

The Role of Business Education in Engineering Curricula

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ABSTRACT: *There are currently many pressures on the traditional four-year degree program and many educators and professional societies are starting to examine the viability of the four-year degree. In the US today many, if not most, new jobs are in small to medium businesses. The engineers in these companies must not only be technically proficient but they must also possess the business sense to ensure the company's success. In addition, the new fundamentals for engineers such as biotechnology, quantum effects for the growing miniaturization technologies, discrete mathematics and logic, etc. are also putting pressure on the four-year curricula. It is apparent that we cannot cover all of the topics that are needed in the traditional four-year undergraduate degree. A compromise that covers the fundamentals and some of the advanced topics and integrates business concepts in the curriculum appears to be the best approach for the undergraduate degree. In depth technical knowledge within a discipline (or disciplines) should be achieved at the graduate level.*

1 BACKGROUND

There are currently many pressures on the traditional four-year degree program and many educators and professional societies are starting to examine the viability of the four-year degree. In the US today many, if not most, new jobs are in small to medium businesses. The engineers in these companies must not only be technically proficient but they must also possess the business sense to ensure the company's success. In addition, the new fundamentals for engineers such as biotechnology, quantum effects for the growing miniaturization technologies, discrete mathematics and logic, etc. are also putting pressure on the four-year curricula. It is apparent that we cannot cover all of the topics that are needed in the traditional four-year undergraduate degree. A compromise that covers the fundamentals and some of the advanced topics and **integrates business concepts in the curriculum** appears to be the best approach for the undergraduate degree. In depth technical knowledge within a discipline (or disciplines) should be achieved at the graduate level.

One of the Hallmarks of 21st Century Engineering Education will be active, discovery based learning that is driven by the customer for our educational products, the student. This educational approach has become a reality at Michigan Tech over the past several years through the implementation of the Enterprise program. The program was initiated with a successful proposal submitted by the Colleges of Engineering and Science & Arts and the School of Business and Economics in response to the NSF Action Agenda for Systemic Engineering Education Reform. The goal of the Enterprise program development was to create a new engineering curricula which incorporates active learning and integrates the engineering education experience while addressing industry's need for engineers with strong technical, communication, interpersonal, and business skills.

2 IMPLEMENTATION

"Engineering Students who graduate from Michigan Tech's Enterprise Program have a choice. They can take a job working for someone else or they can start their own companies." [ASEE Prism, 2003]

When I became Dean of the College of Engineering at Michigan Tech in 1996 one of my most important goals was to develop undergraduate programs that gave every graduate the opportunity to develop the skills necessary so that he or she would have the confidence and skills to be able to start up their own company. Through the Enterprise program at Michigan Tech we have been able to do just that.

With approximately six to eight semester hours of business credits distributed through the last three years students learn how to write a business plan, learn basic accounting, financing and marketing. Students learn what is needed for an enterprise or company to be successful and they learn quickly that the technological challenges are often overshadowed by the financial realities of the project.

MichiganTech's Enterprise Program is intended to provide its students with the opportunity to develop knowledge and skills in their technical field of choice while exposing them to the business and societal issues faced by industry. Faculty mentors and industry partners share in this educational process by helping guide the students through this active learning experience.

Using a multi-disciplinary team-based approach to address real-world projects in a business-like setting, graduates of this program will be better prepared to *Create the Future*. The Enterprise has been structured as a Minor at the University and consists of 20 semester hours. It consists of a minimum of 6 credits of project work, 2 credits of teaming/business problem solving, 2 credits of communications courses, 5 credits of business courses and 5 elective credits from a variety of technical and business topics. Students join an Enterprise at the beginning of their sophomore year (with the new ABET accreditation criteria, all engineering programs can accommodate the Enterprise Path) and continue through their senior year. In 2000-01 there were 11 Enterprises with 230 students, in 2001-02 there are 19 Enterprises with over 400 students, and we expect to grow to approximately 20 Enterprises with over 500 students (depends on industrial support). This curricula path is learner driven from the standpoint of the student's selection of the Enterprise's themes that range from topics such as "Watershed Assessment and Planning" to "Wireless Communications. Assessment results will be presented for the educational objectives and the learning outcomes, and comparisons will be made with the traditional educational paths. Table 1 shows example business modules for the Enterprise program and Figures 1 and 2 depicts a few of the Enterprises, their logos, and the facilities.

Table 1 Representative Course Modules for Enterprise

Entrepreneurship	Global Competition
Analysis	Culture
Working Capital	Demographics
Capital Acquisition Strategies	Language
Opportunity/Risk Assessment	Politics
Exit Strategies	Infrastructure
New Venture Management	
The Business Plan	
Marketing	Project Management
Market Research	Project Scope
SWOT Analysis	Gantt Charts/Pert/CPM
Price Elasticity	Resource Planning
Positioning	Budgeting
Product Life Cycles	Cost Performance
Marketing Mix/Strategy	

19 Enterprise Teams with ~ 400 students from 19 different disciplines

Product Development/Manufacturing

PrISM

Consumer Products Manufacturing

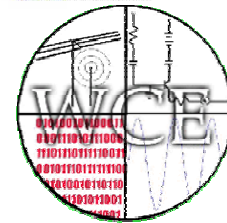
Robotic Systems Engineering

Entrepreneurial Ventures



Information Technology

ITO2



Wireless Technologies

Wireless Communications

Integrated Microsystems



Figure 1 – Example Enterprises

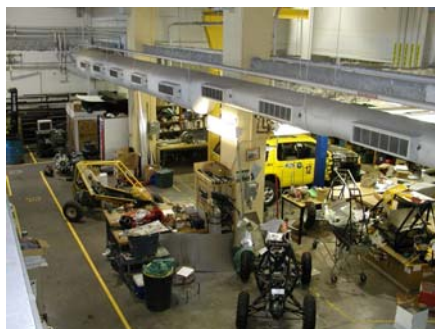


Figure 2 – Enterprise Facilities

3 COMMENTS FROM ON THE PROGRAM FROM AN OUTSIDE OBSERVOR

In January 2004, the Director of Michigan Tech's Center for Teaching, Learning and Faculty Development hosted a panel discussion on the Enterprise program for the campus community. The following represents an excerpt of his comments regarding the panel discussion.

"The Enterprise program involves interdisciplinary teams of students working together to create real businesses that secure real cash contracts to solve a complex series of real-world problems and produce deliverables that ultimately delight their clients. Having spent ten years at another university prior to coming to Michigan Tech, my first guess was that I was seeing the same self-assurance and poise that comes from students involved with traditional coop experiences. Within moments, however, I realized that

this Enterprise experience was an entirely different beast. The difference was that this group of articulate, thoughtful young scholars and fledgling entrepreneurs was describing a series of visceral experiences that were akin to the enthusiasm that springs from the real work of scientists and engineers rather than the sort of short-term bump that springs from simulated projects and gopher work not uncommonly associated with mandatory coop experiences.

These days, there's a lot of talk about the changing ethos our students and problems such as lack of enthusiasm and intellectual engagement. On this cold Wednesday in January, I am proud to report that these problems were nowhere in evidence. Instead, I listened as a student leader described the intricacies of leading teams of students designing components of a nanoscale satellite; components that must perform to NASA's most exacting standards and work with all of the other components designed by the other teams, as well. Another articulate and straight-talking student described the complexities of securing intellectual property rights for inventions arising from their Enterprise project. Still another student leader described the absolute joy of working with other students from widely varying backgrounds and disciplines to produce timely and substantive results for real-world clients. If we fail to broadly proclaim the success of this unique and life-changing program, I fear that we do so at our own peril. A genuine educational renaissance is occurring under our very noses. Imagine an educational innovation that incorporates elements of undergraduate research, cooperative learning, just-in-time learning, service learning, and active learning and you've just skimmed the surface of this new movement born and bred here at MTU."

4 PANEL QUESTIONS

In specific response to the questions posed by the panel co-chairs WE would comment that there is definitely a need for business topics in engineering education and that these topics should be integrated throughout the engineering curricula rather than in discrete courses. This can and is being effectively accomplished by integrating business topics/course modules into an active, discovery based learning environment. At Michigan Tech we called this environment the Enterprise Program and it currently involves over 400 students.

5 CONCLUSIONS

It is interesting that words such as innovation, business, entrepreneurial, and innovation do not readily appear in the new accreditation criteria developed by ABET over the past few years. It is, however, precisely these skills that will define the engineers that will lead their companies into the 21st Century. Not only are these skills desirable, they are necessary and they can be acquired without compromising the technical skills of our graduates in engineering. As more "routine" engineering jobs are being outsourced from the US to India and China, and as they graduate more of their own engineers, it is imperative that the comparatively few engineers that the US graduates annually become the leaders in today's technologically oriented world. We can do this by integrating communication and business topics throughout the curriculum and by giving our students the opportunity to be entrepreneurs early in their educational program and throughout their time on campus.

REFERENCES

ASEE Prism Magazine. *Blazing an Entrepreneurial Trail*, April 2003, pp. 30-34