Design and Startup of an ABET General Engineering Science Program.

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I. Abstract

Union University started up its new engineering program in 2001. The program offers a Bachelor of Science in Engineering with a specialty in either Mechanical Engineering or Electrical Engineering. The first graduating class will be in May 2005, which will pave the way for the application for ABET accreditation¹ (EAC) in 2006.

This paper presents a case study to discuss and showcase our experience with designing and starting up a new engineering program from ground zero. Included in the discussion are (1) the identification of needs both internally and externally, (2) the decision on the type of degree to be conferred, (3) the design of the curriculum to exceed ABET criteria, (3) the training of the faculty on ABET policy and procedure, (4) the interaction with the State Board of Engineering Examiners, (5) the establishment of the program's objectives and educational outcomes, (6) the establishment and implementation of the Continuous Quality Improvement process, (7) the Assessment methods, (8) the documentation and record keeping, and (9) the self- study in preparation for the very first ABET campus visit and accreditation.

II. Introduction

Union University² has a long and rich 179-year history of being a university affiliated with the Tennessee Baptist Convention. The University's academic excellence has been in liberal arts based education. The first professional program, Nursing, began in 1962 at the request of the area physician community. Forty years later, Union University started up another professional program, Engineering, in the same fashion: out of need and at the request of area industries through the Chamber of Commerce. At the time of this writing, the Engineering program³ is in its third year of operation with 21 students and the first class of graduates is slated for May 2005. The program will apply for ABET accreditation in January 2006 for a historic first ABET onsite visit later that year. The design and startup of the Union Engineering program is itself an engineering project as described in this paper.

III. The Design Process

1. Identify the Needs

Union was presented with the need of the community for engineering skills. Through the Chamber of Commerce, it was determined that there was a need to educate engineers who would be willing to stay in the area to support economic growth of the region. The area consists of

nearly 400,000 people with an annual economy of about \$2B, which doubled in just 5 years as of 2003. Because being future-directed is one component of the University's Mission statement, it was only natural that Union responded to the need of the growing community. Demand for an engineering program was also identified by the Enrollment Services department where recruiters were asked by about 30% of potential students on an annual basis as to whether Union has an engineering program to meet their educational needs. Serving this population would fit the people-focused part of the University's Mission statement as well.

2. Define the Scope of the Solution

The new engineering program is to attract, recruit and educate potential engineers who are from west Tennessee. Potential employers are national and international companies who want a stable workforce. They want this to be sustained by locally trained engineers yet insist on quality engineering training that is nationally and internationally accepted for engineering education. ABET represents that yardstick.

3. Conduct research and Investigation

The University formed a committee to explore the feasibility of starting this engineering program. This committee consisted of members both from the University and the industries in the area. A survey was conducted among the industries to confirm the need for hiring engineers, to confirm the need for an Engineering Science program as opposed to an Engineering Technology program, and to explore the type of engineering disciplines that are projected to be in demand among the industries. Consultancy was sought to explore the feasibility of starting and sustaining an engineering program in a university rich with liberal arts educational heritage. An internal study was conducted to explore the fit between a new engineering curriculum and the rest of the campus academically. An internal study was also commissioned to identify the support for this new professional program among the faculty of the university at large.

4. Understand the Constraints

Certain constraints were determined during the study of the feasibility of starting an engineering education at Union.

- The new engineering program must be designed on a liberal arts educational foundation.
- It must not negatively impact other campus wide initiatives.
- It must be accredited.

5. Establish Design Criteria

- The program must be consistent with Union's Core Values and Visions.
- The program must be self-sustained.
- The program must meet or exceed ABET criteria.
- The program must be designed to serve both traditional and non-traditional students.

6. Propose Solutions

- Offer discipline-specific engineering degree such as BSME, BSEE and BSIE.
- Offer non discipline-specific engineering degree such as BS in General Engineering.
- Offer a nontraditional engineering BSE with concentration in either Mechanical engineering or Electrical engineering.

7. Analyze Each Solution

Each solution was analyzed taking into account the needs of the industries as well as the practical available resources for classrooms, laboratory space, supporting library, faculty and the time required to get an engineering program up and running. The department Chair, who also was responsible for assigning the various numerical values, conducted the study.

			n				
Criteria	Weight	Discipline	BS in	BSE with	Discipline	BS in	BSE with
		specific	General	conc. in	specific BS	General	conc. in
		BS degree	Engineering	ME or EE	degree	Engineering	ME or EE
		U	0 0		U	0 0	
	Scale	Scale	Scale	Scale	Scale	Scale	Scale
	(1-10)	(1-10)	(1-10)	(1-10)	(1-10)	(1-10)	(1-10)
Reasonable Lab	7	5	10	8	35	70	56
Cost							
Reasonable	8	5	10	10	40	80	80
Operating Cost							
Industries	10	10	6	8	100	60	80
Needs							
Space Available	5	5	10	8	25	50	40
Library Support	6	8	10	10	48	60	60
Timely ABET	10	7	10	10	70	100	100
Accreditation							
					318	420	416

Table 1: Summary of Type of Program Analyses

8. Select the Optimal Solution

The option to offer discipline-specific BS degree was the least favorable as shown in Table 1. While a BS in General Engineering degree came out with the highest score at the end, a sensitivity analysis was conducted to fine tune the selection of an optimal solution. It turned out that space availability was the primary reason for a BS in General Engineering program to be the most favorable. Based on that, it was decided the issue of space could be worked out relatively easily in light of the more pressing issue of industries needs. In effect, we decided that the weight factor for industry need should have been higher. With that in mind, a BS in Engineering with concentration in either Mechanical Engineering or Electrical Engineering degree program was selected to be the most desirable solution taking into all constraints and established criteria.

9. Write Specification

- The engineering program will be administered by the department of Engineering and housed in the college of Arts and Sciences for academic and administrative support.
- One program is to serve both traditional and non-traditional students.
- Obtain basic program accreditation as soon as the first engineering class is graduated (May 2005).

10. Communicate the Design

In the Fall of 2001 the department of Engineering was formed with an initial offering of four engineering courses in the first year. The industries, business community, west TN communities as well as the community of prospective students were informed of the historic debut of the successful implementation of the first phase of engineering design project— the design and implementation of the engineering education itself.

IV. From Design of an Engineering Program to Design and Startup of an Engineering Education at Union University.

1. **The Curriculum**: the challenge of curriculum design is to optimally meet the requirements as set forth by ABET and the core curriculum of the university. To satisfy both internal and external customers, the following curriculum (Table 2) was proposed and approved and has been implemented. It takes a full four years to finish (meaning eight regular fall and spring semesters plus three accelerated January semesters).

Category	EC Requirement (Credit hours)	Provided by BSE Curriculum (Credit hours)
Mathematics and Basic Sciences	32	40
Engineering Topics	48	61-64
Engineering Design*	Appropriate to Discipline	Included in Engineering Topics
General Education Component	Appropriate to Discipline	35
Other (Old & New Testament)	None	6
Total		141 - 143

Table 2: Credit Hour Summary for BSE Degree

- 2. **The Training of Faculty**: All faculty members in the department are trained and retrained in the continuous quality improvement (CQI) process at the beginning of each academic year. On an annual basis, faculty members, on a rotating basis, are to receive formal training through an ABET workshop.
- 3. The Interaction with the State Board of Engineering Examiners: To ensure proper communication with the State Board of Engineering Examiners, we have visited the capital at least once a year to bring the engineering committee of the board up to date on our progress and to address any questions the committee might have about our new program.
- 4. The Recruitment of Adjunct Professors: We realized from the beginning that attracting, recruiting, retaining and involving adjunct professors would be key to successful startup and on-going operation of the department. At the time of this writing, there are three adjunct professors on staff. Two of them are actively employed by surrounding industries. One is retired from a big-three auto company where he served as R&D corporate manager. At Union, adjuncts are in every way fully involved with the department's operation. They retain ownership of the course they teach. They

participate in monthly departmental meetings. They are actively involved in the design and modification of the curriculum. They participate in every step of the CQI process (to be discussed later). They participate in pedagogical training and implementation such as our active learning campaign. They are extended most privileges that full-time faculty enjoy. They know that they are long-term and committed adjunct professors of the department. They are not adjunct staff in the simplest sense of coming and going or of temporary help.

5. The establishment of the program objectives and educational outcomes: In the second year of startup, the department quickly established the two most important documents which would serve as guideposts for the new Engineering mission. The department drafted the structure of the program objectives consistent with ABET expectations. The constituencies were then requested to "put the meat" on this draft. This was done by first identifying the constituencies of interest and then conducting a convenient internet-based survey using the following form (Table 3 and 4). Program objectives are to be evaluated three years after graduation and three years thereafter.



Engineering Program Educational Objectives— A Survey of Constituencies.

Union University's Mission Statement:

"Union University provides Christ-centered education that promotes excellence and character development in service to Church and society."

As a constituent of the Union's <u>Engineering Program</u>, your comments are sincerely requested on the following **educational objectives**:

- 1. To provide a solid engineering education that is built on a strong liberal arts and science foundation.
- 2. To prepare students for successful careers or advanced studies in engineering or other professional fields.
- 3. To prepare students to think Christianly and act ethically in providing services to their employers, communities, churches and humanities.
- 4. To foster an instructional environment that promotes engineering design skills and inventive thinking.

From t	the	pers	pective	of	(please	check	one)
r i uni u	ιne	pers	pective	UI I	(picase	CHUCK	one

Corporation/Industry	Community college	Graduate program
Chamber of Commerce	Church Representative	Union Administration
Engineering Faculty	Student	
Your Organization:		

Please provide your comments in the following window:

	A	
	-	
4	► E	
Continue		

Table 3: Internet-based Survey form for Program Objectives.

A survey was also done to establish the Engineering Educational Outcomes which represent the specific skills, knowledge and abilities the students ought to have by the time of graduation. The following Table 4 shows the form that we used to obtain feedback from our constituencies. Data of both categories, Objectives and Outcomes, were consolidated and presented to the Engineering faculty for revision, or addition, or both, to reflect comments from the constituencies.

As far as the educational outcomes are concerned, we used the established "a to k" as the core outcomes as set forth by ABET. We also have two additional outcomes, "l" and "m" to reflect our belief in values students ought to have prior to graduation. The first is to ensure at time of graduation that each student will recognize the importance or registration and licensing and, the other, that each student will be aware of the integration of faith and learning.

A note on the internet-based survey: we found it to be very effective. The convenience of being able to "click here for the form" and "click here to submit your feedback" has provided the incentive for responses and much-needed information. It is not only convenient for the responders, it also provides a convenient method for electronic data collection, sorting and analysis. We used this type of survey also to assess student performance during internship assignments, as well as to find out which engineering disciplines were more in demand, when we contemplated broadening our areas of concentration.

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Engineering Program Educational Outcomes-

A Survey of Constituencies.

The following are program outcomes. As a constituent of the Union University's Engineering program, please provide your input to further meet your needs or expectations.

At time of graduation, each graduate shall have:

- a. An ability to apply knowledge of mathematics, science and engineering
- b. An ability to design and conduct experiments and to analyze and interpret data
- c. An ability to design a system, component or process to meet desired needs
- d. An ability to function on multi-disciplinary teams
- e. An ability to identify, formulate and solve engineering problems
- f. An understanding of professional and ethical responsibility
- g. An ability to communicate effectively
- h. A broad education necessary to understand the impact of engineering solutions in global and societal context
- i. A recognition of the need for, as well as the ability to engage in, life-long learning
- j. A knowledge of contemporary issues
- k. An ability to use the techniques, skills and modern engineering tools for engineering practice
- 1. A recognition of the importance of professional registration and licensing
- m. An awareness of the importance of integration of faith and learning





Table 4: Internet-based Survey Form for Educational Outcomes.

Having established our program Objectives and educational Outcomes, the following mapping was conducted to verify that there were indeed relevant relationships between the two as shown in the following Table 5.

Table 5: Relationship between Educational Objectives and Outcomes

Educational Outcomes	Program Objectives					
	Objective 1	Objective 2	Objective 3	Objective 4		
(a) Ability to apply		1				
knowledge of math,	N	N N				
science and engineering						
(b) Ability to design and						
conduct experiments, as	N N					
well as, analyze and						
interpret data	,					
(c) Ability to design to						
meet needs	N	,		V		
(d) Ability to function on						
multi-disciplinary teams	,	N N				
(e) Ability to identify,						
formulate and solve	N N			N		
engineering problems		ļ,	,			
(f) Understanding of						
professional		N N	v			
and ethical responsibilities		ļ				
(g) Ability to						
communicate effectively	ļ,	N N				
(h) Broad education						
necessary to understand	v					
the impacts of engineering						
solutions in a global and						
societal context		ļ,				
(i) Recognition of the need						
for life long learning		V				

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Educational Outcomes	Program Objectives				
	Objective 1	Objective 2	Objective 3	Objective 4	
(j) Have knowledge of		1			
contemporary issues	N	N			
(k) Ability to use					
techniques, skills and		N			
modern engineering tools					
for engineering practice					
(l) Recognition the					
importance or registration		N N			
and licensing					
(m) Awareness of the					
integration of faith and			N N		
learning					

6. The establishment and implementation of the CQI process.

The backbone of our program, as well as any other ABET-approved program, is continuous improvement. The department has a plan to assign the CQI directorship to a faculty member to direct and be responsible for this program. Currently this job rests with the department Chair for accountability of the program startup. Please refer to Table 6 for the CQI process

<u>Week 0</u>: One week prior to the start of the semester, CQI director will send a reminder to each teaching faculty about the need

- To specifically explain to the students the stated educational outcomes, which are expected from the teacher (to deliver) and of each student (to attain).
- To inform the students that the stated educational outcomes will be measured.

Week 12: In preparation for week 13, CQI director will send

- A reminder to each teaching faculty about the need to conduct a point of learning survey the following week. A survey form will be sent out to the instructor. Items to be surveyed are extracted from the course syllabus. A typical POL self-assessment survey form is shown in Table 7 below.
- A reminder to each teaching faculty that in two weeks (week 15) a specific final exam must be designed to test quantitatively the same outcome items defined in the student self-assessments.
- A date is also set to convene all faculty members to meet after final grades are turned in to analyze the collected data (course evaluation, faculty evaluation, outcomes evaluation, faculty's self evaluation for course improvement, etc). This is done soon after grades are turned in to take advantage of the freshness of data).



Table 6: Continuous Quality Improvement (CQI) Process

7. The assessment methods

Since we know we cannot manage what we cannot measure, the program subscribes to ABET's philosophy of quantitative measurement of learning. Our measurement system is based on a triangulation approach:

- **7.1 Point of learning self-assessment by each student**. Toward the end of the semester (the 13th week), students are given the opportunity to evaluate the course as well as the instructor, and the department piggybacks this process by asking the students to do a self-assessment using the following form (Table 7) for each of the outcomes as stated in the syllabus at the beginning of the course.
- **7.2 Point of learning faculty assessment via locally developed test**: Two weeks after students' self-assessment, each faculty of the course will specifically design the final exam to test each of the outcomes as committed in the course syllabus (which contains some but not all eighteen educational outcomes). Please refer to appendix A for a typical syllabus that highlights committed educational outcomes. To facilitate the evaluation of the degree of attainment of each particular outcome, each outcome will be tested separately. For example, the attached syllabus calls for the training on eight relevant

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Table 7: Point-of-Learning Survey

	POINT OF LEARNING DATA SHEET I achieved the following abilities as a result of this course						
	< a lot	t			not at all>		
EDUCATIONAL OUTCOMES	4	3	2	1	0		
An ability to apply knowledge of math, science and engineering							
An ability to design & conduct experiments, analyze & interprete data							
An ability to design a system, component							
Or process to meet desired needs							
An ability to function on multi-disciplinary teams							
An ability to identify, formulate, and solve engineering problems							
An understanding of professional and ethical responsibility							
An ability to communicate effectively							
The broad education necessary to understand the impact of							
engineering solutions in global and societal context.							
A recognition of the need for, and ability to engage in							
life-long learning							
A knowledge of contemporary issues							
An ability to use the techniques, skills, and modern							
engineering tools for engineering practice							
A recognition of the importance of professional registration							
and licensing							
An awareness of the importance of integration of faith & learning				1			

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outcomes, the final exam will have at least eight relevant tests—one for each outcome. Please see appendix B for a typical final exam of a course. While the sum of all the scores of these eight tests will contribute toward a final grade, say, A for the course, it does not automatically translate into high degree of attainment in some of the specific outcomes. The description will be illustrated more clearly in the following Table 8 for one particular engineering course:

		Faculty assessment of	Overall course
	Specific test score	degree of attainment	grade
Course outcomes	(score/max score)	(scale 1-4)	(scale A, B, C, D, F)
(a) Ability to apply knowledge of math, science and engineering	20/40	2.7	
(c) Ability to design to meet needs	9/10	2.7	
(e) Ability to identify, formulate and solve engineering problems	5/10	2.8	
(f) An understanding of professional and ethical responsibility	10/10	3.0	С
(g) An ability to communicate effectively	10/10	3.0	
(k) An ability to use the techniques, skills, and modern engineering tools for engineering practice	20/20	2.3	
(1) Recognition the importance or registration and licensing	3/10	3.0	
(m) An awareness of the importance of integration of faith & learning	10/10	3.0	

Table 8: Specifically Designed Test Scores and their Use as an Assessment Tool.

The student may have had high scores in certain outcomes of the test but could wind up with an overall C grade for the course (Engineering Statics, for example), which took into account other classroom activities such as doing homework assignments, writing term paper, performing in quizzes and other exams, etc. As to the specificity of why the degree of attainment was 3 and not 3.3 or 2.8? It was, admittedly, a judgment call but it was a call by the teaching faculty and was based on specific relevant test that was designed solely for the purpose of making this kind of call. It should be noted that the above tabulation (Table 8) was only for one course by one teaching faculty for one semester. The student may have taken other courses during the same semester. These scores (of the same objectives) were then averaged to give the average degree of attainment for a particular outcome for that semester. Discussion on keeping track of these averages for all courses and all semesters will be given in the next section where it will be shown also how overall program performance can be derived from individual student's learning portfolio. There is no specific link between the course overall grade and the degree of attainment on any particular educational outcome, as shown by the above Table 8. The specific test provides a means to measure outcomes and not the overall student's behavior in the course.

7.3 Portfolio tracking for each student: Scores from self-assessment and faculty assessment (as explained above) are entered into the outcome-tracking database as shown below in Figure 1 and 2. Each student is tracked by the following portfolio, which is based on faculty assessment. The students' self-assessment scores are used to validate or check the correlation of the measured outcomes.



Figure 1: Student's porfolio tracking for outcome "a" (by faculty).





Above are charts of 2 of 13 outcomes for a typical student. This is the tracking portfolio of any one student in the program. We track him or her from the first semester until graduation. Students are expected to start with, realistically, ground zero of any of the outcomes. It is expected that over the course of the training, if the program is effective, their abilities will grow with time.

We also track outcomes of each student via self-assessment. While we do not evaluate the program based on students' self-assessment, we expect that faculty assessment will have good correlations with students' self-assessment on average. That hypothesis can be verified here as we compare the trends Figure 1 and 2 with those in Figure 3 and 4.







Figure 4: Student's portfolio tracking for outcome "c" (self-assessment).

The portfolio tracking as described above is done both for the students on an individual basis as well as for the entire program, as shown by the following tabulation, Table 9:

	Rolling Outcomes												
Student	a	b	c	d	e	f	g	h	Ι	j	K	1	m
1	2.8	2.2	3.1	3.8	3.6	2.3	2.8	3.0	2.5	3.3	3.0	2.3	3.0
2	2.4	2.1	3.1	3.3	2.5	2.5	2.7	3.5	3.0	3.0	2.8	4.0	3.3
3	3.5	2.6	3.5	2.5	3.8	2.5	2.7	2.5	2.0	2.5	3.5	2.3	2.7
4	3.0	2.8	2.9	3.0	3.1	3.0	3.1	2.0	2.0	2.5	3.3	2.3	3.3
5	2.4	2.3	2.7	2.3	2.4	1.4	2.2	1.7	2.0	2.0	2.4	2.5	2.0
Other													
Other													
Other													
Program	2.4	1.2	2.6	1.5	2.4	2.9	2.9	0.8	1.6	0.8	2.8	2.5	2.6

Table 9: Program Performance Tracks Students' Learning Attainment

It is realized that only overall assessment for the program is of interest as far as ABET is concerned. We extract that information from the portfolio of each student in the program, and this information is averaged to provide an overall degree of attainment in each of the thirteen categories. Figure 5 shows evidence of that extraction of data for program assessment:



Figure 5: Overall assessment of the program

8. The documentation and record keeping system

Progress of the program is kept for each outcome, electronically as well as in paper form. The average score for each outcome of the program takes into account the score of each student achieved through locally developed tests over the last rolling 4 years. Physically there are thirteen file cabinets in the department, each representing one outcome. Within each cabinet, students' files are alphabetically arranged. Within each student file there is evidence of performance for that particular outcome filed by progressive semesters. The system works well.

9. The self-study report preparation: Having established all the necessary infrastructure required of a quality engineering educational program, beginning with our 2nd year of operation, the department actively worked on a self-study report for a mock ABET visit, in preparation for an actual ABET visit in 2006 (following our 2005 first class of engineering graduates). The self-study report was not too early in light of the many insightful benefits it offers as shown below. It is an on-going report to be constantly updated with relevant information.

V. Experiences of a New Program

We took advantage of the many benefits of a self-study report very early (beginning with the 2nd year since startup) to build the program. It turned out to be a very effective way of using the self-study mechanism not just to get ready for the ABET visit (although this would be the ultimate goal). This self-study report is meant to be on going and constantly updated. Our on-going self-study report reveals the following state of readiness of our program (Table 10):

Deterrited Develo	Determined		D
Potential Problem	Determined by	Action Taken	Kesuit
or Deficiency			
Lack of EE faculty	Faculty workload	Requested a creation of	Position was created.
	analysis, section 5 of	a new Electrical	Faculty to start fall
	the self-study report	Engineering tenure-	2004 semester
		track position for fall	
		2004	
Lack of sufficient	Students' feedback,	Requested 100%	Got approval for new
laboratory space to	department's growth,	increase in laboratory	lab space.
separate mechanical	and assessment from	space.	
engineering from	section 6 of the self-		
electrical	study report.		
engineering.			
Lack lab equipment	Self-study report	Requested a tensile and	Got approval for the
to teach Materials	session 6.	hardness test machine	equipment.
Engineering courses.		as well as a torsion and	
		beam bending with	
		recorder.	
Lack a ME faculty.	Session 5 of self-study	Requested a creation of	While waiting, 3
	report.	a new Mechanical	outstanding adjunct
		Engineering tenure-	professors are filling
		track position for fall	the ME needs very
		2005.	effectively.

Table 10: Tracking a Learning Organization

Potential Problem	Determined by	Action Taken	Result
Outcomes b, d, h, i and j are not measuring up to minimal criteria of 2.	On-going monitoring of the program's performance profile indicative by Figure 5.	Faculty were asked to commit their syllabi, hence their teaching, to these areas of educational objectives.	Results will be monitored when Figure 5 is again generated at the end of spring semester of 2004.
Retention rate of aspiring engineering students is low	Analysis of student body from section 2 of self-study report.	Work with service- course departments such as Physics and Mathematics to increase tutoring sessions. Increase engineering "clinic" hours in which extra times are set aside by faculty to help with homework sessions.	Retention rate has been improved significantly in the fall of 2003 (88% for the freshmen class and 75% for the sophomore class.
Being apologetic for having a non- discipline specific BSE program	The Chair's in self- reflection of the startup operation to date.	Becoming quite convinced that general engineering program prepares the students well to face the various technical demands more adequately and ambidextrously.	Recruiting and conversation with prospective students have been facilitated with the adjusted viewpoint of what the General Engineering program has to offer.
Ability to educate the public as to why the program is not accredited.	Feedback from Enrollment Counselors as well as faculty who participated in Engineering recruiting.	Internal training was given to help the public to differentiate between being not accredited and being not accreditable and to be informed of accreditation process.	Same as above with respect to recruiting efforts.
Lack of departmental assistance to help filing and maintaining filing system	The implementation of the CQI process with respect to the tracking, profiling and documenting efforts as described above.	Requested an administrative assistant to be assigned to the department.	A shared administrative assistant was assigned to Engineering department. This has been sufficient at this time.

VI. Engineering Anyone?

In a globally economic competitiveness, statistics are not on our side. It has been projected that China is growing its economy at an accelerated rate that may overtake the US position as economic leader by 2030⁴. Also, it is currently known that China graduates about 700,000 engineers annually⁵ while the US graduates only one-tenth of that⁶. Perhaps we can see the correlation of the two trends—economic growth and engineering training. More engineers are to be trained for the technical challenges in our society today. More engineering programs are needed! To design and start up an engineering program, as described in this paper, is very challenging if it is to meet every aspect of ABET requirements, and exceed them. But it is worthwhile. To that end, Engineering anyone?

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About the Author

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Appendix A—A Typical Syllabus (Partially only to show committed outcomes of the course)

Engineering Statics Fall 2003

Basic Information:

Credit:	3 semester hours- lecture-problem format			
	9 – 9:50 M W F Lecture			
	2 – 4 F Engineering workout session**			
Prerequisite:	MAT 212, PHY 232			
Instructor:	Prof. Don Van, PhD., PE., CEM			
Office:	A-3A e-mail: dvan@uu.ee	du Phone: 661-5534		
Office hours:	10:00 - 11:00 T/R; 2 - 4 W; 2 - 4 F or anytime I am in the office.			

Scope of the Course**:

To train the students to solve practical engineering problems involving rigid body structures at equilibrium. The students are to achieve this through the application of mathematics (included but not limited to vector analysis, linear algebra, trigonometry and calculus of integration) and physics (Newton's laws, principle of particle equilibrium, friction, resultant forces and moments, center of gravity and moment of inertia). The students will be trained to apply Engineering method of solution for problem solving and Engineering design process to conduct engineering design project.

Expected Educational Outcomes:**

At the end of this course, each student is expected to have the following concerning Engineering Statics:

- 1. An ability to apply knowledge of Math, Science and Engineering
- 2. An ability to design a system, component or process to meet desired needs
- 3. An ability to identify, formulate, and solve engineering problems
- 4. An understanding of professional and ethical responsibility
- 5. An ability to communicate effectively
- 6. An ability to use the techniques, skills, and modern engineering tools for engineering practice
- 7. A recognition of the importance of professional registration and licensing
- 8. An awareness of the importance of integration of faith & learning

Outcomes Assessment Methods:

Each of the above educational outcomes will be measured by the following 3 assessment methods

- 1. Point of learning self assessment by each student
- 2. Point of learning assessment by the instructor via locally developed exams
- 3. Student portfolio tracking

Textbooks and Materials:

Required texts: *Engineering Mechanics: Statics and Dynamics* 9th Edition 2001 by R.C. Hibbeler Strongly recommended: Schaums Outline-Statics and Strength of Materials Scientific calculator

Appendix B-a Typical Outcome-Related Test

Final Exam

EGR 275 Engineering Statics

Fall 2003

Student:

Date:

This test is to objectively assess the following educational outcomes:

- 1. An ability to apply knowledge of Math, Science and Engineering
- 2. An ability to design a system, component or process to meet desired needs
- 3. An ability to identify, formulate, and solve engineering problems
- 4. An understanding of professional and ethical responsibility
- 5. An ability to communicate effectively
- 6. An ability to use the techniques, skills, and modern engineering tools for engineering practice
- 7. A recognition of the importance of professional registration and licensing
- 8. An awareness of the importance of integration of faith & learning

1. <u>To test your awareness of the Engineering Design Process to identify, formulate, and</u> <u>solve engineering problems</u> (10 points)

Name the Engineering Design Process step by step in correct order AND briefly explain the meaning of each step.

2. <u>To test your awareness of the importance of professional registration and licensing (10 points)</u>

Among the benefits of becoming registered as a professional engineers (P.E) are:

- *Job Opportunities* Employers want engineers who show a commitment to the future by becoming registered. Many engineering jobs require P.E. status.
- *Promotions* A majority of senior engineering positions are occupied by P.E.s. An increasing number of companies are requiring registration for advancement.
- *Consulting* Only P.E.s can consult in private practice and serve as expert witness in court.
- **Respect** P.E.s gain the respect of peers within the engineering community. Registered engineers also enhance their employers' reputation.
- *Professionalism* Registration by a majority of engineers is essential if you are to enjoy the benefits of established professions such as medicine and law.
- *It's the Law* This is probably the most important reason. Tennessee and most other States' law reserve use of the word "engineer" for licensed professional engineers.

Circle the correct answers?

- a. There are two 8-hour exams. The first part called FE (Fundamental Engineering), which can be taken during your senior year. The second part called PE (Principles & Practice of Engineering).
- b. One needs 2 years of practice before being eligible for taking the second part of the exam.
- c. The National Society of Professional Engineers (NSPE) administers both parts of the exam.
- d. Since the test is national, acceptance of the professional engineering license is also national and automatic

3. <u>To test your knowledge, and awareness of, professional engineering code of ethics AND</u> <u>your written communication skill</u> (10 points)

Your project, which is the design of a bleacher for Union University, is a very important project in that it directly impacts people's lives in very significant way. You have worked hard at it!!! Now you are asked to consult the attached Engineering Code of Ethics (the Fundamental Canons) as well as the Tennessee Code Annotated 62-2-102 (the highlighted parts) and decide HOW or WHETHER you should release your design for construction. Explain your action. Please note your written communication skill is also being evaluated.



4. <u>To test your ability to design a system or component to meet needs</u>

This has been tested via your course-end project in which you were graded for implementing the engineering design process to complete the task. No further evaluation will be done here. No duplication of credit will be given here. Please go on...

5. <u>To test you awareness of the importance of the integration of faith and learning</u> (10 points)

Show your awareness of the importance of the integration of faith and learning by doing one of the following 2 tasks:

• In your own word, show how the learning of the materials presented in this course will help to reinforce or make you aware more of your faith?

• OR you may repeat what you have heard from your instructor on how to relate the study of the materials <u>in this course</u> to faith.

- 6. <u>To test your ability to use modern tools and techniques for engineering practices</u> (20 points)
 - Demonstrate your ability to use the computational power of your calculator to solve the following equation:

$$35 = \frac{1}{0.012} \quad * \frac{(4y + y^2)^{5/3}}{(4 + 2.83y)^{2/3}} * \sqrt{0.001}$$

The answer: y = _____

• Demonstrate your ability to use the computational power of Excel to solve the following problem:

Α	В	С	D	Е
1	70	0.25	0.30	0.35
2	80	0.26	0.31	0.36
3	90	0.27	0.32	0.37
4	100	=(C3+1)*B4		=(\$E\$3+1)*B4
5	110	Copy from C4		Copy from E4
6	120	Copy from C5		Copy from E5
7	130			
8	140			
9	150			

The content of cell E5 is _____

The content of cell E6 is _____

7. <u>To test your ability to apply mathematics and science in solving engineering problem</u> (proper engineering method for solution must be implemented for full credit) (40 points)

<u>Problem 7.1</u>: Determine the reactions at the supports as shown in the following drawing:

<u>Problem 7.2</u>: Determine the force members BC, FC and FE and state if members are in tension or compression.

<u>Problem 7.3</u>: The uniform pole has a weight of 30 lbs and a length of 26 ft. Determine the maximum distance d it can be place from the smooth wall and not slip. The coefficient of static friction between the floor and the pole is $\mu_s = 0.3$

<u>Problem 7.4</u>: Determine the moment of inertia I_x of the section as shown below: