helps to identify the civil engineering program's strengths and weakness. The surveys have been used to make various curriculum improvements.

Questionnaires

The questionnaire format was developed that asked the same basic question to the recent graduate and the employer of that graduate. A set of basic performance attributes were selected to identify entry level skills and these entry level attributes were the center piece for the surveys. These entry levels attributes as shown in Table 1. *Entry Level Attributes.*

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Table 1. Entry Level Attributes

Ethical Decision Making	*Creativity*
Technical Ability	*Following Directions*
Reading Comprehension	*Responsibility*
Understanding Complex Issues	*Management Skills*
Oral Communications	*Leadership Skills*
Critical Thinking	*Written Communications*
Problem Solving	*Ability to meet deadlines with quality work*

To get an overall impression of the general abilities of VMI graduates compared to other recent graduates, the recent graduate and the employer are asked to compare the ability to meet each of these attributes with other entry level employees. A five point scale was used; (1) much better than (2) better than (3) equal to (4) worse than (5) much worst than or (6) can not determine. Both groups were asked to select the most critical of these entry level attributes for a starting engineer. The two groups were also asked to list the five strengths and the five weaknesses of the VMI entry level graduates using the list of entry level attributes.

To aid in data comparison and trend analysis the fourteen (14) Entry Attributes were divided into three (3) groups: Technical Skills, Communication Skills, and Professional Skills. The Entry Skill Grouping is shown in Table 2. *Entry Level Attributes Groups.*

Table 2. Entry Level Attributes Groups

Technical Skills	Communication Skills	Professional Skills
-Technical Ability	-Oral Communications	-Ethical Decisions
-Problem Solving	-Written Communications	-Responsibility
-Critical Thinking	-Reading Comprehension	-Leadership
-Understanding Complex Issues	-Following Direction	-Creativity
		-Management Ability
		-Meeting Deadlines with Quality Work

The performance of the graduates in these three (3) skill groups as judged by the Graduates Survey and Employers Survey for the time period of 1987 – 2002 is examined and presented in the results section of the paper. When possible conclusions can be drawn and comparisons are pointed-out. During these fifteen (15) year period changes were made in the curriculum, these will be noted.

Return Rates
The graduate and employer surveys were developed to ask similar questions and therefore have a similar format. When the study began, the graduate and employer would be mailed and the packet included a letter of explanation and a stamped return envelope. The addresses of the recent graduates were provided by the alumni provided office and the employer address by the placement office. This procedure has been altered and the present method uses on-line surveys. Graduates are contacted four times. The first notification was in the CE News Letter. An article

introduces the survey and points out the importance and how the data will be used. The graduates were asked to go on-line and complete the survey and to ask their employer to complete the Employers Survey. A follow-up post card is sent to all members of the graduating classes using the addresses provided by the alumni office and E-mails were sent using addresses collected by the Civil Engineering Department. Finally, a hard copy of the survey was sent to members of the graduating classes, who had not returned a survey.

The Employers Survey is a double blind survey; neither the graduate nor the employer is identified. We do not have the addresses for the employers. Each graduate is asked to have his/her employer go on-line or to fill out a hard copy of the Employer Survey. This type of survey will produce a bias return. The Graduates Survey is only filled out by a self selected group and we must rely on the graduates to supply the Employers Survey to their supervisor. The number of Employers Surveys is reduced by percentage of Graduates that pass on the survey and the number of Employers that choose to fill it out. Considering these limitation the return rates for the survey are in the acceptable range and the rates of return for the surveys are provided in Table 3. *Survey Return Rates* and Figure 1. *Rate of Return for Surveys*.

Table 3. Survey Return Rates

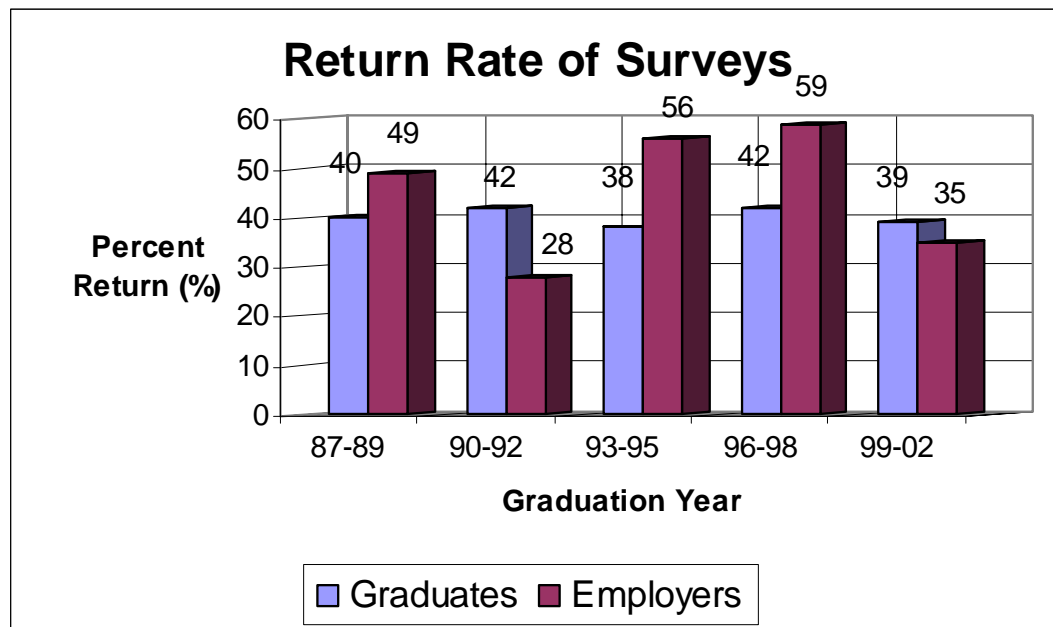| Year	Graduates	Percentage	Employers	Percentage
1987-1989	270	40	61	49
1990-1992	150	42	55	28
1993-1995	126	38	48	56
1996-1998	108	42	45	59
1999-2002	118	39	46	35

Figure 1, Rate of Return for Surveys

The decease in employers' rate of return beginning with the 1990 survey may be the result of employers not willing to provide employee performance information. The method for

distributing the 1993 and 1996 employers' survey was changed so that the employer and the graduate were not identified.

Surveys Results and Changes in VMI Civil Engineering Curriculum

An overview of the changes in the curriculum is provided in Table 4. *An Overview of Civil Engineering Curriculum Changes*. Over the last 15 years the Civil Engineering Curriculum has had three periods of major changes. The first of these was for 1990-1991 academic year. The major changes were to add a required speech course SP 300 and to add a major writing assignment to the junior year during the second semester. This paper is included in a required seminar course. These changes were in response to the need to strengthen the communication skills of the graduate. In addition, two programming courses, BASIC and FORTRAN, were replaced by a single spreadsheet course. The removal of specific programming language courses is a direct result of the survey results.

Table 4. An Overview of Civil Engineering Curriculum Changes	
Academic Year	Changes in Curriculum
1988-1989	Require CE 446 – Capstone Design
1990-1991	Require SP 300 – Speech Course
	Add a Technical Writing Element to all 300 level CE course
	Require CE 319 – Fluids Mechanics Lab
1995-1996	Remove AC 101 – Required Academic Computing course
	Remove CS 106 – Requires BASIC Computing course
	Remove CE 201 – Required FORTRAN Computing course
	Require CE 108 - Required Spreadsheet course
	Moved CE 323 Steel Design from a Required course to an Elective course
	Require CE 450 – Professional Practice course
2001-2003	Replace MA 119 – Finite Math with CE 204 Engineering Computations
	Require CE 352 – Construction Management
	Require CE 322 – Water Resources
	Develop multi sections of CE 446 Capstone Design
2003-2004	Changes in MA sequence
	Added MA 326 – Probability and Statistics

The second set of curriculum changes occurred prior to the 1995-1996 academic years. The primary objective at that time was to reduce the total hours for graduation from 144 to 138. The secondary objective was to strengthen the technical offerings and to address any program weaknesses. The lack of improvement in written communication was addressed by adding writing components to all civil engineering courses. These components included adding more explanations to lab reports, letter writing requirements, term papers requirements for more courses, and formal reports for group projects. In response to the need to improve the technical ability of the recent graduates, the curriculum was modified to allow students to have more technical electives and two new courses were developed. These courses are CE 406 Principles of Contaminant Hydrogeology and CE 412 Environmental Engineering Chemistry. The need for graduates to have some introductory skill in legal aspects of civil engineer and construction management, which was listed in many surveys, was met by a required course in the junior year and an additional Construction Management course was added to the list of elective available to all students.

The last groups of curriculum changes were during the 2002-2003 academic years. The Finite Math course was replaced with a required Engineering Computation course. The Construction Management course was changed from an elective to a required course. Finally, a required Water Resources course replaced the Hydrology elective. All of these changes have been influenced by the graduate and employer surveys, EIT results and faculty desires.

Results from the Recent Graduate and Employer Surveys 1987-2002

The three (3) Skill Groups, Technical Skills, Communication Skills, and Professional Skills, results for both surveys are presented. For each Skill Group the trends of the results are discussed, the effects of any curriculum change are presented and the conclusions for that Skill Group are given. The Technical Skills performance for recent graduates and employers are shown in Figure 2. Assessment of *Technical Skills 1987-2002*.

Technical Skills

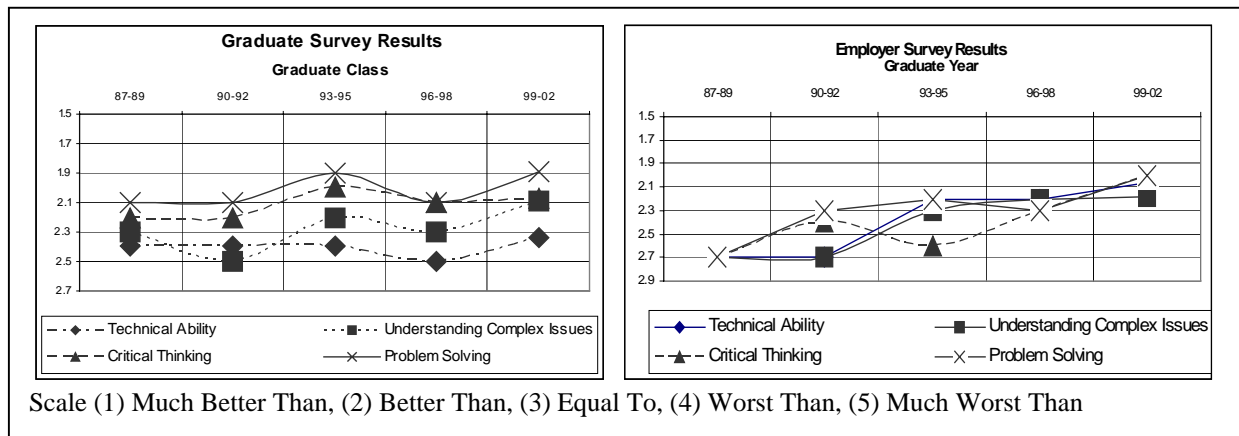Scale (1) Much Better Than, (2) Better Than, (3) Equal To, (4) Worst Than, (5) Much Worst Than

Figure 2. Assessment of Graduates Technical Skills for Classes 1987-2002

Trends
All of the Entry Level Attributes in the Technical Skills Group have received a rating better than 2.5 for the 16 graduating classes. This rating indicates that recent graduates feel that their Technical Skills are at least equal to other recent graduates and in some cases better than other graduates. The overall trends for graduate's technical skills show a modest increase. All of the Entry Level Attributes in this group have increased at leased 10 percent. The relative ranking has also remained constant with the ability to solve problems receiving the highest score and the overall technical ability receiving the lowest score.

The Employer Survey indicates a positive trend for all Entry Level Attributes in the Technical Skills group. All attributes shown at least a half point increase and Critical Thinking and Problem Solving Have improved to a rating of Better Than Other Graduates. The Employers Survey ranks all attributes in this group for recent graduates higher than the Graduates Survey.

Effects of Curriculum Changes
The Curriculum Changes have had a positive impact on the performance of the recent graduates. The improvements in Critical Thinking and Technical Ability may be a result of changes in the

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capstone design course. This course allowed the cadet to concentrate their effort in one area of the Civil Engineering Curriculum.

Conclusion
Overall the recent graduates have shown improvement in the Technical Skills area. Changes in the curriculum are improving the ratings in this skill group. There is some concern that the lowest rated attribute in this group is Technical Ability. The second area of concern is the rating from the Employers Survey for Understanding Complex Issues.

Communication Skills
The results of the Graduate and Employers Surveys for the Communication Skills Group are presented in Figure 3. *Assessment of Graduates Communication Skills 1987-2002.*
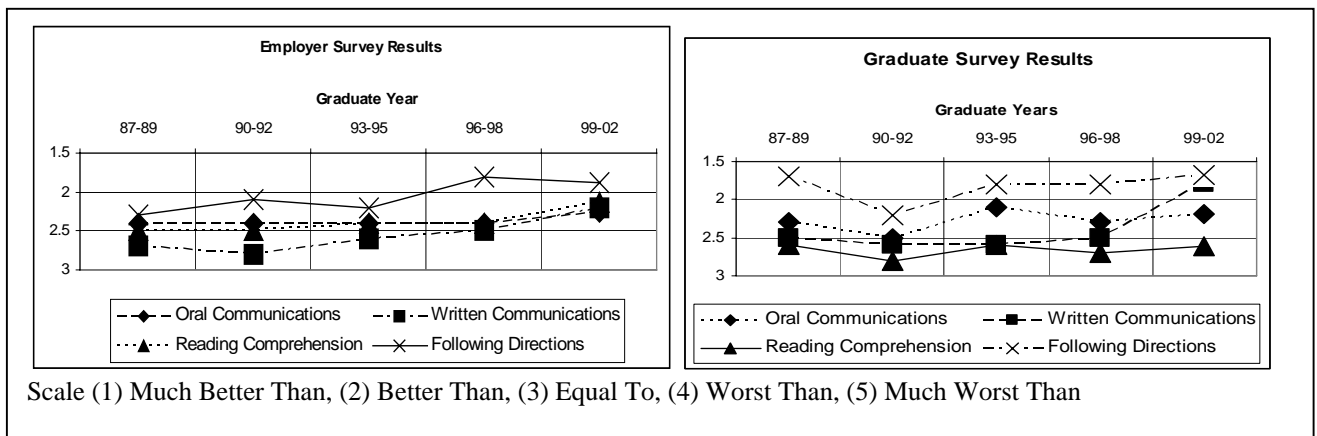

Scale (1) Much Better Than, (2) Better Than, (3) Equal To, (4) Worst Than, (5) Much Worst Than

Figure 3. Assessment of Graduates Communication Skills for Classes 1987-2002

Trends
All trends for the Communication Attributes are positive and the ratings are approaching the "Better Than" benchmark. The ability to follow directions leads the way with a score greater than 1.7 on the 5 point scale. The greatest improvements are in the written communication and the oral communication attributes. The recent improvement is oral communication satisfying. The constant rate of improvement for the graduates writing ability is noteworthy. The lack of improvement in the reading comprehension is of some concern.

Effects of Curriculum Changes
The impact of adding technical writing assignments to all CE 300 level course in the 1990 academic year was enforced by more technical writing in the 1996 academic year has made the recent graduates better writers. The required speech course has also contributed to the improved scores in oral communication. It is difficult for the Civil Engineering curriculum to take credit for the high ratings in the Following Directions category. These ratings are probability the result of the type of students and the military environment at VMI. The improvement in Reading Comprehension Attribute for the 1999-2002 graduates is not a result of any specific curriculum change.

Conclusions
The results from both the Graduate Survey and Employers Survey agree that the recent graduates have good communication skills. Both surveys point out that the best attribute is the ability to

follow direction. The positive trend in writing communication and oral communication attributes are a direct result of curriculum changes.

Professional Skills
Figure 4, *Assessment of the Graduates Professional Skills for the Classes 1987-2002* is shown below.
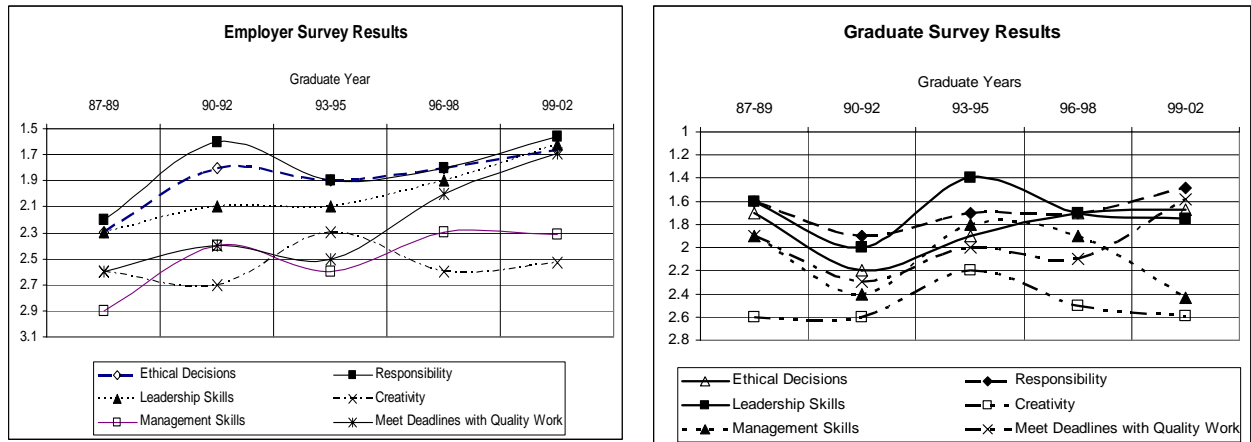
Scale (1) Much Better Than, (2) Better Than, (3) Equal To, (4) Worst Than, (5) Much Worst Than
Figure 4. Assessment of Graduates Professional Skills for Classes 1987-2002

Trends
The Graduate Survey indicates a mixed picture of the trends; there are three (3) positive trends (Ethical Decisions, Responsibility, Meet Deadlines with Quality Work) and three (3) negative trends (Creativity, Management Skills, Leadership Skills). With the exception of Creativity and Management Skills the ratings for the Professional Skills group are all in the "Better Than" range.

The Employers appraisal of the professional skills are positive and approach or exceed the "Better Than" rating. The highest ranking of the attributes are (1) Responsibility, (2) Leadership, Ethical Decisions, and Meet Deadlines with Quality Work.

Effects of Curriculum Changes
The Civil Engineering curriculum has been modified twice to introduce management courses into the required curriculum. These courses have made a minor improvement in the Management Skills attribute.

Conclusions
Both the Graduates and Employers Surveys rate the recent graduates "Better Than Their Peers" in four (4) attributes: (1) Responsibility, (2) Ethical Decisions, (3) Leadership, and (4) Meeting Deadlines with Quality Work. These attributes continue to have a positive trend from both surveyed groups.

Industry Trends and the Responses by Curriculum Changes

The Graduate and Employers Surveys have provided some information that can be used to identity some industry trends**.** The use of computer programs and the required skills which an entry level engineer must bring to the industry have been tracked. The second area of industry trends was the basic question, "What are the five (5) most important entry level skills?" and the follow up question, " What is the single most important skill for an entry level engineer?". The

results of these questions for the graduation years 1987 – 2002 are presented and any impact of a curriculum change is provided.

Computer Skills

Beginning with the survey of 1990 graduates and their employers the surveys asked the importance of the following six (6) general types of computer software: Word-processing, Spreadsheets, Data Bases, CADD, Curve Fitting/Plotting, and Design Programs. The results for the Graduate and Employers Surveys are shown in Table 5, *The Importance of Computer Skills*. An additional computer software type, GIS/GPS, has been added for the most recent survey.

Table 5. The Importance of Computer Skills

Skill Area	Graduate Response					Employer Response				
	1987-89	1990-92	1993-95	1996-98	1999-02	1987-89	1990-92	1993-95	1996-98	1999-02
Word-processing	N/A	2.5	1.33	1.16	1.29	N/A	N/A	1.79	1.44	1.44
Spreadsheets	N/A	2.5	1.15	1.11	1.15	N/A	N/A	1.37	1.41	1.37
Data Base	N/A	1.5	2.38	2.53	2.48	N/A	N/A	2.26	2.26	2.58
GIS/GPS Software	N/A	N/A	N/A	N/A	2.72	N/A	N/A	N/A	N/A	3.12
CAD	N/A	2	2.16	2.23	2.11	N/A	N/A	2.16	2.37	2.57
Curve Fitting/Plotting	N/A	1.8	2.39	2.23	2.72	N/A	N/A	2.74	2.78	3.01
Canned Design Programs	N/A	1.7	3.35	3.21	2.9	N/A	N/A	2.58	3.04	3.07

Scale: (1) Required , (2) Very Desirable, (3) Desirable, (4) Not Important

Trends

The importance of Spreadsheets and Word-processing has become a required skill for entry level engineers. The ability to use CAD equipment has remained a very desirable skill and the ability to use Data Base and Programs Designed for Specific Needs (Canned Designed Programs) has declined in importance. The Employers Survey has grouped the six (6) computer programming skills into three (3) groups: Required – Word-processing and Spreadsheets, Desirable – CAD and Data Base, and Desirable – Curve-Fitting and Specific Design Programs.

The latest addition to the computer software question, GIS/GPS has received a Desirable rating from both surveyed groups.

Effects of Curriculum Changes

The Civil Engineering curriculum has changed to meet the importance of computer applications in the entry level position. Word-processing has been required for all technical writing assignments since 1990 and the BASIC and FORTRAN programming course were replaced by a Spreadsheet course in 1995. CAD drawing course has also been a required course since 1990. The Civil Engineering curriculum has changed to meet the importance of computer applications in the entry level position. A GIS/GPS elective has been added to the curriculum.

Most Important Entry Level Skills

Each of the survey groups, Graduates and Employers, were asked to select the 5 most important of the entry level attributes. The results are provided in Table 6. *The Five (5) Most Important Skills for Entry Level Engineers*. The results were very consistence between the two groups and identified the most important attribute in each of the three (3) skill groups. In the Technical Skills Group the most important entry level attributes were Technical Ability and Problem Solving. The recent graduates selected these two attributes in all graduating years. In the Communications Skills Group, the ability to speak was the most important followed closely by the ability to write

clearly. The ability to produce quality for on time and responsibility were the most important attributes in the Professional Skills Group.

Table 6. The Five (5) Most   Important Skills for Entry Level Engineers

	Graduates					Employers				
	87-89	90-92	93-95	96-98	99-03	87-89	90-92	93-95	96-98	99-02
Technical Skills										
Technical Ability	X	X	X	X	X	X		X		X
Problem Solving	X	X	X	X	X			X		X
Critical Thinking										
Understanding Complex Issues										
Communication Skills										
Oral Communications	X	X	X	X	X	X	X	X		X
Written Communications	X	X	X			X	X			
Reading Comprehension										
Following Directions				X			X		X	
Professional Skills										
Ethical Decisions									X	X
Responsibility	X			X	X	X	X	X	X	
Leadership Skills									X	
Creativity										
Management Skills										
Meet Deadlines with Quality Work		X	X		X	X	X	X	X	X

Trends
The important attributes in each skill group are as follows: Technical Skills – Technical Ability and Problem Solving, Communication Skills – Oral Communications and Written Communications, and Professional Skills- Responsibility and Meet Deadlines with Quality Work. The most consistences of these attributes from both the Graduates and the Employers are Technical Ability, Oral Communications, Responsibility, and Meeting Deadlines with Quality Work. There appears to be less importance from the Employers on Written Communications and an increase importance on Ethical Decisions.

The Most Important Entry Level Skills as identified by the surveys are as follows: (1) Oral Communications, (2) Technical Ability, (3) Problem Solving, (4) Meeting Deadlines with Quality Work, (5) Written Communications, and (6) Responsibility. These attributes for entry level employment are very constant over the 15 graduating classes.

Effects of Curriculum Changes
Changes in the curriculum will affect these attributes in different ways. All changes in the technical content will directly impact Problem Solving and Technical Ability, and to a lesser degree Meet Deadlines with Quality Work. The continued practice of requiring technical papers and oral presentation in Civil Engineering course will improve the Oral and Written Communication Skills.

Conclusions

The information gained was worth the expense of the postage. However, the survey has some weakness that must be noted. The "Class Reunion" effect and the high percentage of graduates receiving a military commission at graduation may have an effect on the data. The "Class Reunion" effect may cause the less successful graduate not to return the survey. The graduate that has an active duty assignment as the entry level position may shift the results toward the Professional Skills Group and away from the importance of the Technical Skills Group. This or any type of self reporting survey should be used as a secondary or compliment to other assessment devices.

Some general observations can be determined from the 20 plus graduating classes that the surveys cover.
- The Freedom of Information Laws discourages employers from providing information on a specific graduate.
- The faculty of the under graduates score the graduates lower than any other group.
- The graduate school faculty has the lowest rate of return for any group.
- The graduate's opinion of their performance usual exceeds the employers' opinion.
- Changes in the curriculum do impact performance of graduates.
- Word-processing and the ability to process data with a spreadsheet are essential skills for an entry level engineer.
- The ability for an entry level engineer to use CADD is desired but not required for entry level engineers.
- The use of curve fitting and design software has the lowest priority for software application.
- Oral Communications, Technical Ability, and the Ability to Meet Deadlines with Quality Work are the most important entry level attributes and have remained constant over the life of the survey.
- There is a trend in the Employer's list of important skills from Technical Skills towards Professional Skills.
- Future curriculum changes should continue to require technical writing, strengthen technical content, encourage oral presentations, foster creativity and critical thinking, and continue to require quality work.

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