AC 2007-1461: INTEGRATED ENGINEERING: AN ENGINEERING DEGREE FOR THE NEXT GENERATIONS WORK ENVIRONMENT

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Integrated Engineering:
An Engineering Degree for the Next Generations Work Environment

Abstract

Integrated Engineering goes beyond the boundaries of common engineering disciplines by approaching engineering problems using fundamental knowledge as if there were no boundaries. The past several decades have resulted in engineering degree programs that provide students an increasingly focused, discipline specific engineering education. Most engineering degree programs emphasize gaining comprehensive knowledge and proficiency in a narrow discipline of engineering yet the work place is becoming more interdisciplinary. As sensors and microprocessors increase in use, design, manufacturing and regulation are being forced to become more interdisciplinary, even integrated, in order to efficiently utilize the latest technologies. More knowledge is required to stay competitive; at the same time there is increasing pressure to streamline engineering degree programs and provide students a realistically achievable four year path to a Bachelor's degree. Hard choices are faced by educators and the result is often the sacrifice of engineering fundamentals that are unrelated to a program's ultimate focus. There is a growing need for graduates that possess comprehensive knowledge of engineering fundamentals from the full spectrum of engineering disciplines to accommodate the increasingly integrated work place. Multi-disciplinary engineering degree programs are attempting to address this need, often by utilizing coursework from various "traditional" departments in well established engineering colleges. Integrated Engineering is an attempt to develop a comprehensive fundamental curriculum where all of the coursework integrally supports the overall course of study. With their broader, fundamental knowledge Integrated Engineering graduates are able to work in a variety of environments and quickly extend their fundamental knowledge to the focus required by a new or rapidly changing environment.

The following subjects are presented and discussed: the constituency that initially proposed establishing an Integrated Engineering degree program; the original curriculum; the shortcomings, growing pains, and maturing of that curriculum; and the programs current ideals.

Introduction

Engineers today impact society to a greater extent than ever before. We depend upon the systems, machines and processes developed by engineers in virtually everything we do. Solving problems in our modern world mandates the use of technology that changes virtually as it is embraced. In this environment, learning is perpetual, change is a constant, and competition is merciless. Problems and solutions alike know no discipline boundaries. The only non-volatile variables in the design equation are the fundamental principles of engineering knowledge which also know no boundaries. To succeed in this environment, the engineer needs to confidently rely upon these unchanging fundamentals, quickly learn how to implement the latest advancements, and perpetually adapt. Engineering fundamentals are learned in school; the latest and greatest application must be learned on the job, in the environment where it will be used.

Background

"Today, we are in the midst of a technology revolution that is even larger and more dramatic in its sweep than the industrial revolution." These words from "*The future of engineering education"* by Dr. Wayne Clough, president of Georgia Tech [1], sound a clarion call to academia to change and adapt. Dr. Clough's thesis is that computer based technology is changing the dynamics of the workplace and that academia must transform if it is to serve the needs of industry and our students. An "innovative interdisciplinary" approach is needed.

Dr. Clough's sentiments are echoed by L.S. Fletcher, a past president of the ASME in a letter to the editor: "Is Mechanical Engineering Obsolete?" Fletcher laments the resistance to change, the narrowed focus of current degree programs, and the lack of an interdisciplinary approach that makes the traditional engineering degree inadequate and outdated. He emphatically concludes that unless the mechanical engineering profession changes to accommodate industry, it will become a "dead or dying profession". This is ironic given the "generalist" origins of mechanical engineering. [2]

Engineering educators and professional societies point to the acceleration of change in society and the workplace driven by the explosion of information technology, the continued impact of computer and microprocessor driven devices, the blurring of boundaries between traditional disciplines, and the "rapid emergence of new technologies" as the driving force for change in the post secondary system of education. [3]

We have all seen the explosion of microprocessor based consumer products from "smart" washing machines and dryers, to robotic vacuum cleaners. The recent History Channel program "Boy Toys" featured "concept cars" that have over 30 microprocessors that are used to control and optimize the various functions involved in driving, navigating, and monitoring the health of the vehicle. The US military has seen and embraced this technological revolution, funding the development of remotely piloted vehicles of all sizes from man-packed drones used for local reconnaissance to larger strategic models. The US Air Force estimates that by 2025, robotic aircraft the size of today's F-16 will routinely be used in high intensity environments. Yet there is no engineering curriculum that comprehensively addresses this intimate integration of microprocessor, electronics, and engineering, across all courses and especially at the undergraduate level.

The integration of technology across traditional engineering disciplines is not limited to "Mechatronic" systems. It occurs in transportation systems, "smart" highways, smart houses, intelligent structures, self navigating vehicles, robotic supply convoys, the distribution of all modern utilities, in sewage treatment, and even in the collection and disposal of solid waste.

In the past 100 years the academic response to the introduction of new technology has been to offer additional courses and specialization ("compartmentalization") in engineering education. At the same time requirements for graduation have been reduced from a range of 150-160 semester hours for a bachelor degree to around 128 hours in an effort to stay competitive with other non-engineering degree programs. The results shown in both a Canadian and US study are that less than half of engineering graduates consider their engineering degree useful in the performance of their duties. [4]

This reduction in engineering degree content in the face of an ever expanding volume of technology is forcing a critical review of the appropriateness of current engineering curriculum, the minimum knowledge necessary for proficiency in practice, and the requirements for professional licensure. ASCE recently adopted Policy Statement 465 which "supports the concept of a master's degree or equivalent as a prerequisite for licensure and the practice of engineering at the professional level". [3] NCEES recently adapted the education requirements in the model law for professional licensure to include requiring a master's degree or 30 semester hours of equivalent education beyond the bachelor's degree to be effective January 1, 2015. [5]

Changing the model law is not enough. What is needed is a comprehensive revision of the "system of education" instead of the typical "tweaking" of specific curriculum as has been the practice in the past. It is our assertion that traditional engineering undergraduate degrees have gutted engineering fundamentals in the rush to reduce hours and increase "competitiveness". Often, the foundation subjects for areas outside of or unrelated to a specialization are eliminated to accommodate a credit hour ceiling. Providing a focus in this manner can make an engineering bachelor's degree look more like a technical or skills degree.[4]

The "revolution" referred to by Dr. Clough of Georgia Tech and others, is being forced by the marketplace. Traditional mechanical, electrical, chemical, civil, industrial, and manufacturing engineering programs do not prepare students to compete in the rapidly changing world environment. In one study, which was conducted in two companies, only 41% of engineers stated that their degree prepared them for their duties and responsibilities. [1, 4]

Narrowly focused, specialized undergraduate engineering degrees are in sharp contrast to equivalent degrees in law, medicine, nursing, and dentistry. [4] With the possible exception of the practice of law, these disciplines, which demand a common broad, unspecialized undergraduate degree, are experiencing the same technological revolution as the profession of engineering. One hundred years ago the engineering profession was the most respected and best compensated of all these disciplines. Today, that is not the case, and it is our fault.

Studies at the turn of this new century by the University of Western Ontario in Canada indicate wide and enthusiastic industry acceptance of a degree program that would produce students with a multidisciplinary engineering education. Sixty-seven percent of 377 companies surveyed stated, "a more interdisciplinary program would *better* serve their needs" and 87% gave enthusiastic approval for a new integrated engineering program. [4]

In response, two Canadian universities, the University of Western Ontario and the University of British Columbia, initiated new "Integrated Engineering" programs to specifically address this vital issue. A review of their programs indicates that the curricula are a compilation of standard core courses taken from the traditional engineering disciplines of mechanical, electrical, and computer science. The four year programs require a total of 144 hours of instruction. [4] Clearly, this would be unacceptable to US students; such a program could not compete with other degree programs requiring only 120-128 hours for graduation.

We cannot respond to the explosion of technology and demand for interdisciplinary solutions by adding more courses to the curriculum for our engineering students. It is impossible for universities to add enough courses to cover all eventualities in the workplace. [4] Likewise, a narrowly focused degree can be just as problematic.

We need to return to our roots. Technology is ever changing *and* perishable. The tools we used just twenty years ago are now relegated to the museum. Soon, even the desktop computer may be relegated to the role of curio. Perhaps what we need to concentrate on, at the undergraduate level, is the development of key transferable skills: the ability to communicate; the ability to work in teams; a thorough grasp of the fundamentals of math, science, and engineering; an ability to learn on one's own; a well developed ability to solve problems; and the ability to analyze and synthesize. These are timeless in their nature, and *always* relevant.

What Employers Want

If we view engineering education as a business with a product, then our goal must always be to produce a product that is in demand by the marketplace or simply put, we will go out of business. What does the marketplace want? Surveys conducted by Southern Utah University (SUU) , while not as extensive as those collected by the University of Western Ontario (UWO), produced nearly identical results.

Almost universally, employers stated that they expect new engineers to have a thorough grasp of the fundamentals of math, science, and engineering. The key differentiator (81% for UWO, 100% for SUU) is the ability to communicate effectively both orally and in written and graphical form. All of them expect new engineers to be teachable, fast learners and possess well-developed problem solving skills. A high percentage of employers stated a desire for graduates with advanced CADD (computer aided drafting and design) skills; but the specifics of which software package to utilize were all over the map. Finally, all employers stated that any specialized knowledge required to work in their companies is provided either through further training and study or during apprenticeships within their organizations. [4]

SUU's Response

When the Integrated Engineering curriculum approved by the Utah Board of Regents (UBOR) was initially offered, it was apparent from the first semester that the curriculum was going to have to evolve over time. The faculty also realized that in naming the degree "*Integrated Engineering*" the program had been licensed to break all traditional engineering boundaries. Correctly designed, it was evident that this program could become *the* undergraduate degree for the 21st century.

Program Design Cycle

Fortunately, ABET doesn't care if you have the "school solution" for your program design cycle. They only care that there is a method of feedback that continuously improves the program. In that light, the program cycle used at SUU has evolved into the cycle shown in Figure 1. Since our program essentially started from scratch, this organization is useful for our purpose; it is simple, flexible and not tied to any particular frequency.

The first step after surveying our constituents should have been to determine what an Integrated Engineer should be able to do after graduation (Educational Objectives). With that knowledge in hand, we could have developed a pertinent Mission Statement. Our current assessment of what employers want is summarized in the Educational Objectives shown below.

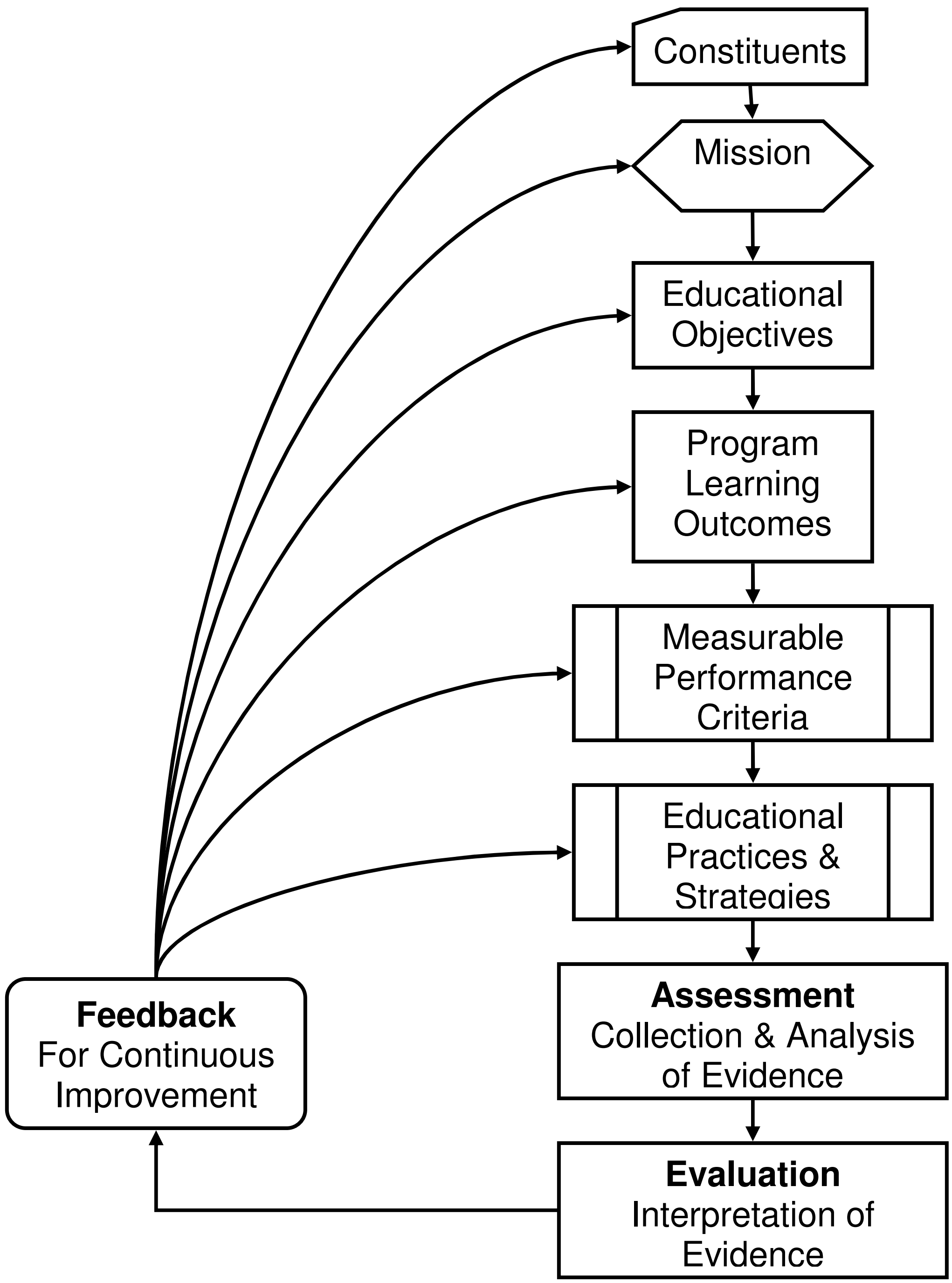

Figure 1: ABET Program Cycle.

Educational Objectives:

1. Leadership in multi-disciplinary design
    a. Takes a systems approach to design
    b. Able to design components or specify design objectives for other team members
    c. Able to analyze, synthesize, and solve problems of an increasingly complex nature
2. Leadership in project management
    a. Lead projects either as the project manager or project engineer
    b. Communicate effectively in written, oral and graphical form
3. Continued professional development
    a. Attend seminars
    b. Pursue an advanced degree
    c. Pursue professional licensure
    d. Gain expertise with codes, professional practices, statutes, and technology
    e. Develop new skills in the use of modern engineering tools
4. Current in their field
    a. Able to design using current standards, statues, codes
    b. Society membership, regular chapter meeting participation and attendance

As may be typical with a new engineering program, we initially focused on our mission and creating a list of courses to teach rather than on our Educational Objectives. We "compiled" a curriculum using "off the shelf" courses from civil, mechanical, and electrical engineering rather than building a curriculum that supported our objectives. In fact, we ended up creating our initial objectives and Mission Statement after the curriculum was designed. Having been through one self-study and ABET accreditation cycle, we are now trying to go back and review our program in light of objectives developed using input from our constituents. This process started with an assessment of our constituent's requirements and since we now have graduates we have a better definition of our constituency.

IE Constituency

Growth in the region served by SUU during the past 20 years and a "Year 2000" Governor's initiative to dramatically increase the number of engineers graduating from state universities prompted the simultaneous call by professional engineers, businesses and engineering educators for the UBOR to expand SUU's well established pre-engineering program to include a cross-disciplinary engineering Bachelor's degree. Independently, and within days of each other, SUU engineering faculty and the President of the Utah Manufacturing Extension Partnership approached the SUU President with proposals for a four year engineering program. The President agreed and directed the engineering faculty to identify and survey constituents within the region, to visit well-established interdisciplinary engineering programs, and to then draft a curriculum for a four year program to present to the UBOR.

At that time, the region served by SUU's pre-engineering program included all of Utah and extended into areas of the neighboring states. The program emphasized serving the rural population; however, students from throughout the region, both the urban and rural areas, attended SUU for the smaller class sizes and personal environment. Engineering students would typically study at SUU for two or three years and then transfer to a four year engineering program within the state. While attending SUU, students were quite successful in finding employment as interns within the local consulting, manufacturing and public service offices and businesses. These employers, who had dreamed of having a full fledged engineering program in their back yard for years, longed for the technology, experience, and diversity of resources that would accompany implementing the proposed engineering degree program.

Constituents specifically identified to benefit from the proposed engineering degree included manufacturers, consulting firms, and government offices scattered throughout the rural areas of Utah and neighboring states. It was anticipated that these employers would require engineers capable of solving fundamental engineering problems in a wide range of areas traditionally associated with a specific engineering discipline (such as manufacturing, industrial, civil, mechanical and electrical engineering); but due to the size of the office only be able to justify a small engineering staff. Often only one or two engineers might be employed by the office or business. To serve the region, the program would have to produce graduates that could work in a very large technological and regulatory arena.

IE Proposed Curriculum

To meet the identified engineering needs of the region, the engineering faculty proposed a fundamentally broad engineering curriculum reinforced with extensive hands-on laboratory and design experiences. The original program curriculum is summarized in Figure 2 with the schedule of specific courses shown in Table 1. The concept was initially developed as an Engineering Science degree; however, while gaining UBOR acceptance in April of 2001 the name of the degree was changed to "Integrated Engineering".

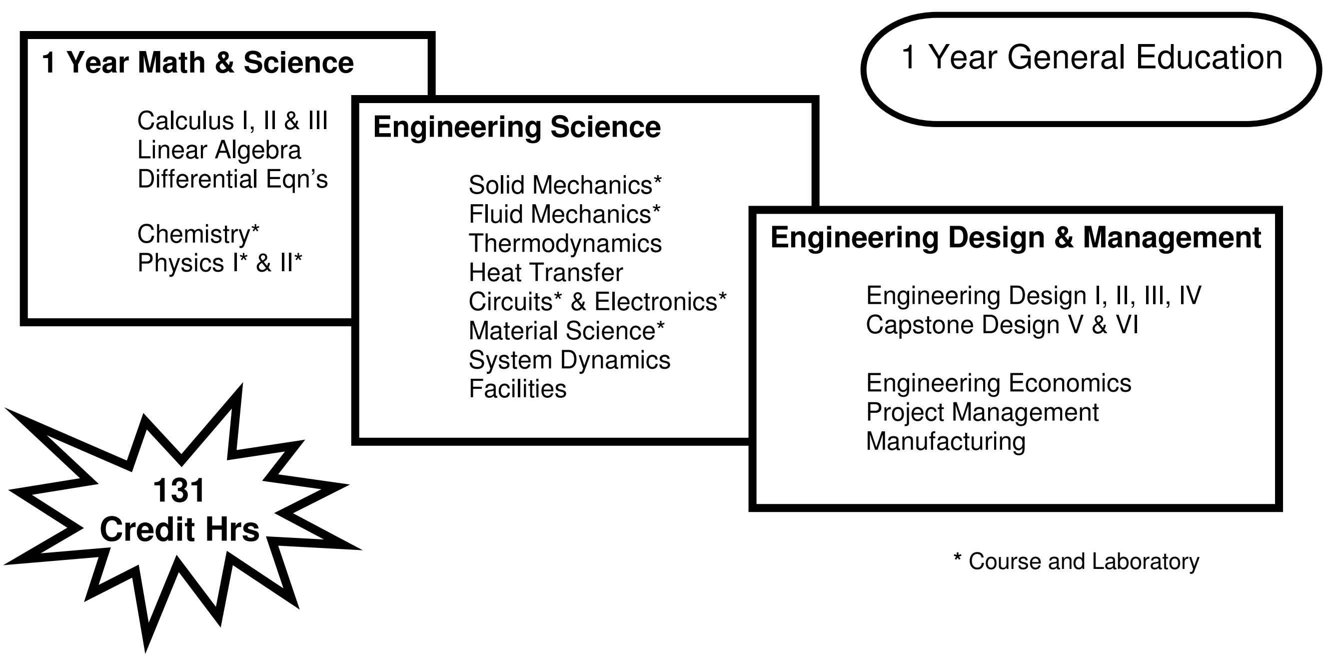

Figure 2: Curriculum accepted by UBOR in 2001.

Table 1: The 131 semester credit hour curriculum accepted by the UBOR for SUU's Integrated Engineering program in April 2001 (general education courses are shown in italics).

Freshman Courses		Sophomore Courses		Junior Courses		Senior Courses	
Calculus I	4	Calculus III	4	Differential Equations	3	Numerical Analysis	3
Chemistry I	4	Physics I	4	Thermodynamics	3	Systems Dynamics and Controls	3
Chemistry I Lab	1	Physics I Lab	1	Material Science Engineering	3	Heat Transfer	3
General Education	6	FORTRAN	3	Material Science Engineering Lab	1	Electronics	3
Information Literacy	1	Statics	3	Project Management Processes	3	Electronics Lab	1
Engineering Fundamentals	2	Engineering Design I	1	Engineering Design III	1	Engineering Design V	1
				Technology in Society	3	*General Education*	3
Calculus II	4	Linear Algebra	3	Fluid Mechanics	3	Structural Analysis	3
Applied Statistics	4	Dynamics	3	Fluid Mechanics Lab	1	Manufacturing	3
Communications	3	Strength of Materials	3	Electric Circuits	3	Facilities Design	3
Writing for Science	3	Strength of Materials Lab	1	Electric Circuits Lab	1	Engineering Design VI	2
CAD	1	Physics II	4	Engineering Economics	3	*General Education*	3
		Physics II Lab	1	Engineering Design IV	1		
		Engineering Design II	1	*Thinking and Listening Critically*	3		
		General Education	3				
Total Credits per Year	**33**		**35**		**32**		**31**

The curriculum approved by the UBOR included 42 credit hours of General Education, three science laboratories, five engineering laboratories, and six engineering design courses (a total of 7 semester hours). In reviewing the curriculum you will notice that all of the course titles could be found in traditional engineering programs throughout North America. However, few programs currently include all of these as full semester treatments.

Including the many fundamental engineering courses in the curriculum precludes offering any elective engineering courses and makes the program somewhat inflexible. Other than the 15 hours of elective General Education, the proposed curriculum was completely prescribed.

IE Curriculum Evolution

Upon implementation of the approved curriculum, several immediate program adjustments were required. Campus efforts to optimize course utilization prevented the introduction of courses in the engineering program that appeared to duplicate existing courses in other programs offered at SUU. The administration required engineering topics such as CAD, Electric Circuits, Electronics and Engineering Economics to utilize existing courses taught by other programs on campus. In some cases, the "fit" between engineering course requirements and existing campus courses was not good. The most severe action was the specification of three general education economics courses to marginally cover Engineering Economics concepts.

After the first year, the one-semester hour design courses were determined to be ineffective. Only one contact hour per week had been set aside in the faculty workload to accommodate the first five design courses. Two contact hours were provided for the sixth which was to be a capstone experience. There were two severe problems. First, the contact was too infrequent and not of long enough duration to accomplish anything significant involving engineering design. Second, there was no equivalent course work in the state's traditional engineering programs to accommodate transfer students. This meant that students transferring into Integrated Engineering from other schools were at a severe disadvantage.

The design content was rethought and radically changed in the third year of the program. Design courses prior to the junior year were dropped and the remaining junior and senior design courses were uniformly revised to include three periods of contact per week consisting of a one-hour lecture, a three-hour laboratory, and a one-hour seminar. The content of the junior year design courses evolved into a more structured course of study with specific course objectives in mechanics and numerical analysis. The first junior semester design course teaches students the concept of mechanical design and how to use solid modeling tools. The assigned projects include conceptualization, specification, procurement of materials, design for manufacturability, assembly, performance, and evaluation tasks. A commonly assigned semester project has been to design, build and run a simple engine at two speeds. The students actually go into our shop and machine the parts for their design. This is a fantastic period of realization and awakening for the students; it is often frustrating and always memorable.

The second junior semester design course is focused upon the utilization of numerical analysis techniques. Students explore several analytical techniques and software tools for the analysis of solids, fluids and systems. Like the first semester, students are required to conceptualize, optimize, and execute a design. Often students will choose to analyze and optimize a design from the previous semester.

The senior year design projects are diverse and often driven by industry needs. Student design teams are paired with an industry partner and faculty mentor and then given a design problem. The students prepare proposals, budgets, identify resource requirements, and negotiate deliverables with the clients. They are required to brief clients periodically on the status of the project. They prepare a final written report and give an oral presentation to a body of engineering and industry professionals. Projects completed to date have included land development, water supply, sewage collection, system automation, industrial structural systems, mechanical systems, carbon composite structures, transportation analysis, and metallurgical processes.

In 2003, the UBOR challenged all degree programs in the state to trim their curriculums to 120 semester hours. This challenge was initially met with outrage from the engineering faculty. At the time, we were contemplating adding two more elective courses. However, after a great deal of heated deliberation and the recognition of several professional society initiatives aimed at defining what an engineering education should require to prepare for professional practice, the faculty concluded that trimming the program to the required 120 hours would be advantageous. This action was envisioned as a declaration that undergraduate engineering degrees were synonymous with learning fundamentals and that graduate degrees were for discipline focused education. All of the courses in the curriculum were evaluated for engineering merit. Several service courses were deemed to be of little overall value, ineffectively taught for engineering's need, or a duplication of effort and were cut from program.

The revised and current curriculum is summarized in Figure 3; the four year schedule of courses is shown in Table 2. The current curriculum includes 38 credit hours of general education, three science laboratories, five engineering laboratories, and four engineering design courses.

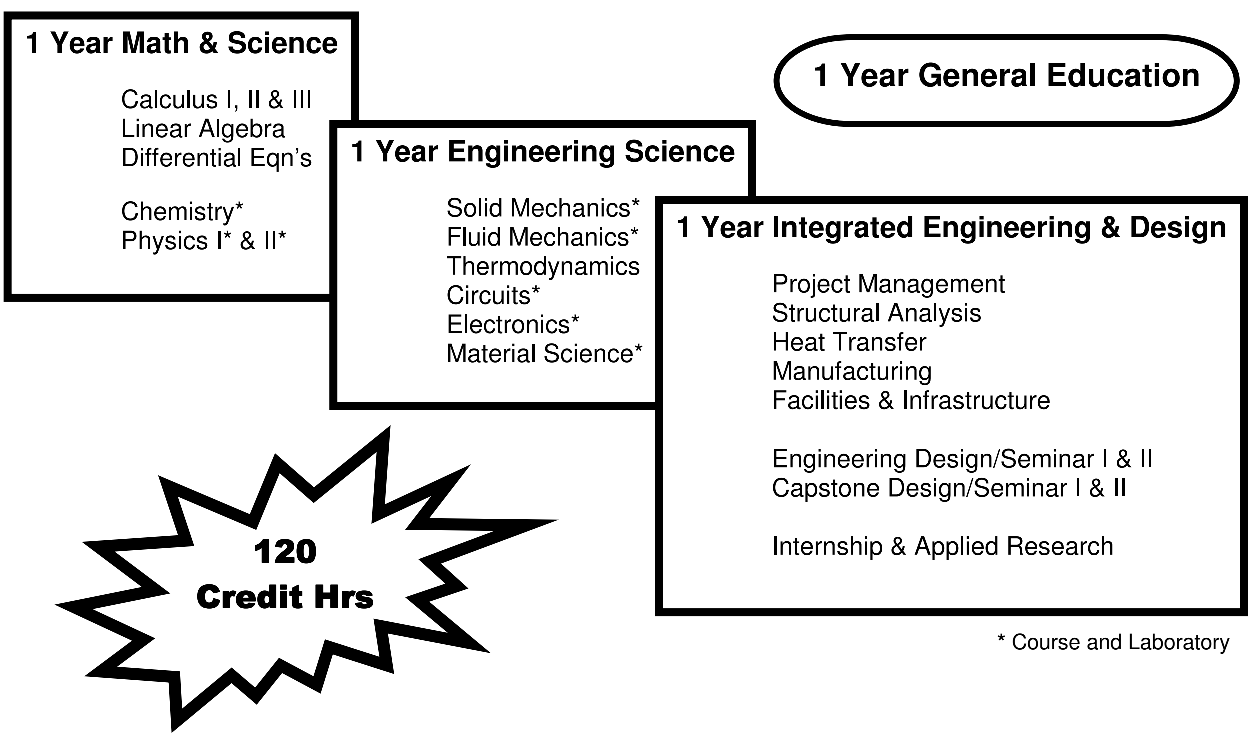

Figure 3: Current curriculum in 2007.

Table 2: The current IE curriculum; 120 semester hours with 38 semester hours of general education (shown in italics).

Freshman Courses		**Sophomore Courses**		**Junior Courses**		**Senior Courses**	
Calculus I	4	Calculus III	4	Structural Analysis	3	Heat Transfer	3
Chemistry I	4	Linear Algebra	3	Thermodynamics	3	Manufacturing	3
Chemistry I Lab	1	Physics II	4	Material Science Engineering	3	Integrated Eng. Design I	2
Freshman Year Seminar	1	Physics II Lab	1	Material Science Engineering Lab	1	*General Education*	3
Information Literacy	1	Statics	3	Engineering Design I	2		
Engineering in the 21st Century	3			Electronics	3		
English I	3			Electronics Lab	1		
Calculus II	4	Differential Equations	3	Fluid Mechanics	3	Facilities and Infrastructure	3
Computer Programming	3	Dynamics	3	Fluid Mechanics Lab	1	Integrated Eng. Design II	2
Physics I	4	Strength of Materials	3	Project Management Processes	3	*General Education*	9
Physics I Lab	1	Strength of Materials Lab	1	Mechatronics	3		
CAD	3	Electric Circuits	3	Engineering Design II	2		
English II	3	Electric Circuits Lab	1	*General Education*	3		
Total Credits per Year	**35**		**29**		**31**		**25**

Taking Back the Curriculum and Fixing Problems

Degree programs offered at a university naturally include service courses. These courses teach specific fundamental knowledge to a diverse audience of users. For example, algebra is usually taught to engineers, sociology, education and science majors using the same course. If a service course does not fully meet the needs of a program, the program must find alternate ways of including the missing content using another course. In addition to math and science there is now pressure at SUU to utilize an increasing number of service courses in areas such as drafting, mechanics, materials, electric circuits, manufacturing and project management. The programs served by these service courses have radically different goals and expectations for the course.

Engineering, technology and technology education majors all take courses in the aforementioned areas that have the same title; however, they also have a wide range of expectation regarding the depth of coverage required. In some programs an algebraic treatment is all that is required while another program may require modeling systems using differential equations. In this case a single curriculum does not serve both programs well.

The forced utilization of the technology department's introductory CAD and electrical engineering courses resulted in not obtaining all of engineering's curriculum goals. Technology's CAD instruction was developed to support follow on graphics and modeling courses in the computer aided drafting and manufacturing major. For the engineering majors, it is the only CAD class they take and it needs to prepare them to create engineering drawings in their follow on laboratory and design courses. Many of the techniques engineering students need to explore are reserved for detailed treatments in upper level CAD courses. Instead, the details of elementary mechanical drawing are investigated exhaustively when engineering students only need an overview. Technology's electric circuit curriculum includes individual courses for AC and DC current. Both courses utilize common algebraic expressions to analyze circuitry. Engineering's goal in taking a one-semester electric circuit course is to become proficient in modeling circuits and in using differential equations. The course names are similar, but the objectives are so different that the goals of neither program can be met by a single course. Convincing administrators and managers of this isn't easy. In fact, it may be impossible.

Similar arguments can be made for traditional service courses in math and physics. For example, calculus is usually taught from a generic mathematics position. For an engineering program, it may be better to teach calculus emphasizing engineering applications rather than mathematical theorems and proofs. [6]

Being served by service courses requires two way communication and a willingness to provide a true service. One thing is certain, if a unique need for the service has not been made known then what will be provided is going to be 'plain vanilla'. SUU's service course providers have demonstrated a willingness to include content benefiting the engineering program when engineering has provided a concise laundry list. These problems demonstrate why engineering faculty must maintain control of their curriculum. While "sharing" courses for efficiency may look good on paper to administrators, the engineering faculty must insure accomplishment of their mission. Often, these two goals are in opposition to each other.

Barriers to Success

SUU is attempting to create a version of UWO's Integrated Engineering program that is lean (120 semester hours) and intimately integrates the coursework. Why is this process so hard? Because it requires change; it requires adjusting curriculum and deviating from a course that has been traveled for decades. The practiced course is familiar and comfortable. Change is synonymous with work! As in any market driven process, there are barriers to implementing change that must be overcome. Our experience is not unique. Program killers include faculty and administrators not understanding the ABET requirements for continuous improvement, not achieving widespread faculty buy-in, apathy, and token support.

The ABET method of continuous program review and improvement is based on very successful business practices and seeks as it's objective, the production of a product (graduates) in demand by the marketplace (employers). According to Dr. Gloria Rogers (ABET Director of Research and Assessment) during a recent ABET program assessment workshop, the arrangement of the blocks in the ABET program evaluation cycle is not as important as the fact that there is a cycle with an effective method of assessment, evaluation and feedback that leads to program improvement. The concept of "if it ain't broke, don't fix it", which is often used to perpetuate stale and outdated courses, runs counter to the ABET desire for continuous self-improvement and is a significant barrier to program improvement. Why? Because a program that is producing graduates that are getting hired appears to be "successful". However, if the graduates are not meeting *all* of the employer's expectations, there is room to improve. Because we didn't do it right in the beginning we have to be willing to go back and revisit/revise our program starting with the constituent needs and the proposed Educational Objectives. This "going back" is consistent with continuous improvement, but some administrators see it as "fixing what ain't broke". The first order of business for us, therefore, is to educate our bosses.

It seems that many professors want to create a curriculum and then teach it without any changes for the next 25 years. Our modern society will no longer tolerate that approach and there is a growing feeling that universities are no longer the keepers of all knowledge. [2] Another significant barrier is faculty (and administration) buy-in. Professors need to be willing to think outside the box and adapt new concepts if a college education is to retain its allure.

Lack of adequate budget hamstrings a new program. The concept of continuous improvement requires a continuous infusion of budget to effect changes that support the program. If administration makes the mistake of removing budget as soon as the ABET team clears the front gate, the program cannot realistically improve. Thus, there needs to be greater understanding and commitment by administrators to the ABET concept. Our experience is no different. We are faced with a 90% yearly growth and a 60% cut in budget.

A minor barrier is the non-standard name of the degree. Employers, especially large employers with human resource departments, typically look for a specific and well-known degree. Often the first cut in a stack of resumes is the name of the degree. Our experience has been that graduates (in these limited cases) need to be more aggressive and educate the people doing the interviewing. Once educated, the acceptance has been enthusiastic.

Defining Success

Approached from a marketplace point of view, the success of any program will be ultimately judged on whether the degree is valued. A recent visit to Switzerland by one of the authors saw first hand why this is so important. Only 40% of graduates from the visited program had job offers when they graduated. The marketplace speaks with a very loud voice. Western Ontario's experience is undoubtedly similar to ours. Our graduates have all been employed before graduation, average starting salaries have been slightly higher than the average for all engineering salaries in the state, and all are still employed though some have been "stolen away" from their first employers. The major research university in the state now actively recruits for graduate students from our program, and the state Department of Transportation now recruits two types of engineers, Civil and Integrated.

A Degree for the 21st Century

The explosion of technology and the rapidly growing interdisciplinary nature of the marketplace make Integrated Engineering the degree for this new century. A focused degree that concentrates on technology could be obsolete before the student graduates. Tools that were current 25 years ago are no longer useful today, but fundamental knowledge is timeless.

The objective of the Integrated Engineering Bachelor's degree is to give students a broad interdisciplinary foundation. Specialization will occur on-the-job and/or in graduate school. A broad knowledge base gives graduates the flexibility to remain competitive in an ever-changing marketplace. Life long learning is not simply a program byword for Integrated Engineering; rather, it is the way graduates will do business in this century.

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