The Fundamentals of Engineering Exam as an Assessment Tool of Engineering and Engineering Technology Programs:

A Plan For The Future

2012 Executive Board of the NSPE Professional Engineers in Higher Education

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Introduction

With the assistance of the National Council of Examiners for Engineering and Surveying (NCEES), the Professional Engineers in Higher Education (PEHE) interest group of the National Society of Professional Engineers (NSPE) has been soliciting engineering and engineering technology programs to share methodologies of use of the Fundamentals of Engineering (FE) Exam as an assessment tool for ABET accreditation.

PEHE collected the details of how such programs use the FE data in their respective self-study reports. This document describes the compilation of methodologies received from programs that chose to participate. Programs that provided input to this collection are presented in Table 1.It is noted that the few contributions to this effort represent a broad cross-section of program types and sizes.

Table 1. Programs participating in this survey

Contributions contained within this compilation were each prepared by representatives of the corresponding programs, and represent the methods and the analysis of data that is performed by each program demonstrating their individual use of FE data in their assessment process.

Background

The use of the FE for assessment began receiving attention in the 1990s. It was recognized that many factors besides basic engineering aptitude contribute to performance, with adequate motivation to pass thought to be one of the most significant.[1] However, the NCEES did not make the data available for the purpose of assessment at that time.

In 1996, the exam was formatted to permit program-specific assessments to be made. The NCEES provided raw FE performance data to the University of Missouri-Rolla in 1998 to permit a study of the value of such data in the assessment of student learning. The subsequent analysis by Watson[2] concluded that the FE examination generated significant amounts of useful assessment data that was not being utilized by engineering programs. It was once again noted that the examinee's motivation to pass contributed to the viability of the results obtained. It was further noted that sample size could confound the analysis. The author concludes that NCEES should be providing performance data to institutions to permit the use of these results in program assessment.

Since that time, a number of methodologies for applying FE results to assessment have been published[3,4,5,6,7,8,9] that have used historic FE performance data to assess the overall program, topics within a program, as well as individual course content within a program.

The National Council of Examiners for Engineering and Surveying (NCEES) published a white paper[10]containing contributions from a half-dozen authors having extensive credentials in administration and evaluation of academic programs, preparation of the licensing examination, and governance of the licensing process. This white paper included previously published content.[11]

In 2010, the NCEES sought to understand the extent to which the FE exam is used as an assessment tool. The NCEES subsequently surveyed the 380 EAC/ABET institutions that receive the Subject Matter Report. Only 84 responses to the survey were received, of which 30 indicated that some programs within their institution required students sit for the FE as a condition of graduation (consistent with earlier findings[12]), while 57 institutions indicated that the FE is used for ABET assessment by at least some departments.

The white paper presents three methods for using the FE results in program assessment: Percentage-Correct Method; Ratio Method; and Scaled-Score Method. Examples for each method are presented, demonstrating how a program might incorporate the FE results into their assessment process. For each method, the treatment of data is discussed and the results are graphically compared to example program expectations.

Survey Results

The following sections present summaries of the responses from the eight participating programs. These sections contain detailed analyses performed by the named departments in the assessment of their respective programs in engineering and engineering technology. These contributions are either descriptions of how each program includes FE data in their assessments, or the actual quantification efforts to process the raw data and evaluate the results.

Plans for the Future

It is the position of the NSPE PEHE interest group that licensure should be promoted and encouraged to students of engineering programs by the faculty, and that engineering programs should dictate attempting the FE exam as a requirement of graduation. Such action will not only improve the viability of assessment data, but will also ensure the next generation of engineering and technology graduates carry this important qualification. PEHE members are available to provide support and advise institutions that wish to implement use of the FE in their curriculum as an assessment tool.

PEHE supports the work by the NSPE Licensure & Qualifications for Practice Committee (L&QPC) directed toward requiring faculty who teach upper division and graduate courses containing design components to achieve licensure. To accomplish this goal of increasing the number of licensed faculty who teach the design content of engineering and engineering technology curricula, it is necessary that students understand that attaining the license begins at the undergraduate level, when they retain a majority of the fundamental knowledge needed to perform well on the FE exam. PEHE is willing and available to provide support to all faculty who strive for licensure.

Acknowledgements

NSPE/PEHE would like to thank Lehmon Dekle and NCEES for assisting in identifying the users of FE data to solicit their participation in this project.

University of Evansville
Civil Engineering Program

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The civil engineering program at the University of Evansville (UE) uses the Fundamentals of Engineering (FE) Exam as one of ten tools to assess program outcomes for EAC-ABET accreditation. The civil engineering program defines "students" as civil engineering students at the time of graduation from the University of Evansville. The outcomes are listed below:

a. Students will apply knowledge of mathematics and science
b. Students will design and conduct laboratory experiments as well as analyze and interpret data
c. Students will complete a civil engineering design to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, and sustainability
d. Students will function on multidisciplinary teams
e. Students will identify, formulate, and solve problems in at least four major civil engineering areas
f. Students will understand professional and ethical responsibilities of civil engineers
g. Students will use effective communication techniques in the completion of engineering projects
h. Students will have the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
i. Students will have a recognition of the need for, and an ability to engage in, life-long learning.
j. Students will be knowledgeable of contemporary issues
k. Students will use the techniques, skills, and modern engineering tools in use in the civil engineering profession
l. Students will apply knowledge of the fundamentals of engineering science specific to civil engineering
m. Students will begin the professional registration process by registering for and taking the Fundamentals of Engineering Exam

Program Outcome Assessment Using FE Exam Data

Several of the civil engineering program outcomes are linked to student performance on the FE exam, including outcomes a, c, f, k, l, and m.

The civil engineering program graduates 10-18 students annually. All civil engineering seniors are required to take the Fundamentals of Engineering Exam in partial fulfillment of the course requirements in CE 497, the second course in a 2-semester long senior capstone sequence. Most (> 90%) of civil engineering students take the civil engineering, rather than the general, afternoon FE exam, thus providing the program with important assessment data. Assessment criteria (performance indicators) were initially established for the program outcomes in 1999. The criteria have been modified twice since then. FE exam data is assembled and analyzed annually. The data is recorded in a 4-column civil engineering program assessment report. Assessment results are evaluated and summarized in narrative form in the report. The report is reviewed annually by the Civil Engineering Advisory Council (CEAC), a group that represents all four of the program constituents: employers, alumni, faculty, and students.

The CEAC met on April 29, 2011. The following was included in the CEAC minutes,

> *"A copy of the 4-column civil engineering program outcome assessment report was provided to each CEAC member for review. Several CEAC members observed that the strength of UE civil engineering students seems to be in hydrologic and hydraulic systems, structural design, materials, circuits, and ethics while the students are weaker in chemistry, construction management, and structural analysis. FE scores in structural analysis have recently improved; students have exceeded the 50th percentile three of the past four years. Changes were made to the construction management course (CE 324) in 2010. FE scores in both structural analysis and construction management will continue to be monitored."*

The portion of the 4-column civil engineering program outcomes assessment report pertaining to the use of FE exam data is provided next.

University of Evansville
Civil Engineering Program
Assessment Plan for Program Outcomes

University of Evansville Mission:
The University of Evansville is dedicated to active learning and scholarship. We are committed to the liberal arts and sciences as a basis for intellectual and personal growth. The university endeavors to prepare women and men for lives of personal and professional service and leadership. The university is aware of the challenges of living in an international community and therefore adopts a global view in its programs and vision.

The University of Evansville preserves its independent nature and values its ties to the United Methodist Church. It emphasizes undergraduate education and supports an array of liberal arts and sciences and professional programs. The university selects talented and motivated students and faculty. The student-faculty ratio promotes individual attention and optimal learning. The university values learning as a means of attaining freedom from ignorance and prejudice. Because education is a lifelong process of critical inquiry, the university commits resources to continuing education programs in the greater community.

CIVIL ENGINEERING PROGRAM OUTCOMES	ASSESSMENT CRITERIA (Performance Indicators) Underline – Expected Results	ASSESSMENT RESULTS Underline – Meets Expectations Bold –Does not meet Expectations	EVALUATION OF ASSESSMENT RESULTS
a. Students will apply knowledge of mathematics and science	**a1**. Civil engineering students will score at or above national Fundamentals of Engineering (FE) exam averages (normalized scores) in mathematics, chemistry and material science (Note: UE requires CE students to take the FE exam; most civil engineering programs make this exam optional, although the majority of students at other universities take it.) (FE exam)	**1a1**. 1999-2010 UE Nat. Mathematics 1999 **51** 56 2000 **58** 53 2001 **45** 54 2002 **56** 57 2003 **52** 59 2004 **67** 54 2005 **59** 60 2006 **71** 64 2007 **65** 68 2008 **67** 60 2009 **71** 67 2010 **53** 58 Probability and Statistics 2006 **71** 63 2007 **64** 64 2008 **59** 60 2009 **58** 53 2010 **62** 62	**1a1**. Meets expectations in material science but is marginal in mathematics and chemistry. The mathematics scores for CE students have been below the national average 4 times in the past 8 years. CE faculty encourage students to attend the mathematics FE review sessions to prepare for the exam. The scores are shared with the math department and the Civil Engineering Advisory Council. The FE exam began testing probability and statistics in 2006, material that is covered in ENGR 390. Student performance has been very good in probability and statistics. Chemistry scores have been below the national average 4 of the past 5 years. These scores are forwarded to the Chemistry Department. The Math and Chemistry Departments assist in teaching the FE exam review course. Material Science scores have been outstanding during the past eight years. Beginning in 2009, the civil engineering curriculum was modified to allow students take CE 230 during their freshman year.

Civil Engineering Program

University of Evansville

CIVIL ENGINEERING PROGRAM OUTCOMES	ASSESSMENT CRITERIA (Performance Indicators) Underline – Expected Results	ASSESSMENT RESULTS Underline – Meets Expectations Bold –Does not meet Expectations	EVALUATION OF ASSESSMENT RESULTS
		Chemistry 1999 **61** 70 2000 **64** 58 2001 **59** 62 2002 **63** 60 2003 **74** 71 2004 **66** 59 2005 **54** 59 2006 **64** 64 2007 **63** 67 2008 **67** 69 2009 **59** 64 2010 **75** 76 Material Science 1999 **63** 71 2000 **63** 49 2001 **61** 58 2002 **44** 48 2003 **56** 49 2004 **64** 48 2005 **54** 52 2006 **46** 48 2007 **68** 64 2008 **58** 54 2009 **71** 56 2010 **67** 62	
e. Students will identify, formulate, and solve problems in at least four technical areas appropriate to civil engineering	**e1**. Civil engineering students will score at or above the national average (normalized scores) in at least four civil engineering areas. (FE exam)	**e1**. UE Nat'l Construction Management 1999 **58** 49 2000 **62** 43 2001 **29** 37 2002 **48** 48 2003 **52** 44 2004 **46** 49 2005 **43** 49	**e1**. For the time period 2002-2010, results met expectations in structural design, hydraulics & hydrology, environmental engineering, soil mechanics and foundations, civil engineering materials, and transportation engineering. Results do not meet expectations in surveying and construction management. Results for structural analysis are improving. FE exam results are distributed to all CE instructors. For ABET accreditation purposes, the CE program has an outcome that states that CE students will be proficient in four civil engineering technical areas. The civil

CIVIL ENGINEERING PROGRAM OUTCOMES	ASSESSMENT CRITERIA (Performance Indicators) Underline – Expected Results	ASSESSMENT RESULTS Underline – Meets Expectations Bold –Does not meet Expectations	EVALUATION OF ASSESSMENT RESULTS
		2006 **60** 64 2007 **63** 69 2008 **62** 63 2009 **78** 72 2010 **59** 60 Environmental Engineering 1999 **60** 59 2000 **56** 49 2001 **46** 53 2002 **46** 44 2003 **59** 67 2004 **79** 56 2005 **38** 42 2006 **63** 55 2007 **62** 64 2008 **77** 70 2009 **81** 73 2010 **62** 66 Hydraulics & Hydrology 1999 **69** 54 2000 **44** 41 2001 **48** 48 2002 **72** 58 2003 **69** 59 2004 **48** 31 2005 **57** 49 2006 **61** 63 2007 **60** 50 2008 **72** 50 2009 **63** 62 2010 **56** 57 Surveying 1999 **38** 44 2000 **49** 42 2001 **35** 35 2002 **61** 55 2003 **46** 47	engineering faculty have identified these four areas to be Structural Engineering, Geotechnical Engineering, Hydraulic Engineering, and Transportation Engineering." The past eight years of FE exam data indicates high student performance in hydraulic engineering (66th percentile) and structural design (60th percentile), followed closely by environmental engineering (57th percentile), and transportation engineering (56th percentile), Scores are improving in geotechnical engineering and structural analysis. Scores have been consistently good in civil engineering materials. A new civil engineering professor joined the department in August 2009 and taught geotechnical engineering, construction management, and transportation engineering courses the pat two years.

CIVIL ENGINEERING PROGRAM OUTCOMES	ASSESSMENT CRITERIA (Performance Indicators) Underline – Expected Results	ASSESSMENT RESULTS Underline – Meets Expectations Bold –Does not meet Expectations	EVALUATION OF ASSESSMENT RESULTS
		2004 **50** 42 2005 **37** 46 2006 **58** 53 2007 **57** 59 2008 **65** 57 2009 **48** 51 2010 **39** 49 Soil Mechanics/Foundations 1999 **46** 53 2000 **78** 60 2001 **42** 54 2002 **44** 40 2003 **44** 47 2004 **44** 51 2005 **53** 58 2006 **58** 60 2007 **54** 54 2008 **73** 54 2009 **48** 45 2010 **56** 56 Structural Analysis 1999 **35** 48 2000 **44** 48 2001 **31** 39 2002 **46** 50 2003 **44** 47 2004 **44** 46 2005 **45** 43 2006 **46** 51 2007 **48** 42 2008 **50** 45 2009 **41** 48 2010 **64** 62 Structural Design 1999 **33** 41 2000 **42** 48 2001 **33** 44	

CIVIL ENGINEERING PROGRAM OUTCOMES	ASSESSMENT CRITERIA (Performance Indicators) Underline – Expected Results	ASSESSMENT RESULTS Underline – Meets Expectations Bold –Does not meet Expectations	EVALUATION OF ASSESSMENT RESULTS
		2002 **52** 41 2003 **41** 43 2004 **69** 55 2005 **45** 31 2006 **42** 42 2007 **49** 48 2008 **53** 52 2009 **57** 51 2010 **61** 53 Transportation 1999 **29** 41 2000 **51** 51 2001 **56** 58 2002 **52** 47 2003 **37** 43 2004 **46** 43 2005 **52** 49 2006 **74** 64 2007 **47** 51 2008 **63** 53 2009 **57** 53 2010 **52** 59 Civil Engineering Materials 2006 **50** 49 2007 **62** 55 2008 **65** 63 2009 **60** 59 2010 **64** 57	

CIVIL ENGINEERING PROGRAM OUTCOMES	ASSESSMENT CRITERIA (Performance Indicators) Underline – Expected Results	ASSESSMENT RESULTS Underline – Meets Expectations Bold –Does not meet Expectations	EVALUATION OF ASSESSMENT RESULTS
f. Students will understand professional and ethical responsibilities of civil engineers	**f2.** Civil engineering students will score at or above the national average in the ethics portion of the FE exam (FE exam).	**f2.** Ethics 1999 **90**% 82% 2000 **82**% 76% 2001 **78**% 81% 2002 **69**% 66% 2003 **87**% 75% 2004 **58**% 67% 2005 **72**% 62% 2006 **80**% 78% 2007 **84**% 78% 2008 **77**% 75% 2009 **87**% 83% 2010 **76**% 78%	**f2**. Meets expectations; Students exceeded the national average in 5 of past 6 years. Ethics is a component of CE 497 and all civil engineering students write papers for the annual ASCE sponsored Daniel Mead paper competition (which typically has an ethics related topic).
k. Students will use the techniques, skills, and modern engineering tools in use in the civil engineering profession	**k1.** Civil engineering students will score at or above the national average (normalized scores) in the computers section of the FE exam. (FE exam)	**k1.** Computers UE Nat. 1999 **41** 55 2000 **66** 57 2001 **72** 77 2002 **71** 62 2003 **56** 53 2004 **79** 69 2005 **64** 60 2006 **65** 64 2007 **71** 79 2008 **73** 68 2009 **69** 62 2010 **65** 69	**k1**. Meets expectations. Students' scores have exceeded the national average 7 times in the past 9 years. CE faculty will continue to provide opportunities for students to use computers in design projects & homework in most junior and senior civil engineering courses (CE 3XX and CE 4XX).

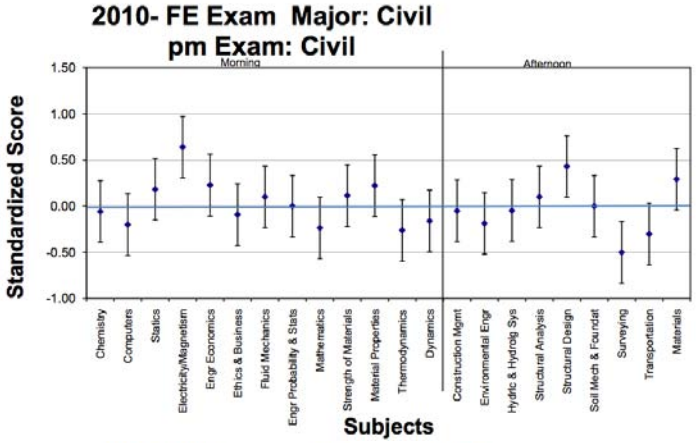
CIVIL ENGINEERING PROGRAM OUTCOMES	ASSESSMENT CRITERIA (Performance Indicators) Underline – Expected Results	ASSESSMENT RESULTS Underline – Meets Expectations Bold –Does not meet Expectations	EVALUATION OF ASSESSMENT RESULTS
I. Students will apply knowledge of the fundamentals of engineering science specific to civil engineering	**II.** Civil Engineering students will score at or above the national FE exam average (normalized scores) in statics, fluid mechanics and mechanics of materials (FE exam)	**III.** 1999-2010 UE Nat. Statics 1999 **59** 63 2000 **43** 45 2001 **44** 49 2002 **73** 64 2003 **51** 55 2004 **60** 54 2005 **61** 62 2009 **75** 69 2010 **77** 74 Statics and Dynamics 2006 **71** 66 2007 **62** 70 2008 **72** 69 Fluid Mechanics 1999 **72** 71 2000 **71** 59 2001 **63** 69 2002 **74** 55 2003 **53** 51 2004 **80** 70 2005 **60** 55 2006 **64** 60 2007 **72** 66 2008 **80** 66 2009 **67** 66 2010 **66** 64 Mechanics of Materials 1999 **59** 65 2000 **57** 51 2001 **55** 64 2002 **58** 57 2003 **54** 54 2004 **56** 57 2005 **64** 66	**III.** FE scores meet expectations in fluid mechanics and scores have been improving in statics and mechanics of materials. The FE exam combined statics and dynamics in 2006-2008 but separated the two subject areas beginning in 2009. FE exam scores in statics are improving. They have been above the national average 4 of the past 5 years. Scores in all three areas are distributed to faculty who teach these courses. Civil engineering faculty believe that an improved statics and mechanics of materials scores will lead to an improvement in the CE structural analysis scores. It is clear that the high scores in fluid mechanics are linked to the high scores in hydraulic and hydrology on the afternoon portion of the exam.

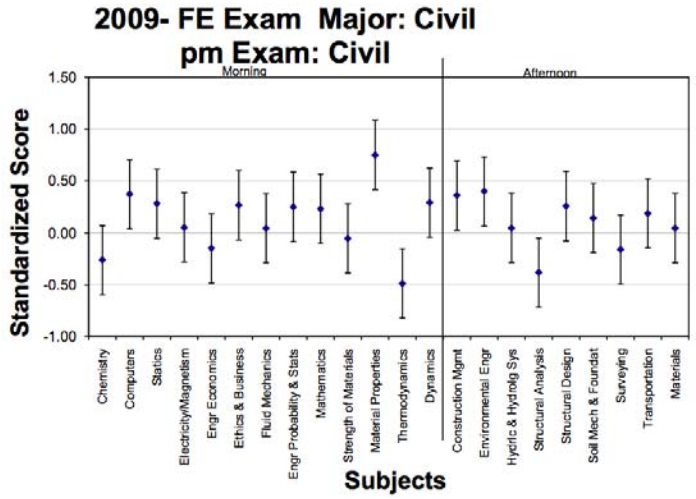
Civil Engineering Program

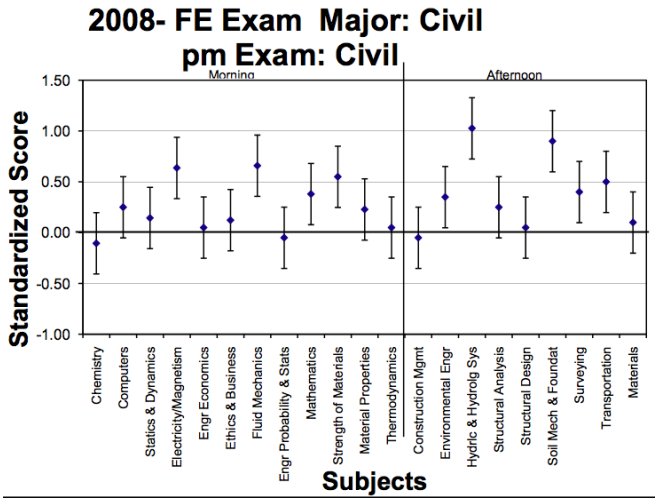
University of Evansville

CIVIL ENGINEERING PROGRAM OUTCOMES	ASSESSMENT CRITERIA (Performance Indicators) Underline – Expected Results	ASSESSMENT RESULTS Underline – Meets Expectations Bold –Does not meet Expectations	EVALUATION OF ASSESSMENT RESULTS
		2006 **74** 73 2007 **64** 69 2008 **77** 66 2009 **68** 69 2010 **58** 56	
m. Students will begin the professional registration process by registering for and taking the Fundamental of Engineering exam *Summary of Methods used by the Civil Engineering Program to gather assessment data:* 1) FE exam 2) FE exam exit questionnaire 3) Samples of student work 4) Senior Survey 5) Design presentations 6) Design competitions 7) Ethics Case of the Month 8) ASCE Mead paper competition 9) Exit Interviews **10)** Team Project Survey	**m 1**. UE civil engineering students will exceed the national passing rate for the fundamentals of engineering exam the first time they take it. (FE exam)	**m 1**. UE National 1997 - **80**% (N=5) 69% 1998 - **72**% (N=11) 72% 1999 - **80**% (N=10) 78% 2000 - **85**% (N=13) 65% 2001 - **55**% (N=11) 76% 2002 - **89**% (N=9) 79% 2003 - **89**% (N=9) 78% 2004 - **80**% (N=10) 76% 2005 - **72**% (N=11) 81% 2006 - **83**% (N=12) 72% 2007 - **78**% (N=18) 76% 2008 - **100**%(N=12) 71% 2009 - **90**% (N=10) 79% 2010 - **82**% (N=11) 75% Cumulative: **81.1**% 74.8%	**m 1**. Meets expectations. The passing rate for UE CE students has met or exceeded the CE national average for 11 of the past 13 years. Civil engineering faculty will continue to encourage and motivate students to prepare for the FE exam. The FE exam content changed in 2006. Student performance on the exam will be closely monitored to look for areas of strength and weakness.

Below are sample “standardized score graphs” that the civil engineering program assembles (using FE exam statistical data), to account for uncertainty associated with small sample sizes.







University of Florida
Engineering School of Sustainable Infrastructure and Environment

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Extracts from a Draft Self-Study

Under Criterion 1 F. *Graduation Requirements*

Students must complete an exit interview with a faculty undergraduate advisor and must take (but not necessarily pass the Fundamentals of Engineering (FE) Exam administered by NCEES.

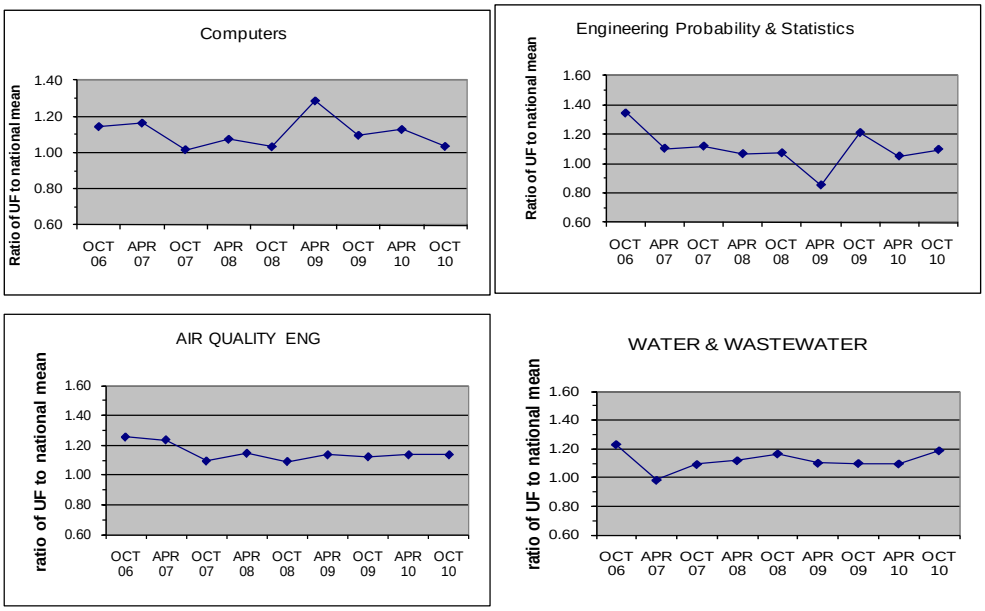
The FE exam is offered twice a year, each October and April. Application to take the FE exam must be completed six months prior to taking the exam.

Despite notices from the EES undergraduate staff assistant, students on occasion in their terminal year forget to apply for the exam by the application deadline or fail to follow up through with additional application details required approximately three months after the application date. If, for example, a student who intends to graduate either at the end of the spring semester or summer semester fails to properly register in the previous October, they cannot take the exam in April and therefore cannot satisfy graduation requirements. EES has not held up a student's graduation under these circumstances if they successfully petition the department for relief of the requirement. Part of the petition paperwork, however, is evidence of registration for the next exam.

In the example from above that would mean the student must register for the exam in April so that they can take the exam the following October, after they have graduated.

Under Criterion 4 B. *Student Outcomes*

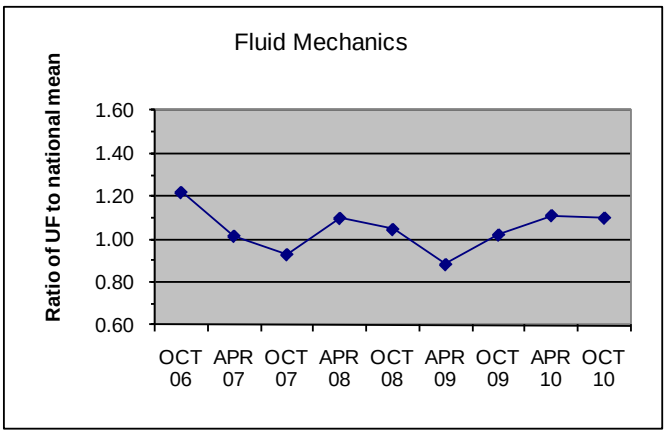
The Fundamentals of Engineering Exam provides an excellent assessment of student outcomes. This exam, taken in the terminal semester of the undergraduate program, is a comprehensive exam that can be related to many of the student outcomes and as such can give valuable insight regarding the success of the program. The evaluations made by the ABET committee, discussed at the beginning of this section and detailed in attachment 3, relate FE exam results to specific outcomes. The complete report on Fundamental of Engineering Exam results is given in attachment 5. A few of these results are displayed below. In each of the following graphics, the ratio of the UF environmental engineering average for a particular topic in each FE exam to the environmental engineering national average is plotted as a function of time.



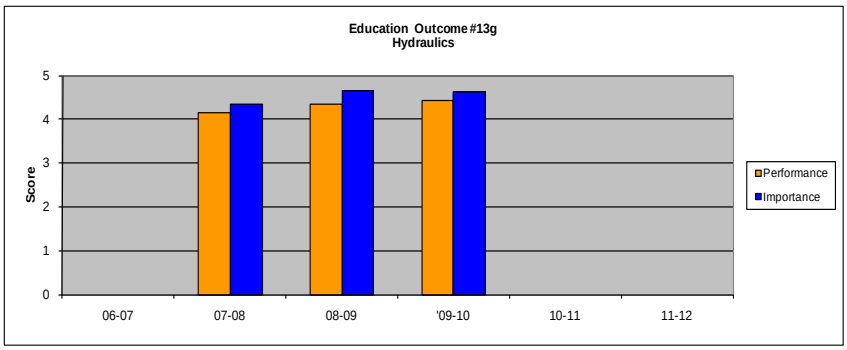
The above graphics show that in these topic areas, the UF environmental engineering performance was above the national environmental engineering average achievement in almost all instances.

Change in Hydraulics Course – In 2001, the current department chair recommended a course change to satisfy the hydraulics requirement. The civil engineering course CWR4202, Hydraulics, was to replace the environmental engineering course, ENV4561, Hydraulic Systems Design. The course would then be required in both the civil and environmental engineering programs. This change was made in conjunction with another curriculum change in civil engineering, dropping the requirement for CWR4542, Water Resources Engineering, a civil engineering course, and replacing it with the environmental engineering course, ENV4514C, Water and Wastewater Engineering. The change was justified on the basis of better teaching efficiency. The change was implemented, but after a few years of experience with the course, feedback from the EAB in 2006 and feedback from several consultants caused some concern in the curriculum committee. CWR4202 was not covering pump design and hydraulic profiles in water and wastewater treatment plants, two important topics for environmental engineers. In addition, some hydrology was being taught in the course – a topic that is covered in two separate courses in the environmental engineering curriculum. To avoid this hydrology redundancy and to ensure that environmental engineers received important instruction on pumps and plant profiles, the curriculum was changed to again require ENV4561 in place of CWR4202. A faculty member who had taught the course before retirement, came back to the classroom as a professor emeritus to teach the course and has taught it each semester since that time. Subsequent employer feedback collected at technical conferences was positive, as students now were able to assist with pump station design, one of the first designs that challenge many environmental engineers in their first job.

Fluid mechanics FE exam results, primarily based on CWR3201, Hydrodynamics, and ENV4561 have shown a general positive trend except for two exam dates, October 2007 and April 2009 as shown in the figure below.



Exit interview results were also positive. Outcome #13, *a proficiency in mathematics through differential equations, probability and statistics, calculus-based physics, general chemistry, hydrology, microbiology, ecology and hydraulics*, was divided into the seven areas described in 2007. So, exit interview data on student achievement with respect to hydraulics could only be determined from 2007 forward. These results which were deemed positive by the curriculum committee are presented in the figure below.



Student perceived personal performance in hydraulics and their perceived importance of this topic to environmental engineers is high and shows an upward trend. Finally, instructors of capstone design courses in water and wastewater treatment commented that students were better prepared in hydraulics by taking the ENV4561 course.

New Mexico State University
Department of Chemical Engineering

Contributor: David A. Rockstraw, Ph.D., P.E. (drockstr@nmsu.edu)

The content below is excerpted from a number of memos

The Chemical Engineering Department at New Mexico State University initiated an assessment program in 2000 that listed the Fundamentals of Engineering (FE) Examination as an assessment tool. Each year, the responsible faculty member collected and critiqued the FE exam data and prepared a report. It was found over the ensuing years that students in the program were not finding much value in taking the exam. Consequently, the sample size was always too small to provide any useful assessment information.

The National Council of Examiners for Engineering and Surveying (NCEES) report entitled "Using the Fundamentals of Engineering (FE) Examination to Assess Academic Programs" by LeFevre, Steadman, Tietjen, White, and Whitman suggested use of a "scaled score" method to treat the FE data for use as an assessment tool. Previously collected data was treated by this method, but again data provided little value as the error bars on the scaled scores were of extremely large size relative to the scale of the scores. It was noted by the Ch E faculty that analysis by this method assumes the results are for a population rather than a sample, and does not address whether the sample taking the exam reflect the population (all students from Ch E).

It is assumed that the FE exam represents a national norm capable of providing a useful assessment of the effectiveness of a program. It was thus suggested that the curriculum be modified so that taking the FE exam is a requirement of graduation. In this manner, the true population would be reflected by the data, and a method of treating the data to perform an assessment could be developed.

Because students do not have to pass the exam as a degree program requirement, concern was expressed that students would not put forth a valid effort. A protocol was developed to moderate this concern. Beginning in 2007/08, students in the program will be required to sit for the exam during the fall semester of the senior year, with the registration fee paid by the department. Students who do not pass the exam must take it a second time at their own expense in the spring semester. The requirement to take the exam a second time at their own expense will help to ensure students will put forth their best effort to pass. In this manner, a delay in graduation timeframe is avoided, yet the department collects more useful data. In addition, by coordinating the effort to register and prepare for the exam (using the already existing Senior Seminar as the vehicle for this effort), the department will also know which students are taking the exam at each sitting, as well as which students passed the fall administration of the exam. Such data will be useful in analyzing the pass/fail results.

In support of this new curriculum requirement and to avoid a five-year lag before meaningful data is obtained, a member of the faculty will assist students in the department to charter a student organization affiliated with the National Society of

Professional Engineers (NSPE) and the New Mexico Society of Professional Engineers (NMSPE). The student chapter will serve to support students in preparing for the FE through regular meetings and social activities.

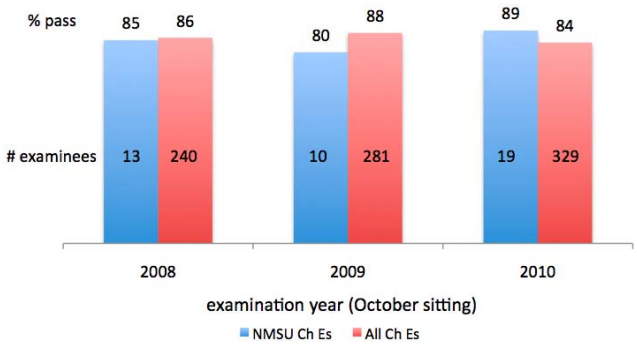


Figure 1. FE pass rate comparison of NMSU Ch E seniors vs. national average of first time examinees(based on performance of examinees taking the chemical engineering PM exam).

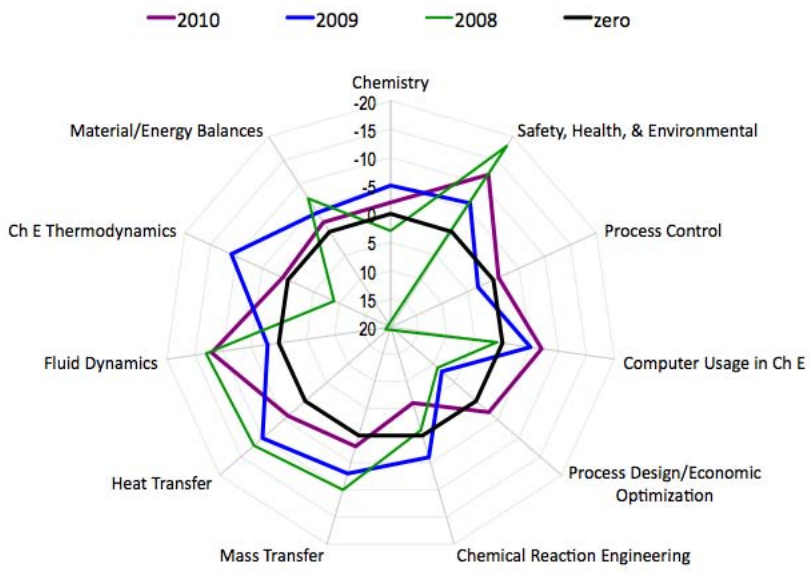


Figure 2.Radar chart of performance of NMSU Ch E senior vs. national average of first time examinees on the PM subjects of the FE exam. Axis represents percentage of questions answered correctly of NMSU seniors less national average. Note that data points within the black "zero" circle represent performance that exceeds national average, while data points outside of the zero circle are less than the national average.

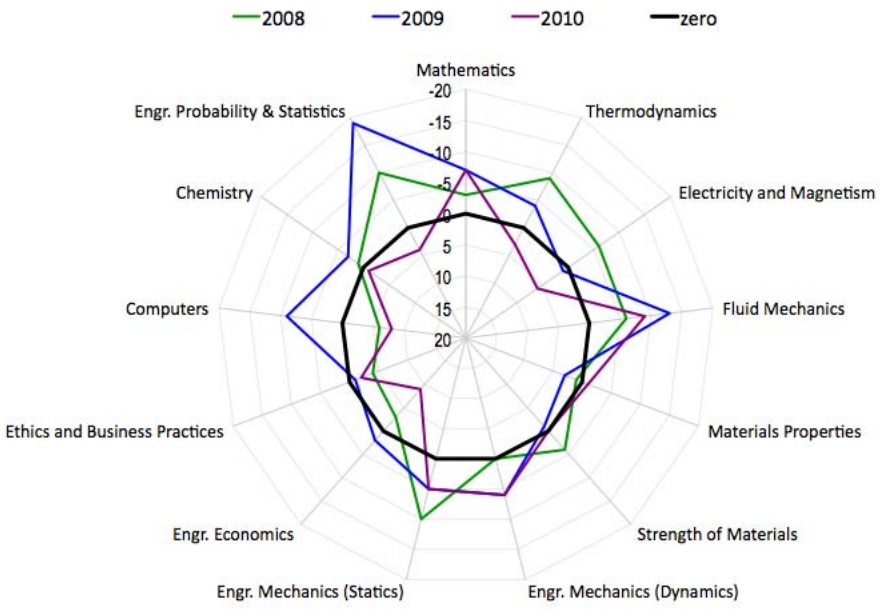


Figure 3.Radar chart of performance of NMSU Ch E senior vs. national average of first time examinees on the AM subjects of the FE exam. Axis represents percentage of questions answered correctly of NMSU seniors less national average.

The following excerpt comes from an NMSU Ch E internal memo reporting the fall 2010 FE performance results to the faculty. It describes the departmental metric for identification of a threshold at which a topical area of the program may need to be investigated or applauded.

NMSU Ch E performance was compared to the national average for each of the 13 topics of the AM general exam as well as for the 11 discipline-specific topics of the PM chemical engineering exam. Data below is based on the same metric as was established last year, whereby a flag is raised if NMSU Ch E performance was outside of a range of ±10% of the national average on that topic. Using this metric, flags can be positive (10% above national average), or negative (10% below the national average). The table below provides a summary of topics flagged in both the 2010 exam results and in the 3-year average.

		2010		3-yr avg.	
Subject	Exam	Δ	Ψ	Δ	Ψ
Process Control	PM			8	66
Engineering Economics	AM	9	74		
Computers	AM	8	74		
Electricity and Magnetism	AM	6	55		
Safety, Health, and Environmental	**PM**	**-12**	**51**	**-12**	**46**
Fluid Dynamics	**PM**	**-12**	**54**	**-9**	**56**
Fluid Mechanics	**AM**	**-9**	**63**	**-9**	**56**
Heat Transfer	PM			-9	61
Engineering Probability and Statistics	AM			-8	56
Engineering Mechanics (Statics)	AM			-7	43
Engineering Mechanics (Dynamics)	**AM**	**-6**	**53**	**-6**	**47**

Δ ≡ deviation from national average of enrolled chemical engineering students taking the FE
Ψ ≡ NMSU performance (% correct) on noted topic

NMSU Ch E performance over the 3-year period remains strong in PM exam topic of Process Control as was noted in last year's report. Historically strong performance in Process Design and Economic Evaluation was eliminated from positive flag in the 3-year average by performance in 2010 below the national average. Positive performance flags have been raised in the AM exam areas of computers, engineering economics, and electricity and magnetism.

Weak student performance continues in the same PM topic areas as last year: Safety, Health, & Environmental; and Fluid Dynamics. Negative flags persist in both Statics and Dynamics (AM subjects not required in the curriculum), Probability & Statistics (AM), Heat Transfer (PM), and Fluid Mechanics (AM).

Oregon State University
School of Civil and Construction Engineering

Contributor: Thomas H. Miller, Ph.D., P.E.

6.4. Fundamentals of Engineering Examination Results

The FE passing rate for OSU CE students taking the exam in April 2007 was 95% (35/37); in April 2006 89% (32/36); in April 2005 93% (28/30); in April 2004 97% (35/36) and in April 2003 100% (30/30).

A detailed summary of the results for OSU CE students taking the FE exam in April 2006 is shown in Table 3-8. A number of related program outcomes are listed for each subject area.

In general, the performance of OSU CE students is superior to the national average for almost every FE exam subject area. OSU is slightly below the national average in Mathematics (by 3%), and Computers (by 3%). The only area where there is a significant difference is in Material Properties (12% below the national average). This most likely reflects the decision a number of years ago to eliminate one of two courses in the CE curriculum on materials. The materials course dropped covered metals and wood, while the one retained covers asphalt and concrete. Much of the material properties coverage in the AM section covers topics no longer in the CE curriculum at OSU or covered in less detail in CE 383 – Design of Steel Structures and WSE 458 – Wood Design.

The FE exam results are another strong, direct indication that our students taking the exam can successfully perform the Program Outcomes listed in Table 3-8.

Table 3-8. OSU CE Performance on FE Exam (April 2006)

Related Program Outcomes	Subject Area on FE Exam	# of exam questions	OSU CE Avg % Correct	National Avg % Correct	OSU Avg % Correct/National Avg % Correct
	AM Subject				
A	Mathematics	19	62	64	0.97
A,P,E	Engineering Probability and Statistics	8	67	63	1.06
A	Chemistry	11	66	64	1.03
K	Computers	8	62	64	0.97
F,M,O,C	Ethics and Business Practices	8	81	78	1.04
A,C,E,H	Engineering Economics	10	73	70	1.04
A,E	Engineering Mechanics (Statics and Dynamics)	13	72	66	1.09
A,E	Strength of Materials	8	81	73	1.11
Q,E	Material Properties	8	42	48	0.88
A,E	Fluid Mechanics	8	64	60	1.07
A,E	Electricity and Magnetism	11	47	45	1.04
A,E	Thermodynamics	8	56	48	1.17
	PM Subject				
A,E,K	Surveying	7	61	53	1.15
A,C,E,K	Hydraulics and Hydrologic Systems	7	70	63	1.11
A,C,E,K	Soil Mechanics and Foundations	9	63	60	1.05
A,C,E,H,K	Environmental Engineering	7	59	55	1.07
A,C,E,K	Transportation	7	71	64	1.11
A,E,K	Structural Analysis	6	56	51	1.10
A,C,E,K	Structural Design	6	44	42	1.05
M,O,Q	Construction Management	6	66	64	1.03
Q,E	Materials	5	63	49	1.29

Southern Utah University
Department of Integrated Engineering

Contributor: Glen R. Longhurst

Utilization - The Integrated Engineering program at Southern Utah University is almost unique in the United States in that the goal is to provide engineering students with capability in the areas of mechanical, civil, electrical, and manufacturing engineering. It fills a niche in the modern business climate where multidisciplinary skills are needed to contribute in high-technology assignments where single-discipline training is no longer adequate.

We make use of the Fundamentals of Engineering Examination (FE) in three ways. Taking the FE is a graduation requirement. We use the results of the FE to assess the quality of our program. Preparation for the FE is a means of furthering faculty involvement with the students.

Graduation Requirement – A requirement for receiving the Bachelor of Science in Integrated Engineering has been successfully passing the FE. Students were being denied their graduation credentials until they had successfully passed the FE exam. In many cases, it takes more than one attempt to pass the examination. Our Department Industry Advisory Board requested that this policy be reviewed citing that in many instances, employers are willing to hire the student who has the graduation diploma, but the employer has no interest or requirement that the prospective employee be professionally registered or have taken the FE examination. In such instances, the engineer will perform work that contributes to the organization's overall mission, but either the specific field itself is not one that requires licensure, or there is a licensed engineer within the organization who is designated to maintain professional oversight, and licensure is therefore not required for all contributors. Delay in granting the diploma poses severe financial hardship on students who have job offers conditional upon a diploma but with no need for professional licensure.

The Department Curriculum Committee made a careful study of this matter. There are two principal advantages to students taking the FE examination. Foremost is the inculcation of the concept that professional licensure is an important aspect of the practice of engineering and it contributes to the establishment of practice in the field as an occupation of importance and respect. The other is the opportunity for a nationally normalized evaluation of student performance. The correlated results from FE exams, without individual performance data, are used routinely in assessing strengths and weaknesses of the SUU Integrated Engineering program. This feedback is useful in the process of continual improvement of the Integrated Engineering program.

A survey was made of engineering schools to clarify current practice regarding requiring passage of the FE examination. At the time of the survey, only two of more than 10 engineering schools surveyed required passing the FE exam as a condition of graduation. Both of these were in Utah. Of the other schools surveyed, some

required taking the FE exam, but many had no requirement to even take the exam. The Committee subsequently learned that the two other Utah schools requiring passage of the FE exam had recently changed their policy to require taking the exam but not passing it. In a meeting of the College Industry Advisory Board, by vote of the Board members, it was a strong recommendation that the SUU Integrated Engineering program adopt a similar policy. The committee surveyed our alumni and considered their input in the final decision and ultimately decided to drop the requirement to pass the FE examination.

A programmatic change was implemented for the Fall of 2010 that Integrated Engineering students are required to take the FE Exam and the degree will be awarded upon passage of the examination or after two unsuccessful attempts if all other graduation requirements have been met.

Program Quality Assessment – ABET criterion **k**, "Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice," is achieved as students successfully negotiate coursework and laboratories and is evaluated in most of the courses by course grading, by successful completion of the capstone design project, and through feedback from questionnaires to alumni. Another means of program evaluation is feedback received from Department and College Industry Advisory Boards (IAB). Following each IAB meeting, the Department Curriculum Committee reviews the findings and recommendations received from the IAB to see if there are implications for program structure. A third measure of success is the achievement of SUU Integrated Engineering students on the FE examination.

Results from FE examinations are used each year in our annual program self-evaluation. They are also provided to the ABET Accreditation Visit Team. The FE is an important source of information on program quality. Reports available from the National Council of Examiners for Engineering and Surveying (NCEES) who administers the FE, provide feedback showing performance of our students (as a group, without individual identifying information) on the various subject areas of the examination, compared both with national averages and with averages of schools in the same category as SUU.

Student Involvement – Preparing for the FE is a means of increasing faculty involvement with students. Extra involvement with student development comes through department seminars and training sessions for the FE exam.

Findings

Data in the table below averaged over 5 years to 2009 show that we have a significant challenge in most areas to bring our students to meet or exceed national norms. Two strength areas are Ethics and Business Practices and Engineering of Materials.

AM Subjects	Nat'l Avg % Correct	SUU Average % Correct	SUU % lessNat'l Avg %
Mathematics	69	59	-14
Engineering Probability and Statistics	60	46	-23
Chemistry	66	51	-23
Computers	71	75	6
Ethics and Business Practices	77	89	16
Engineering Economics	63	52	-17
Engineering Mechanics (a)	67	67	0
Engineering Mechanics (b)	56	55	-2
Strength of Materials	66	67	2
Material Properties	60	59	-2
Fluid Mechanics	66	52	-21
Electricity and Magnetism	54	48	-11
Thermodynamics	53	48	-9
PM Subjects			
Advanced Engineering Mathematics	61	51	-16
Engineering Probability and Statistics	50	52	4
Biology	55	40	-27
Engineering Economics	54	52	-4
Application of Engineering Mechanics	48	33	-31
Engineering of Materials	47	53	13
Fluids	54	43	-20
Electricity and Magnetism	55	50	-9
Thermodynamics and Heat Transfer	48	48	0

The University of Texas at Austin
Cockrell School of Engineering

Contributor: Cindy Wilson (cindy.wilson@austin.utexas.edu),
Director of Academic Projects, Cockrell School of Engineering

Analysis

Currently, four departments in the Cockrell School of Engineering use the Fundamentals of Engineering Exam as an assessment tool for ABET accreditation. The departments are civil, architectural, and environmental engineering; chemical engineering; mechanical engineering; and petroleum and geosystems engineering.

The civil, mechanical, and petroleum departments use the exam to help assess specific learning outcomes that are mapped to exam technical topics. The chemical engineering department uses the exam as an overview assessment that is used in conjunction with other measures.

The sample size varies by department and those departments that have relatively low sample sizes (chemical and petroleum) use the exam in a more limited way.

The metrics range from requiring a mean score of greater than 95 in civil to a comparison between UT students and other students in the same academic area.

Civil and Architectural Engineering

Since 2005-06, approximately 80% of the students in civil and architectural engineering program have taken the FE exam.

The civil and architectural engineering department uses both the FE morning and afternoon exams to assess ABET program outcomes.

The morning exam was used to assess program outcomes:

a. an ability to apply knowledge of mathematics, science, and engineering

   Exam technical topic results used for evaluation: Mathematics, Engineering Probability and Statistics, Chemistry, Computers, Statics, Dynamics, Strength of Materials, Material Properties, Fluid Mechanics, Electricity and Magnetism, Thermodynamics

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

   Exam technical topic result used for evaluation: Engineering Economics

f. an understanding of professional and ethical responsibility

   Exam technical topic used for evaluation: Ethics and Business Practices

h. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

Exam technical topic result used for evaluation: Engineering Economics

The afternoon civil engineering exam is used to assess:

e. an ability to identify, formulate, and solve engineering problems

   Exam technical topic results used for evaluation: Hydraulics and Hydrological Systems, Soil Mechanics and Foundations, Environmental Engineering, Transportation, Structural Analysis, Construction Management, Materials

h. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

   Exam technical topic results used for evaluation: Environmental Engineering

k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

   Exam technical topic results used for evaluation: Hydraulics and Hydrological Systems, Soil Mechanics and Foundations, Environmental Engineering, Transportation, Structural Analysis, Construction Management, Materials

Metrics of Performance

One threshold was established to evaluate the results for each technical topic on the FE exam:
Average score: Acceptable if mean ≥95% of national average score for civil engineers.
If the average score is not acceptable, the accreditation steering committee flags the technical topic for further analysis, and if necessary, recommends measures to be initiated for improving achievement of that program outcome.

Chemical Engineering

Chemical engineering uses the FE exam as an overview assessment in their evaluation rather than mapping the exam to a specific program outcome. The exam is used in conjunction with course outcome evaluations, the EBI exit survey, the EBI alumni survey, writing performance assessments, and course instructor surveys. Exams were analyzed over a six-year period with an average of about 30 chemical engineering students taking the exam each year.

Metrics of Performance

The performance of UT students is compared against the national averages. The goal is for UT students to score above the national average.
The results are useful for mapping to specific required courses in the degree plan. The technical topics analyzed are: Chemistry, Mat/Energy Bal., ChE Thermo., Fluid Dyn., Heat Trans, Mass Trans, Reaction Eng., Process Design, ChE Computing, Process Cntrl, and Safety + Environ.

Mechanical Engineering

The FE exam is an opportunity to assess student knowledge and problem solving abilities in a variety of academic areas associated with the mechanical engineering program outcomes. It also provides a way to compare the University of Texas M E students against nationally normed data.

The FE morning exam addresses the following program outcomes:

b. an ability to apply knowledge of mathematics, science, and engineering

   Exam technical topic results used for evaluation: Mathematics, Statics, Probability and Statistics, Dynamics, Chemistry, Strength of Materials, Material Properties, Fluid Mechanics, Electricity and Magnetism, Engineering Mechanics, Thermodynamics

e. an ability to identify, formulate, and solve engineering problems

   Exam technical topic results used for evaluation: Mathematics, Statics, Probability and Statistics, Dynamics, Chemistry, Strength of Materials, Computers, Material Properties, Ethics and Business Practices, Fluid Mechanics, Engineering Economics, Electricity and Magnetism, Engineering Mechanics, Thermodynamics

f. an understanding of professional and ethical responsibility

   Exam technical topic results used for evaluation: Ethics and Business Practices

h. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

   Exam technical topic results used for evaluation: Ethics and Business Practices, Engineering Economics

j. a knowledge of contemporary issues

   Exam technical topic results used for evaluation: Ethics and Business Practices, Engineering Economics

k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

   Exam technical topic results used for evaluation: Computers

Metrics of Performance

The performance of UT students is compared against the national averages. The goal is for UT students to score above the national average.

The results of the FE exam scores for mechanical engineering show that UT ME students achieve scores at a rate of 80% higher, when compared to the national norm.

Petroleum Engineering

The FE exam addresses the following program outcomes:

a. an ability to apply knowledge of mathematics, science, and engineering

   Exam technical topic results used for evaluation: Mathematics, Chemistry, Fluid Mechanics, Economics

f. an understanding of professional and ethical responsibility

   Exam technical topic results used for evaluation: Ethics

k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

   Exam technical topic results used for evaluation: Computers, Probability and Statistics

Metrics of Performance

The metric for assessment is an average of 70 or better in a given content area, or a score above the national average for petroleum engineers.

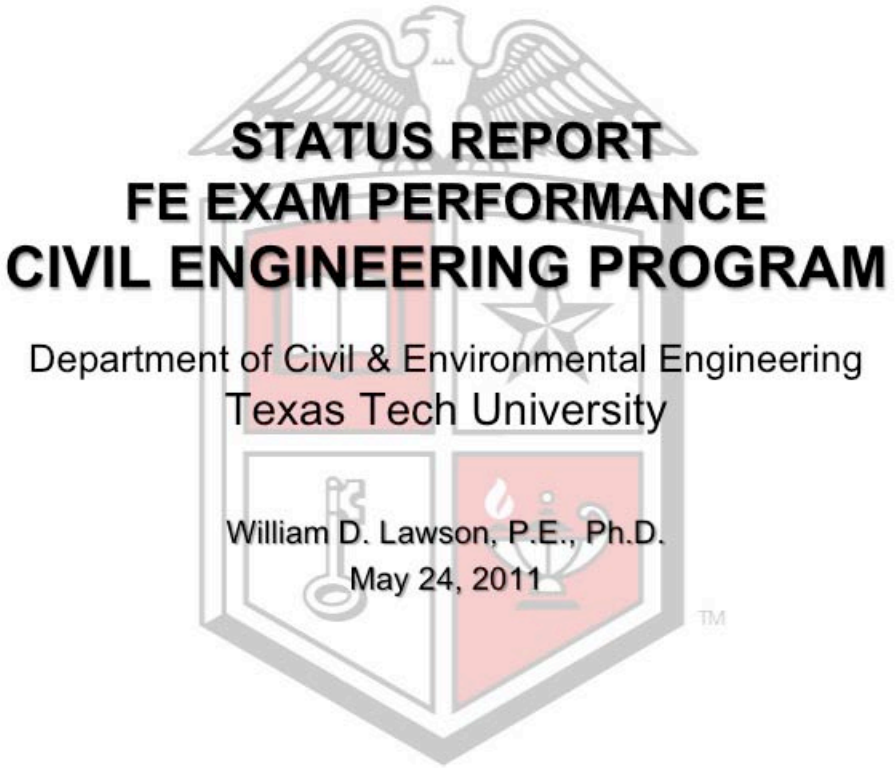
Although not required for graduation, many PE undergraduates take the Fundamentals of Engineering Exam. The 70% score criterion is not strictly used because there is no petroleum specific exam. The petroleum engineering students usually take the civil engineering, chemical engineering, or environmental engineering exam.

The number of students taking the PGE exam each year is approximately 40 which represents 40% of the graduating class.

Texas Tech University
Department of Civil & Environmental Engineering

Contributor: William D. Lawson, P.E., Ph.D.

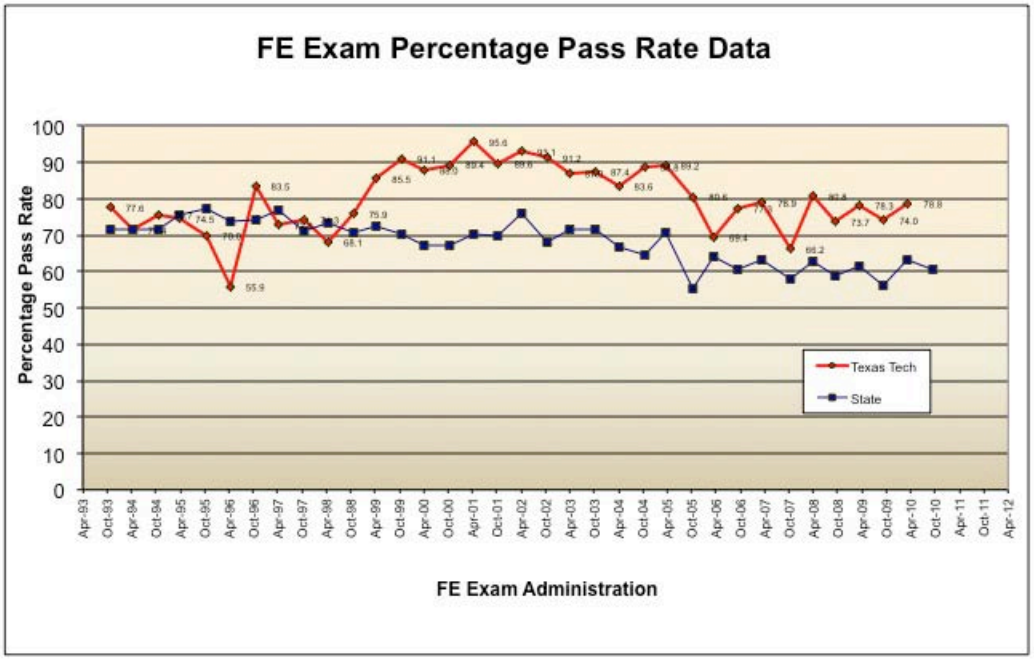
The following is excerpted from a presentation as titled below. Data, observations, and conclusions were prepared for in two presentations, one each for the civil and environmental engineering programs. Only portions of the analysis are provided herein, though each topic of the exam includes historic performance data.



Overview

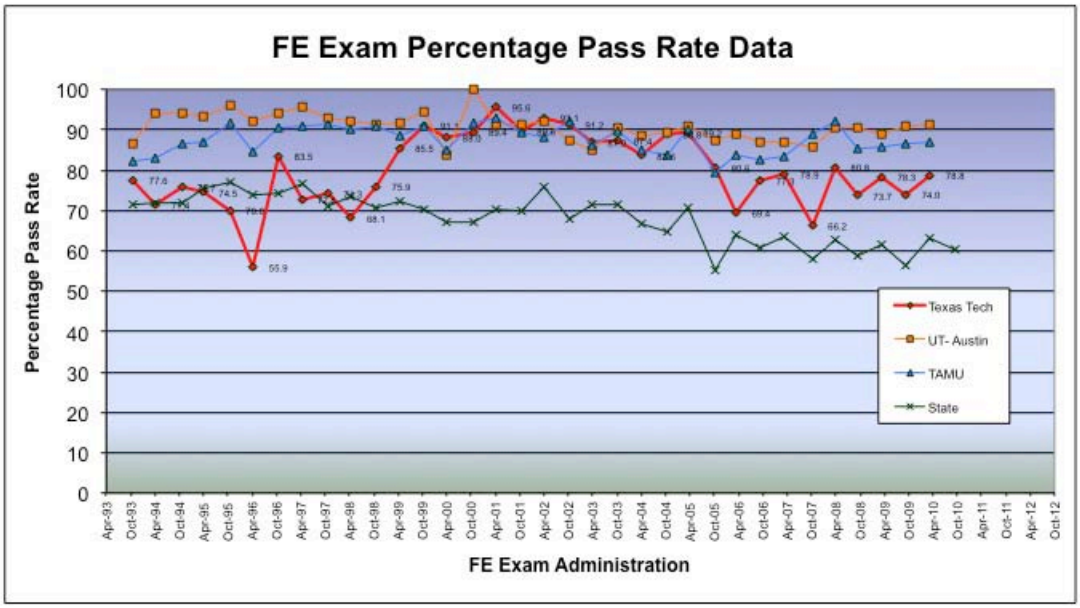
- College Performance
  - Comparison with peer universities
- Civil Engineering Program Performance
  - Overall
  - AM – subject content
  - PM – subject content
- Some Observations
- Recommendations

College Performance



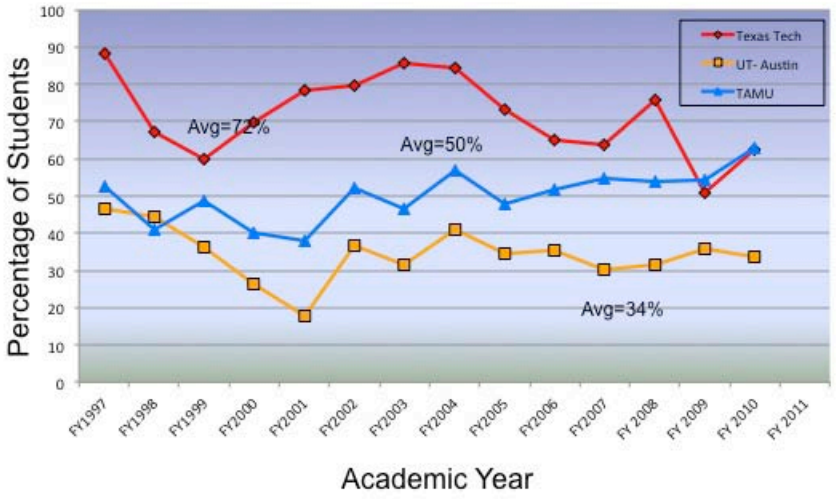
College Performance

Comparison with Peer Universities



College Performance

Comparison with Peer Universities
Percentage of Engr. Students Taking FE Exam

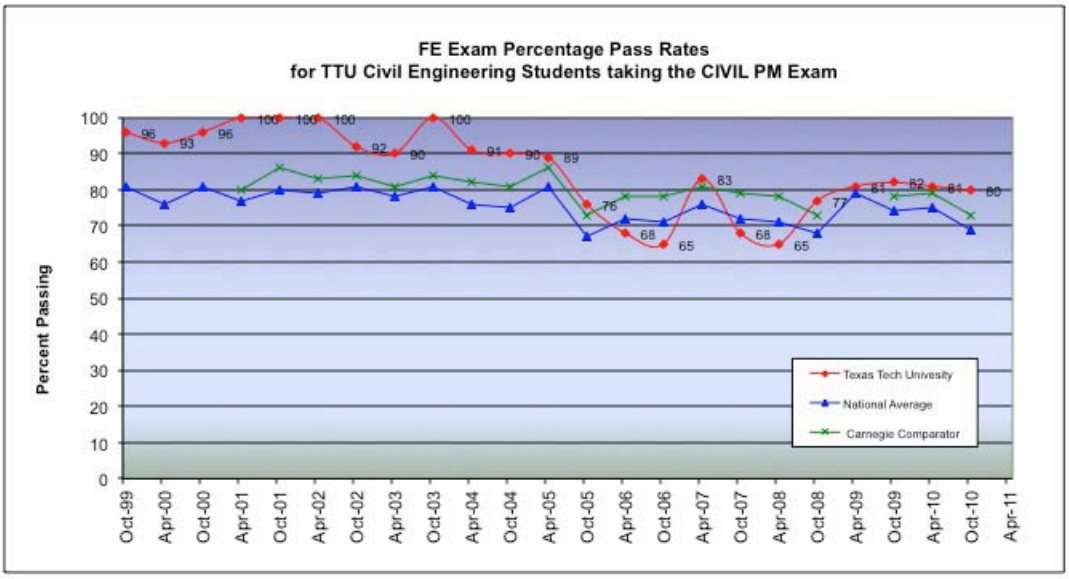


Percentage = (Exam Takers/ BS Engineering Degrees Awarded) *100
No. of students taking the FE… based on NCEES data
No. of students receiving BS degrees in engineering… based onTHECB data (does not include engineering technology).

College Performance
Observations

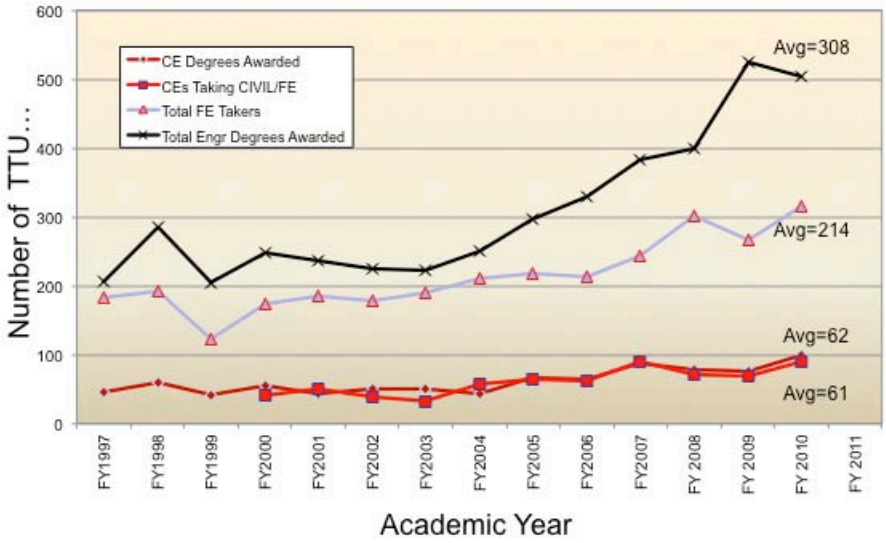
- NCEES introduced the PM Discipline-Specific exam format in October 1996.
- Texas Tech's overall performance on the FE Exam had been erratic and below comparator universities prior to that time.
- Texas Tech has always had a larger percentage of their students take the FE Exam, compared to UT-Austin (2.1x) or TAMU (1.4x)
- Texas Tech introduced the FE Exam Initiative in August 1999 to address FE Exam performance concerns.
- From 1999 through 2005, Tech's performance on the FE Exam was consistently strong, average 89%, which is typically equal to comparators and in some cases leading the state.
- In October 2005, NCEES changed their FE Exam Specification. The FE Specification change coincided with curriculum changes in many TTU engineering programs.
- Since October 2005, Tech's average percent pass rate on the FE has dropped (average 76%), and performance has been more erratic, typically 10% to 13% below comparator universities.

Civil Engineering Program Performance - OVERALL



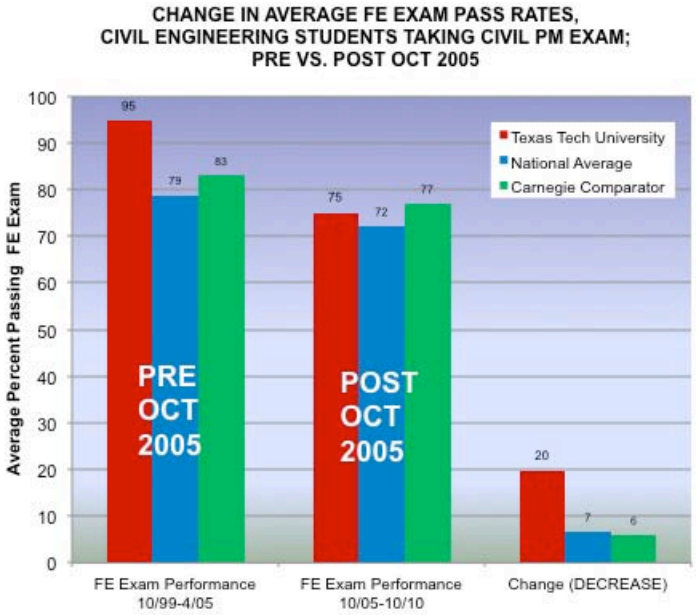
Civil Engineering Program

TTU Engineering Students Taking FE Exam
CE Students Taking CIVIL PM Discipline-Specific Exam



Civil Engineering Program

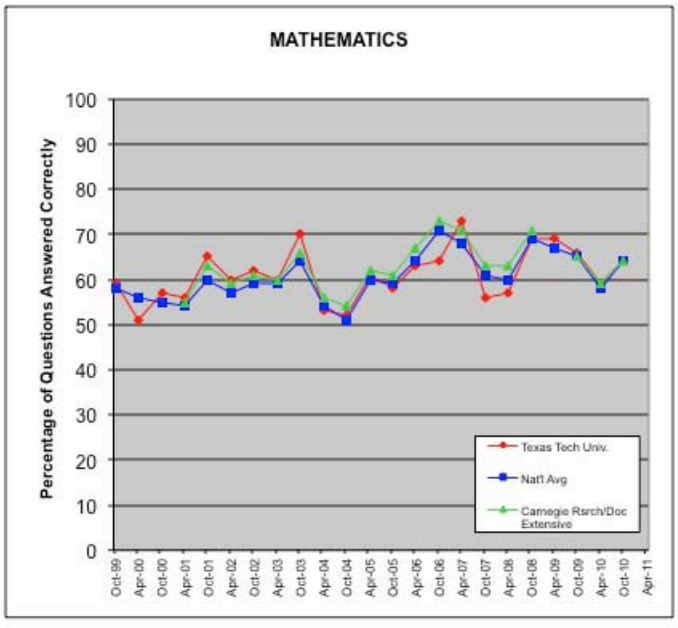
Pre/Post Oct 2005 Comparator Analysis



Civil Engineering Program
FE Performance Observations

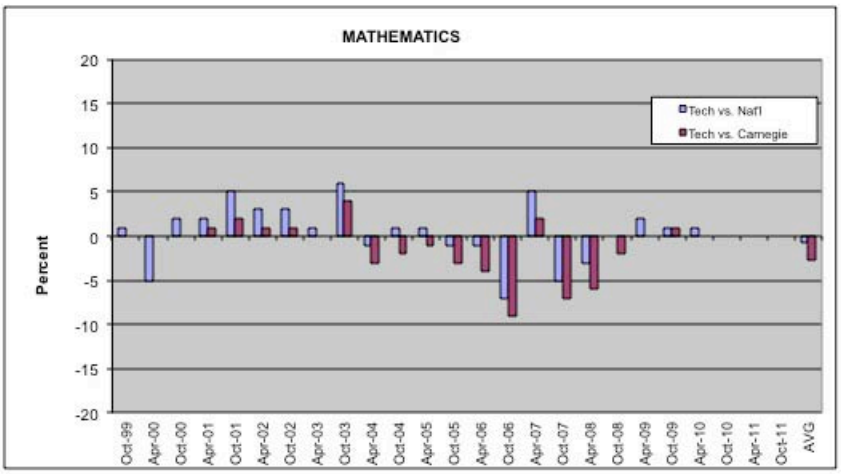
- From 1999 through April 2005, the period of the FE Exam Initiative, the performance of Texas Tech CE students on the FE exam (Civil Engineering students taking the CIVIL PM exam) was consistent and strong, with a typical pass rate of 89% to 100%, average 95 percent, well above comparators.
- In October 2005, NCEES changed the FE Exam Specification, and about that time, the TTU CE program curriculum changed.
- Notwithstanding some variation at the College level, the number of Tech CE students taking the FE Exam has remained consistent, typically close to 100%.
- Beginning in October 2005, performance on the FE exam dropped dramatically and consistently at all levels, with comparators dropping 6% to 7% and Texas Tech dropping 20%. Texas Tech performance since October 2005 has been erratic, in some cases below comparators.
- In the past two years, Texas Tech CE performance on the FE Exam appears to have stabilized at about 81 percent.
  - This is 2% to 11%, average 7%, higher than the National average (2009-10)
  - This is 2% to 7%, average 4%, higher than the Carnegie comparators (2009-10)

Civil Engineering Program
AM Portion



15%

Civil Engineering Program
AM Comparison



15%

MATHEMATICS

Tech vs. Nat'l	**-0.7**
Tech vs. Carnegie	**-2.8**

CIVIL Program Performance
PM-Challenges (May 2011)
(Averages Oct 2005 – Oct 2010)

ENVIRONMENTAL ENGR (12%)

Tech vs. Nat'l	**3.5**
Tech vs. Carnegie	**2.1**

SOIL MECH & FOUNDATIONS (15%)

Tech vs. Nat'l	**2.1**
Tech vs. Carnegie	**1.2**

TRANSPORTATION (12%)

Tech vs. Nat'l	**1.8**
Tech vs. Carnegie	**1.4**

STRUCTURAL DESIGN (10%)

Tech vs. Nat'l	**1.8**
Tech vs. Carnegie	**1.0**

HYDRAUL/HYDROLOG SYSTEMS (12%)

Tech vs. Nat'l	**2.0**
Tech vs. Carnegie	**0.5**

CONSTRUCTION MGMNT (10%)

Tech vs. Nat'l	**-0.1**
Tech vs. Carnegie	**-2.7**

MATERIALS (8%)

Tech vs. Nat'l	**-1.0**
Tech vs. Carnegie	**-2.6**

STRUCTURAL ANALYSIS (10%)

Tech vs. Nat'l	**-1.3**
Tech vs. Carnegie	**-2.9**

SURVEYING (11%)

Tech vs. Nat'l	**-2.2**
Tech vs. Carnegie	**-3.5**

Summary Observations

1. NCEES change the FE Exam in Oct 2005.
2. Texas Tech's percentage pass rate (CIVIL & College-level) has decreased significantly since then.
3. Why?
   - Change in FE Topics
   - Curriculum changes
   - Faculty changes
   - Feeling that there is some confusion among faculty (and students) of what is expected of them
4. CIVIL Program analysis suggests that AM performance needs improvement in 8 of 12 topics.
   - Esp.; Thermodynamics, Material Properties, Mathematics, Engineering Probability & Statistics, Strength of Materials, Engineering Economics, Fluid Mechanics
5. PM performance needs improvement in 4 of 9 topics.
   - Esp.; Surveying, Structural Analysis, Materials, Construction Management

Recommendations

- SHORT TERM
  - Encourage students NOT to take FE early
  - FE review course: special attention to reviews in problem topics
    - AM: Thermodynamics, Material Properties, Mathematics, Engineering Probability & Statistics
    - PM: Surveying, Structural Analysis, Materials, Construction Management
  - Faculty evaluate curriculum relative to FE topics/specification
- LONGER TERM
  - Evaluate CE curriculum design relative to FE topics
  - Evaluate Course Performance relative to FE specification
  - Re-think Scope and Focus of FE Review Course (CE 4101)
    - Review? Re-Learn? Learn?
  - Implement CE 4200 in Fall 2012 semester to augment FE Review course (CE 4101). CE 4200 will provide additional topic reviews on selected topics, one semester before FE Exam.

Vermont Technical College
Department of Architectural & Building Engineering Technology

Contributor: Scott A. Sabol, P. E.

The department receives from NCEES the results of the FE and PE pass rates and area breakdowns each year. We have not set a target for how many of our students we hope to have pass, nor have we set specific benchmarks for various FE subject areas. However, several of the engineers in my department review the student performance levels in the various subject areas over time to see if there are certain subject areas that are trending in good or bad directions, or are remaining stagnant but below what we believe is a good level of achievement (about 70%). Our ABET assessment/evaluation plan uses the FE information as an indirect measure of program performance and as anecdotal evidence, rather than statistically valid evidence, of program achievement in subject areas. We use the PE pass rates only as an indirect measure of our graduates' ability to achieve PE status.

A challenge for our program is that often Vermont Tech students represent 100% of the national sample of students taking the exam who categorize themselves in the area of architectural engineering technology. Thus, the total number of test takers nationally will exactly equal the number of Vermont Tech students who took the exam. We therefore do not have good data to compare our performance to peer institutions. We sometimes make use of the civil engineering technology data to give us benchmarks in certain subject areas common to both architectural engineering technology and civil engineering technology (e.g., statics and strength of materials; fluid mechanics).

Another challenge is in how students self-report their affiliation/background to NCEES for the FE exam. Some of our students obtain an associate's degree with us but then leave the field of architectural engineering technology and go to another school for a bachelor's degree in a different area of engineering or engineering technology. They sometimes/often to not report their Vermont Tech affiliation as part of the process.

In addition, we know that one or more students every year may actually not provide the identifying information to indicate that they are Vermont Tech students (or graduates) in/from the architectural engineering technology program (in other words, we know of students who took the exam in a particular sitting but their data are not included in any NCEES summaries). Thus, we cannot rely on the data from a statistical perspective. I have discussed the issue with NCEES, but there is no way to force or validate the correctness or completeness of what FE test takers furnish for information regarding the test when they take it.

About 12 years ago, we offered a voluntary FE review course, and primarily our best students who did want to become PEs eventually would take the FE exam. Our pass rate was reasonable (about 30-45%) for a technology school. We then made the FE review course mandatory (and expanded it to be more of a general critical thinking capstone course worth 1 credit), and this resulted in more of our less prepared

students sitting for the exam. We noticed that we had a lower pass rate (and in a few years, no passers, because some of our best decided not to take it). Our general goal is to have a program where our best students, especially those with the highest math skills (our highest mathematics requirement is only Calculus II, and we do not require probability/statistics), have a reasonable chance of passing on a first or second try. We have noted that a number of our students fail the exam their senior spring but pass when they re-take it within 18 months after that.

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