

**The Engineering Entrepreneurial Program at Lawrence
Technological University
Lawrence Technological University in Southfield, Michigan**

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Background

Lawrence Technological University, a private undergraduate and graduate institution located in the center of the Detroit Metropolitan Area, has an enrollment of nearly 5,000 students in day and evening degree programs and continuing education/professional development programs. Lawrence Tech has been a dynamic partner to the Detroit area's engineering, manufacturing, and automotive industries for nearly 70 years.

A factor that has contributed immeasurably to the success of Lawrence Tech students is the University's location in one of the most fertile areas of the nation for engineering entrepreneurial activity. Oakland County, Michigan, where Lawrence Tech is centrally located, has been labeled an "economic powerhouse," the site of more entrepreneurial activity than any other county in Michigan. In the two years between 1996 and 1998 the state received a \$400 million increase in venture capital, resulting in an increase in the number of start-up and relocation businesses representing technology and other industries. Between 1996 and 1998, there were a total of 38,578 new incorporations in Oakland County alone, approximately 42 percent of the new incorporations statewide. More than one-third of Michigan's R&D firms are located in Oakland County.

Although more than 170 *Fortune 500* companies do business in Oakland County, the work culture in the county, which traditionally focused on employment with the Big Three automotive companies, has broadened to smaller, technically advanced suppliers of services, materials, tooling, components and systems. This environment, offering a profusion of small and emerging entrepreneurial initiatives, provides a truly advantageous setting for an entrepreneurial program, and Lawrence Technological University offers the faculty, facilities, programs, students, and corporate contacts to make the program a resounding success. Lawrence Tech's entrepreneurial program draws from a pool of entrepreneurial business talent that is second to none. A grant from the Lear Corporation in 2002 established **The Lear Entrepreneurial Center** at Lawrence Tech. in order to develop and implement a comprehensive academic program that will help students integrate business and entrepreneurial skills with engineering technical skills.

Engineering graduates play many roles in industry, all of which require business and entrepreneurial skills. Most of the business expertise and skills that are required by the industry

are not easily taught within a traditional classroom setting. In response to this situation with support from Lear Corporation, Lawrence Technological University has developed an entrepreneurial program within the College of Engineering. The program addresses entrepreneurial management in start-up ventures and new business development in existing companies. The entrepreneurial program provides a vehicle for sharpening the student skills in business process and teamwork as well as specific industry technical skills. These are skills that students will find indispensable when, working in small businesses, initiating jobs in larger companies, or starting their own companies. A recent survey of Lawrence Tech industry advisory members verified the view that business skills were as important to success as an engineer as technical expertise.

Engineering students at Lawrence Tech. now have two options: the traditional engineering path and Entrepreneurial path. The second option includes a greater emphasis on communications, leadership, and business aspects of the engineering profession. Both paths require 131 credits and lead to a B.Sc. in engineering, however, students who successfully complete the Entrepreneurial Program also obtain an Entrepreneurship Certificate. A unique feature of Lawrence Tech's Entrepreneurial program is the integration of "business skills" throughout the curriculum in the form of "just in time one unit modules" combined with a capstone experience participating in the operation of a student run enterprise. Therefore, a graduate of the Entrepreneurial Program will receive a B.Sc. in engineering degree with the same total number of credits as a student in the traditional path to a B.Sc. degree. The Entrepreneurial Program includes an extensive multi-disciplinary design experience. Thus, the College of Engineering has established a number of engineering/business entities, called Student Engineering Enterprises, where students form a "company" and work with other students, faculty, and industry partners to manage a real company. The employees (students) solve real-world problems, perform testing, analyses, build prototypes, manufacture parts, stay within budget, and manage multiple projects.

Entrepreneurial Program Goals

The program is designed to provide students with the tools, knowledge, and skills necessary to meet the challenges of working in today's corporate environment, which may include starting a company or working for a large corporation. Students who graduate from the program will have the ability to:

- Work in growth oriented organizations
- Start and manage their own firms
- Develop management and leadership skills for leading teams of professionals in large and small corporations
- Communicate effectively for ongoing entrepreneurship success
- Develop a complete business plan
- Develop sound marketing and financial plans

The Entrepreneurial Program Structure

The Entrepreneurship Program is a 3-year experience as can be seen from Table 1. The curriculum is two-pronged and consists of:

- 1- Active participation in the operation of a student Engineering Enterprise
- 2- Completion of course material (instructional modules)

The entrepreneurial program is designed to preserve the technical content of Lawrence Tech's engineering program while maintaining the same credit hour requirements for a B.Sc degree. This is accomplished by redefining some technical electives and restructuring the traditional engineering capstone project sequence as a student enterprise.

Table 1: Entrepreneurial Program at Lawrence Technological University

	Fall Semester Credit	Spring Semester Credit
Year 1		
Year 2	Technical & Professional Communication 3 credits	Finance for engineers 1 credit
	Marketing for Engineers 1 credit	Engineering Enterprise 1 credit
Year 3	Business Law for Engineers 1 credit	Strategic Management for Engineers 1 credit
	Business Plan Development 1 credit	Engineering Enterprise 3 1 credit
	Engineering Enterprise 2 1 credit	
Year 4	Enterprise Elective 1 credit	Enterprise Elective 1 credit
	Capstone Design 1 2 credits	Capstone Design 2 2 credits
		Total Credits 17

The one unit instructional modules have been designed to provide an introduction to business skills such as finance, marketing, strategic management, project management, etc. These instructional modules (each representing 15 contact hours per semester) provide an introductory view of the topics, which are then reinforced through application in the student run enterprises. Of the 17 credits, 7 credits result from working on real-world projects in the Student Engineering Enterprises courses. The tasks and responsibilities within the enterprise are many and will vary depending on the students' seniority, maturity, and technical expertise. The remaining 10 credits in the Entrepreneurship Program result from involvement in instructional modules, some of which are required and others are elective. The philosophy behind this approach is that students will better master the subject matter through its immediate application and further development within the student enterprises. Some modules are required of all enterprise students and some are elective. The elective modules cover a wide range of subjects. Students select the modules that match their professional interests or those that are required for the particular execution of their responsibilities within the company.

A strength of Lawrence Tech's program is the pool of highly qualified and experienced entrepreneurs and engineering business leaders in the Metropolitan Detroit area as resources for these instructional modules. Lawrence Tech. has a long tradition of close ties with the engineering, manufacturing, and automotive center of Michigan. Consistent with Lawrence

Tech's motto, "Theory and Practice", students are exposed to subject matter presented by practitioners in the field. The current pool of instructors includes a venture capitalist, certified project manager, certified financial analyst, several founders of entrepreneurial companies, intellectual property attorney, business law attorney, and marketing executive, and a technology acquisitions manager for a large automotive supplier.

Entrepreneurial Modules

The following list of entrepreneurial instructional modules has been developed and were initially offered in the Fall semester of 2002.

Technical and Professional Communication

This course is designed to help members of the enterprise teams study business communication. Students develop competencies in observing, interviewing, analyzing, synthesizing, and giving oral presentations. Students learn and practice strategies for effective oral, visual and written communication in technical and professional setting.

Finance for Engineers

Entrepreneurial Finance is intended as an introduction to the concepts in and around financing entrepreneurial companies. The purpose of the course is to teach future general managers how to use the financial perspective to make better decisions in entrepreneurial settings. Concepts and material that are covered include the following: basic principles of financing, stock capitalization, company valuation, equity vs. debt, evaluating financing providers, staged financings, initial public offerings, and others. A combination of teaching and learning techniques are used, including lecture/ discussion sessions, readings from articles and company prospectus, case studies, and guest lecturers.

Business Law for Engineers

This course provides students with a foundation in business law including types of business formations, sole proprietorships, partnerships, corporations, and Limited Liability Companies. The strategic management of intellectual property assets is introduced, with special emphasis on internal protection and management of these assets. Issues of product liability and ethics are introduced through a mix of classroom lectures, readings, case analyses and projects.

Marketing for Engineers

This course provides an introduction to marketing concepts, methods, and practices that are important to modern technical enterprises. As a discipline, marketing is responsible for facilitating the exchange process. This is accomplished through an understanding of the perceptions, preferences, and behaviors exhibited by customers and consumers. That understanding is translated into a complete offering (product/service/features, price, advertising/promotion, and distribution system) consistent with those customer needs, the firm's capabilities, and the competitive environment.

Project Management for Entrepreneurial Engineers

Project Management is a basic course for the entrepreneurial engineer. Basic concepts are project management tools, fundamentals of team building, project risk analysis, tracking, measuring and controlling projects, project closeout, budgets, and business cultural issues. The course concentrates on the information required to identify project participants, goals, objectives, activities, and constraints. Quantitative methods include network diagrams, Gantt charts, CPM

scheduling, activity duration compression, project activity optimization, activity analysis, cost and schedule performance indices, and cost estimating. Active learning is utilized with a combination including lectures, discussions, readings, case studies, and hands-on projects.

Strategic Management for Engineers

This course deals with how top management develops plans to attain outcomes consistent with an organization's mission and goals. Using case studies, students will learn how to establish an organization's mission and develop its goals, analyze opportunities and threats or constraints that exist in the external environment, analyze the organization's strengths and weaknesses, formulate strategies to match the organization's strengths and weaknesses with the environment's opportunities and threats, develop ways to implement strategies and ways to implement control activities to ensure that the organization's goals are attained.

Engineering Enterprise Work 1

This course is the first course in the Enterprise Work sequence. During this course, students will have the opportunity to work in teams on a real-life engineering project. Students will be introduced to basic machine shop operations including safety principles and will have hands-on experience in building and testing. Students will form student enterprises that will expose the student to the entire life cycle of a product in an experiential learning mode. Each Student Enterprise Team will be responsible for working on an assigned business opportunity and general product requirement. The team will then be responsible for generating a business plan, managing the business, managing the product development, and managing production or implementation of the project. Additionally, the team will report to a board to obtain project approval, report status, and project conclusion. Students are also introduced to applications of project management, engineering design, technical communication, and teamwork through working on teams with senior level students.

Engineering Enterprise Work 2

This course is the second course in the Enterprise Work sequence. This course is a continuation of participation in student enterprises at Lawrence Tech. and provides an opportunity for students to become engaged in a more complex business opportunity. The team is responsible for managing the business, managing the product development, and managing production or implementation of the project. Additionally, the team reports to a board to obtain project approval, report status, and project conclusion. Principles of project management, engineering design, budgeting, technical communication are emphasized in student projects, and teamwork skills are reinforced through working on teams with senior level students. The skills that were introduced in the first course of this sequence are reinforced and applied at a more advanced level than in the first course.

Engineering Enterprise Work 3

This course is the third course in the Enterprise Work sequence. This course requires the student to apply the principles of the engineering design process, proposal writing, project planning, and project management. During the course, students will form groups, choose a senior project, and submit a project proposal. The project proposal will be a complement to the business plan being generated in the EGE3341 Business Plan Development course.

Future Entrepreneurial Modules

Creativity and Innovation

'Creativity and Innovation' is a study of the methodology and motivation for inspiring creativity in new and existing technology firms. Subjects covered include creative problem solving process, planning and analyzing, idea generation, concept development and optimization, concept evaluation and selection.

Entrepreneurship & Business Plan Development

The course explores the factors involved in turning an idea into a serious business venture. Research and analyze a new business opportunity of choice and produce a business plan for the venture. Create the business venture, develop a critical path, analyze financial statements, and look at cash flow vs. profit.

Corporate Entrepreneurship

The course studies the nature of entrepreneurship and the effective implementation of entrepreneurial strategies in large industrial enterprises. The course focuses primarily on managerial effects aimed at the identification, development, and exploitation of technical and organizational innovations, the management of new product or process developments, and effective new venture management in a corporate context. .

Global Business and Competition

Topics covered include entry strategies for global competition, country risk profiles, and political risk factors.

Managing Entrepreneurial Operations

The course explores the issues and problems facing the entrepreneur in daily business operation. Topics include the impact of pre-startup decisions, problems encountered during startup, operating problems created by rapid growth, and surviving in an adverse environment. Forecast the impact of acquiring, developing and changing process and product technology in an entrepreneurial firm.

Description of Student Engineering Enterprises

The strategy for Student Engineering Enterprises involves groups of students forming companies on campus to make a product or complete a project. Priority will be given to products/projects identified by the industry. It is intended that each enterprise will operate like a real company in the private sector and run by the students. Non-engineering students (particularly College of Management students) will be allowed to work on the companies for credit through coordination between colleges. An University Entrepreneurial Council comprised of representatives from the College of Engineering, College of Arts and Sciences, and College of Management has been established to provide oversight and direction for these student run companies. Each student enterprise will address and complete (or partially complete) at least one major project/product per year.

The students join the company at the beginning of their sophomore year and remain until graduation. While participating in the company operation, the students will be attending the instructional modules. Each year the students will be given new responsibilities based on their maturity, abilities, and technical knowledge. Each company will have a Board of Directors organized from industry advisors. This allows the students to benefit from the wealth of

experience of the industry. Each company (student team) will have faculty advisors from the colleges of engineering, management, and/or humanities. The faculty advisors monitor progress, offer advice, and help troubleshoot.

Students will be typically organized in three groups: management, business/marketing, and production engineering. Management will be responsible for the overall project management, including development of the annual project plan and tracking of performance relative to the plan. The management group will be responsible for coordinating project-wide reports and presentations, including the midterm and the end of year presentations, and the end of year report to the faculty and industry advisors. Business/marketing will be responsible for coordinating development of the business plan for the annual project, including an analysis of projected market for the product. It will be responsible for all financial transactions, and accounting functions. Production Engineering will be responsible for developing and manufacturing the product.

Company Deliverables

Each enterprise is required to address and complete (or partially complete) at least one major project/product per year. Students will be required to make presentations to their industry mentors and faculty twice every semester, and submit mid-year and end-of year reports.

Company Work Evaluation

The students will not be evaluated upon the percentage of times they were right, but by the value of their contribution throughout the entire project. Answering many insignificant questions with 100% accuracy is not important if they do not contribute to the final success of the company. The students will learn that you can be successful even if you were right one time, as long as the problem solved is considered important.

Assessment of Pilot Experience (2002 – 2003)

The first entrepreneurial modules were offered in the Fall 2002 semester: *Finance for Engineers*, *Strategic Management for Engineers*, *Business Law for Engineers*, and *Marketing for Engineers*. *Project Management for Engineers* was offered during the Spring 2003 semester. These courses were scheduled during the early evening time period, allowing us to draw upon a pool of Detroit area “practitioners” to instruct these courses:

- Finance for Engineers - was taught by the CEO of a Management Consultant firm
- Business Law - was taught by a practicing attorney with an engineering background
- Strategic Management - was taught by the CEO of a high tech start up company with Venture Capital experience
- Project Management - taught by a former Project Manager from a Fortune 500 Company
- Marketing - taught by the former Marketing Director from one of the “Big Three” automotive companies.

Feedback from the initial group of students was overwhelmingly positive. Students showed enthusiasm for being exposed to the “non-technical” aspects of engineering by people who were practicing in their fields of specialization. Case studies and personal examples were used in these classes contributing to the relevance of these courses. A common complaint, however, was that most of these courses required considerable effort for a “one unit” credit course. Students complained about the amount of writing required by some of the courses, as writing

requirements in an engineering program are typically confined to the humanities and arts. However, all students expressed an appreciation for the importance of writing and communication and also identified this as a need in their programs of study and careers. The entrepreneurial faculty commented that the quality of student writing improved considerably during the duration of these courses.

Engineering Enterprise 1

The course was offered for the first time in the Spring 2003 semester, and was “team taught” by two professors. One student team was formed, and the students experienced the broad spectrum of an enterprise, including identification of a product concept, generation of a business plan using business plan software, and marketing of a product. The feedback for this course was positive, and the students were enthusiastic about their first experience in a student enterprise. An inventory of student enterprise projects has been assembled for future classes, and it is anticipated that the second offering in the Spring of 2004 will involve more students as awareness of the course increases. .

Summary

The goal of the entrepreneurial program at Lawrence Tech. is to promote a learning atmosphere where faculty serve as mentors and coaches; that is, they move from simply imparting knowledge to helping students discover knowledge. This program includes concepts such as innovation, creativity, business processes, communication, sustainability, ethics, and safety. This will be a program where inquiry and innovation will be the norm, where theory and practice go hand-in-hand, and where students and faculty work in a team environment on problems of significance to industry.

The entrepreneurial program provides a vehicle for sharpening the student skills in business process and teamwork as well as specific industry technical skills. These are skills that students will find indispensable whether they work for a large corporation, a small company, or start their own business.

Biographical Information

Greg Feierfeil, P.E. is a college professor at Lawrence Technological University and is the coordinator for the Lear Entrepreneur Center for the Mechanical Engineering Department. He received a B. S. in Mechanical Engineering from the University of Detroit and an M.S. in Mechanical Engineering from Wayne State University, in Detroit. He retired from Ford Motor Company after nearly 36 years in Engineering and Information Technology.

Dr. Rizk holds three degrees in Engineering, including the Doctor of Science in Engineering Management and Systems Engineering from the George Washington University. He represents the Civil Engineering perspective for Lawrence Tech’s Entrepreneurial Program. Dr. Rizk provided much of the initial direction and influence in establishing this program. He has received a patent and authored numerous technical papers.

Steven Howell is the Chairman and Professor of Mechanical Engineering at Lawrence Technological University. Prior to joining Lawrence Tech. in 2001, Dr. Howell led a Knowledge Based Engineering project for Visteon Automotive Systems and taught Computer Aided Design

classes for Ford Motor Company engineers. Dr. Howell also has a total of sixteen year's experience as an engineering faculty member at Lawrence Technological University, Northern Arizona University, University of Pacific, and University of Zimbabwe. Since joining Lawrence Tech. Dr. Howell has provided leadership in the direction and implementation of Lawrence Tech's Global Engineering Program and Lear Entrepreneurial Center.

Patricia Shamamy, P.E. is Professor of Mechanical Engineering, has degrees from St. Joseph College and the University of Illinois-Urbana and does consulting work in materials and manufacturing. She also serves on the University E-Learning Committee and the College of Engineering Entrepreneurial Program Committee.

Chris Riedel is an Assistant Professor in the Mechanical Engineering Department. He joined the Lawrence Tech faculty in 1999. He holds a Ph.D. degree in Mechanical Engineering from Wayne State University. His research interests are in the areas of belt and chain drives, nonlinear vibration and coupled systems.

Lisa Anneberg, P.E., Ph.D., has been an associate professor of electrical and computer engineering at Lawrence Tech. since 1990, and is an alumni of Washtenaw Community College, University of Michigan Ann Arbor [B.S in IE] and Wayne State University, in Detroit MI [MS and PhD in Computer Engineering]. She has certification from the Society of Manufacturing Engineers and the American Society for Quality. She is also active in ASEE, SAE, and SWE.