

2006-630: THE ENTERPRISE PROGRAM: A VERTICALLY INTEGRATED ENGINEERING TECHNOLOGY CURRICULUM

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The Enterprise Program: A Vertically Integrated Engineering Technology Curriculum

Abstract

The “Enterprise Program” at Michigan Technological University, gives students the opportunity to participate as teams to solve technology problems supplied by industry partners. This ongoing vertically integrated curriculum initiative is designed to promote a learning atmosphere where faculty mentor students in a nontraditional format without increasing the number of course credits needed for graduation. It is intended to engage students throughout their undergraduate career, beginning at the sophomore level, using industry sponsored projects that illustrate the various stages in the operation of an “enterprise.”

Introduction

The development of an innovative curriculum option, the “Enterprise Program”, gives teams of students at Michigan Technological University the opportunity to participate in real-world settings to solve technology problems supplied by industry partners. The program prepares students for the challenges that await them after their educations, and gives new perspectives to the sponsors, businesses and organizations who participate.

The multi-disciplinary program is intended to serve the needs of both students and industry and includes concepts such as sustainability, ethics, safety, business processes, innovation, creativity and communication. All Enterprise team members have prescribed responsibilities corresponding to their level of maturity, abilities, and technical education. Within the projects, students perform testing and analyses, make recommendations, manufacture parts, stay within budgets and schedules, and manage multiple projects while faculty members act as coaches and mentors.

Vertically Integrated Curriculum

This ongoing curriculum initiative is designed to promote a learning atmosphere where faculty mentor students as they discover knowledge in a vertically integrated format. It is intended to engage students throughout their undergraduate career using industry sponsored projects that illustrate the various stages in the operation of an “enterprise.” The project work associated with each enterprise commences in the sophomore year and is fully integrated with the academic curriculum. As individual students progress through their academic program their level of contributions to the enterprise project work are expected to increase hence, the vertical integration.

The curriculum is comprised of traditional engineering technology courses presented in a standard format with sequential lectures on a general topic within a specified timeframe. The vertically integrated enterprise project courses, which involve sophomores, juniors, and seniors working together, are taught in parallel to the traditional curriculum beginning in the sophomore year. In addition to the project work, the vertical curriculum includes a series of thematic course

modules with topics such as communications, entrepreneurship, project management, budgeting, strategic leadership, and product development to name just a few.

Typical Enterprise

Although each enterprise that is created holds true to its own goals, ideas, and strategies, there is a commonality that combines with the uniqueness of each enterprise to help students develop the skill and experience necessary to succeed in industry. One of the enterprise groups that have demonstrated these dynamics and traits is ITOxygen, a student-run information technology enterprise team that focuses on emerging technologies and their applications in business, organizational, and academic settings. Team members collaborate to problem-solve a wide variety of technology and communication problems that are facing industry today.

Since its inception in 2000, ITOxygen has made consistent progress in constructing a reputable and successful enterprise program that has become recognized and supported by several areas of industry. The team has risen to each of the challenges they have encountered and have overcome obstacles, both internal and external, that are common in a true industry environment.

According to ITOxygen's faculty advisor, the enterprise's biggest challenge was to transform the team of three unenrolled and rather uncommitted students with no support, no affiliations, and no projects, to a seventeen student enrolled team, each with different expertise, and a fully-funded sponsor of \$40,000 dollars in the time-span of one year. The group accomplished this task by focusing on creating a sound corporate structure while developing more productive business practices. This radical change within the team's organization enabled an efficient decision making process, defined responsibility for the various areas of the group, and prepared the students for the business ethics and practices used within industry. This transformation of the group's structure and practices was supported by industry, which soon had confidence in the organization's business abilities as well as their technical skills. This notion became evident when Emphasys, a business management software company, agreed to sponsor the ITOxygen enterprise. Since then, the ITOxygen team has not looked back and has had continued success in each of its endeavors.

ITOxygen's organizational structure models a typical business hierarchy. The positions within the team are awarded by a democratic election process and are termed on a calendar year appointment. Each team member's vote is measured equal to that of any other team member. The member who carries the majority of votes is awarded that specified position. The program's positions consist of a Chief Executive Officer (CEO), Chief Operations Officer (COO), Chief Information Officer (CIO), Chief Marketing & Communications Officer (CMCO), Chief Financial Officer (CFO), Chief Technical Officer (CTO), and Lead Architect. The remaining team members are encouraged to make suggestions on different aspects of policy, regulations, operations, etc., however the ultimate decisions that the team must make resides with the individuals who have been elected to the specified areas. This collaboration and respect for the final decision made by the elected official has been vital to the team's success.

Each team member brings a unique area of expertise and culture to the organization. This group's dynamic has added to the skill set of the enterprise program and has therefore made the team more marketable and attractive to a wider variety of industry areas. The team's expertise includes programming languages, software development and testing, peer-to-peer networking, database development, and multimedia platforms. In addition, the program has one of the most culturally and cross-disciplinary diverse groups on campus. ITOxygen draws upon team members from Africa, Europe, Malaysia, and the United States. The students reach across multiple fields of study among the University, which include computer science (CS), computer network system administration (CNSA), Management Information Systems (MIS), Computer Engineering (CE), Electrical Engineering (EE), and Science & Technical Communications (STC).

Due to the broad areas of expertise, ITOxygen has been able to accept and complete a variety of technology and communication related problems facing industry. Project durations range from as short as one day to long term projects that exceed a calendar year. Some examples of the types of clients that ITOxygen attracts along with their respective projects are as follows:

Financial and Investment Education Web Site Development

Client: Envital

Design Project: Envital ® was established in 2000 for the purpose of providing individual investor education on mutual fund investing with an emphasis on unbiased, timely, low-cost information, and service.

Project Goal: To develop a web site that provides the latest mutual fund and market commentary, as well as investing education.

Post-Secondary Education Web-Based Discussion Board

Client: Textweaver.org

Design Project: TextWeaver is sponsored by The Fund for the Improvement of Post-Secondary Education of the US Department of Education, which brings new ease and convenience to participation in the discussion on the Web.

Project Goal: To develop the documentation and implement within a web-based discussion board for educational purposes.

Web-Based Database Solutions

Client: College of Engineering

Design Project: Web-based database solutions to be used in the collection, review, and interpretation of information on university degree programs efforts to meet the outcomes outlined by ABET (Accreditation Board of Engineering and Technology Programs)

Project Goal: To develop a web-based database solution within the allocated parameters to meet the required outcomes specified by ABET.

Deliverables

Throughout each individual enterprise program there are technical products or outputs of the teams' work. A yield such as a developed software package that can run over multiple platforms or a constructed surface that simulates hard-packed snow year round to be used for

brake testing are some examples of products that the enterprise teams have completed. These outputs, produced by the enterprise program, are tangible, can be measured, and contribute to solving problems within industry.

Each year, at the end of April, each of the twenty-two enterprise teams submit detailed written reports that include the results of their specific projects. The students also make an oral presentation to their faculty and industry mentors. Upon request, they will give a presentation on-site or via video teleconference to the industry partners.

The completed projects and deliverables that have been achieved by the Enterprise Programs span a wide spectrum of specialization. The teams have delivered products from the areas of video game programming and development, aerospace, wireless communication, and computer/network security to automotive systems, alternate fuels, innovative casting, and robotics to name a few. The diversity of these accomplished projects in the technical field has been transformed into significant benefits for many different industry areas.

The types of outputs that have been created by some of these teams include the following examples:

Wireless Communication Enterprise:

Biomedical Wireless Project: Currently the Wireless Communication Enterprise is executing a R&D contract with Guidant, to integrate biomedical sensors with a web-based patient monitoring system using Bluetooth technology. In addition, a contract effort was implemented with RPC International to develop the electronics and packaging for a proprietary biomedical instrument.

Blue-Marble Security Enterprise:

Secure and Reliable Communications: The team secured a R&D contract with Rockwell Collins last year, an aerospace company in Cedar Rapids, Iowa. This successful project explored how to insure reliable and secure communications for mobile and autonomous systems. Applications associated with the project included enhanced air traffic control systems and effective control of unmanned air vehicles or robots. A follow-on project is underway with Rockwell Collins which includes mapping propagation effects for secure emergency communication nets.

Alternate Fuels Enterprise:

MULE Project: The goal of this project was to completely design and construct a military vehicle, which will be powered using fuel cell technology. The United States Army Tank Automotive and Armaments Command (TACOM) will specifically use this project, known internally as a MULE. The final deliverable project will be a prototype and proof of concept, however it will provide a basis for TACOM to create an actual battlefield-ready vehicle.

The MULE is a ground vehicle weighing up to one ton that performs military transportation missions, which will also have sensing and communication capabilities. This vehicle may incorporate mechanisms (such as robot arms and hands) to facilitate loading and unloading of equipment and/or supplies.

This vehicle will possess the capability to travel at speeds of approximately 30 to 40 miles per hour on improved roads using a diesel hybrid electric powertrain. The engine will be run on alternative diesel fuels. A fuel of particular interest is a synthetic diesel fuel, which is made from natural gas using Fisher-Tropsch synthesis. The MULE will also be able to travel at walking speeds of 4 miles per hour for at least twenty minutes with silent propulsion. The source of electric propulsion for this quiet movement will be a fuel cell. In addition, auxiliary power for the unit will be obtained from the fuel cell.

Automotive Systems Enterprise:

Load Sensing Knuckle: The objective of this project was to actively monitor the forces on a steering knuckle through the use of strain gauge. This monitored data is then relayed in real time to the vehicle computer through a data acquisition system developed by the team. The prototype for this project is currently being dynamically tested on a Ford Explorer.

Benefits for Companies and Industry Sponsors

Those companies who have become sponsors of Enterprise have gained a number of benefits:

- (a) **Fresh-look at Engineering Problems:** Even the best engineering groups can fall into the habit of using the same kinds of solutions over and over again. Enterprise students often bring a fresh perspective to engineering problems and develop potential solutions that might otherwise have been overlooked.
- (b) **Application of Unique Facilities and Expertise:** Universities often have unique facilities that Enterprise students can access in support of an engineering problem. Also, university faculty members are often national and international leaders in their field.
- (c) **Exposure to Latest Theories and Techniques:** The research being performed by university faculty today often forms the basis of applications of the future. By sponsoring an Enterprise, companies gain access to these theories and concepts ahead of the rest of their peers.
- (d) **Observe Capabilities of Talented Undergraduates:** Many companies have taken advantage of the opportunity to observe the talented Enterprise students in action, hiring them afterwards for co-op programs, as summer interns, or even as employees following graduation.

Benefits for Students

Students involved with the Enterprise program gain a great deal from the experience, including:

- (a) **Hands-On Experience Solving Real-World Problems:** Enterprise work involves contracting with real customers to address real-world problems. Solving these problems requires that the students apply not only technical knowledge, but also interpersonal and business skills. In addition, the students are exposed to all of the complications of real-world projects. This is contrasted with the canned assignments students get in typical classes.
- (b) **Apply Critical Thinking and Problem Solving Skills:** Since the work encountered in Enterprise projects is more open-ended than classroom assignments, students have

- greater opportunity to apply and develop critical thinking skills as they work to solve the problems they face.
- (c) **Development of Project Management and Teaming Skills:** As students proceed through the Enterprise program, they go from being project team members to project team leaders. Along the way, the students learn project management skills both as a team member and as a team leader. They also learn the importance of being able to work in diverse, cross-functional teams.
 - (d) **Accomplish Multiple Objectives and Goals:** The workplace is full of situations where accomplishing multiple objectives and goals must be juggled with the constraint of available resources. Enterprise work provides the students with exposure to these dynamics in a realistic environment.
 - (e) **Communicate with Diverse Constituents:** While working on an Enterprise project, students will write reports and make presentations for different groups with diverse technical backgrounds. To be effective, the students will adjust how they present their information to suit the audience.
 - (f) **Work Experience:** As Enterprise students graduate and enter the workforce, the experience gained working on the Enterprise provides evidence for the student's resume of the ability to work effectively on diverse project teams.

Summary

The Enterprise Program, which originated in the College of Engineering, has now become a signature program for Michigan Technological University. Teams of students from every part of the University are enriching their educational experience through the application of technical concepts and practices while developing an understanding of the social, environmental, and economic concerns of business operations. Students are better prepared to be immediately productive upon entering the workforce having experienced the value of communication skills, teamwork, and lifelong learning in the entrepreneurial environment.

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