Integration of Lehigh's Entrepreneurship Minor into the Undergraduate Engineering Curricula

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Abstract

Entrepreneurship education at Lehigh University has been recently enhanced by substantial institutional investments in new academic programs, the development of a campus center for student entrepreneurs, and through several grants from federal, state and private organizations. One such grant, from the Commonwealth of Pennsylvania, focuses on the development of an entrepreneurship minor open to all undergraduates, including all engineering students. The sixteen-credit minor has been developed and will be implemented by a cross-disciplinary faculty committee with faculty representatives from engineering, business, arts and sciences, the Integrated Product Development Program (IPD) [Refs 1-4], the Integrated Business and Engineering Program (IBE) and the graduate MBA vSeries seminars on new venture creation. The undergraduate minor program consists of four new courses and one existing prerequisite. The pedagogical approach is project based experiential learning, with support from the University's Small Business Development Center, the Office of Technology Transfer, and the Ben Franklin Technology Partners. In the spring 2005 semester, the first and third entrepreneurship courses will be piloted, while numbers two and four begin fall 2005. This paper is a report on a work in progress. It describes the background, benchmarks, design and planned implementation of the entrepreneurship minor and how it is integrated into Lehigh's undergraduate curricula. We plan to follow up with additional papers in the future with details on the implementation, assessment metrics and lessons learned.

Background

In 2003 Lehigh University received a grant from the Pennsylvania Department of Community and Economic Development to improve the Lehigh University infrastructure in support of commercializing university Intellectual Property (IP) including licensing and new company start up. As part of this grant, specific funds have been set aside for the establishment of a entrepreneurship curriculum. In late 2003 a joint development committee from the College of Business and Economics and the PC Rossin College of Engineering and Applied Sciences started the process by developing a working definition of entrepreneurship, a defense of the potential redundancy in proposed courses and a list of sample benchmark programs. This background work led to develop an entrepreneurship minor open to all undergraduates.

Defining Entrepreneurship

The concept of entrepreneurship has evolved significantly over more than 300 years, so no single agreed-upon definition exists. However, in the Lehigh context, we favor that developed by one of the leading researchers and educators in the field, Howard Stevenson of the Harvard Business School:

- *Entrepreneurship is “the pursuit of opportunity beyond the resources you currently control.”* [Refs 5-7]. We add in the title of our first course, that we conceive the root of entrepreneurship, whether in emerging or existing enterprises, as “Managing Discovery for Wealth Creation.”
- *Entrepreneurship is widely recognized as an academic field* in its own right, with a huge research literature that spans, inter alia, organizational management, technology management, engineering management, economics, finance and marketing. The American Academy of Management has an entire division devoted to entrepreneurship. The American Society of Engineering Education does too. Babson College has become the leading undergraduate business program in the nation by focusing on an integrated curricular approach to entrepreneurship. The large number of existing educational programs in entrepreneurship (see benchmarks below) is also testimony to the academic breadth, independence and rigor of entrepreneurship as an academic field of inquiry.
- *Entrepreneurship differs from traditional business research and education* in the nature of the problems, of the decision making processes and of the mindsets involved. In the Lehigh context, the curricular approach is guided by Stevenson’s process definition, outlined conceptually in Table 1 below.

Entrepreneur	Key Business Dimension	Traditional Manager/Administrator
Driven by perception of opportunity	Strategic Orientation	Driven by resources currently controlled
Quick commitment	Commitment to Opportunity	Evolutionary with long duration
Multistage decision-making with minimal exposure at each stage	Commitment Process	Single-stage with complete commitment upon decision
Episodic use of rent of required resources	Control of Resources	Ownership or employment of required resources
Flat with multiple informal networks	Management Structure	Formalized hierarchy
Value-based & team-based	Reward System	Resource-based individual and Promotion Oriented

Table 1. Stevenson’s Process Definition of Entrepreneurship [Ref 7].

According to Stevenson, “Almost everything we traditionally teach about management has to do with managing resources. To teach students to be entrepreneurs, we have to focus them on opportunities.... The entrepreneur, the person himself, is the key. His company is fueled by his knowledge, contacts, resources, and skills. Successful entrepreneurs have characteristics in common: tenacity, attention to detail, an understanding of risk, a belief in self and purpose, and an understanding of what motivates other people to take action.”

Entrepreneurship Minor Programs Example Benchmarks

More than 825 colleges and universities have some form of entrepreneurship program, according to a recent national survey by Entrepreneur.com [Ref 8]. We attach at back their list of 279 undergraduate programs (majors, minors, concentrations) that they ranked in their “Top 100 Entrepreneurial Colleges” lists. Similarly, according to a 2002 study by the Kauffman Foundation, fully 61% of US colleges and universities have at least one course in entrepreneurship. Review of these programs have led us to the following observations:

- Very few of the first courses in entrepreneurship have pre-requisites, and neither do they generally exclude students from particular majors – including business students. Simply put, there appears to be little overlap between entrepreneurship courses and the traditional business courses. Some entrepreneurship minor programs do require a few introductory business core courses, but many do not and there is a wide mix of approaches to designing a minor.
- We’d like our program to emulate a rigorous in-depth series of courses focused entirely on entrepreneurship, open to all students. The closest example we found is the one at North Carolina State [Ref 9]. Emulating this program, we would like ours to be:
 - technology focused but not exclusively technology-entrepreneurship;
 - deep and rigorous in entrepreneurship, rather than what we consider to be business-lite approaches; (e.g. repackaged series of introductory business functional topics courses, with only one or two introductory courses in entrepreneurship);
 - considerably more focused on entrepreneurship than the smorgasbord approaches at a surprisingly large number of schools (e.g. selecting from across many options in business functional areas, with only one or two introductory courses in entrepreneurship);
 - a reasonable number of credits so that we can attract engineering and science students whose undergraduate curricula have few electives and for whom a minor might require summer school, overloads or an additional year;
 - hands-on, experiential and multi-disciplinary rather than traditional textbook courses focused on narrow functional skills;
 - a campus center of gravity and locus for fostering a campus-wide culture of entrepreneurship.

Curiously, no real pattern seems to emerge in the business-lite and smorgasbord approaches in terms of the mix of introductory marketing and/or finance and/or accounting and/or management courses in entrepreneurship minors. Credit constraints in minors require limiting the business core somehow, and local idiosyncrasies or course availability and bundling convenience seem to dictate what various schools leave in and out. This ad hoc approach and lack of cohesion is another reason we prefer to focus entirely on the realm of entrepreneurship. A focus on entrepreneurship as a distinct discipline from general business management also allows us to offer the same minor to

business and engineering and arts and sciences students, without double counting business courses for the business students, increasing the additive value of the program.

In summary, the joint committee agreed that we would like our program to be a minor (not a major), and to have the following features:

- rigorous in-depth series of courses focused entirely on entrepreneurship
- emphasize experiential learning with cross disciplinary teams
- have considerable interaction with successful entrepreneurs
- be open to all majors, including business, engineering and arts and sciences.

Proposal for a Minor in Entrepreneurship

In the fall of 2004, the joint faculty committee proposed to offer a co-sponsored (business college and engineering college) minor in entrepreneurship with pilot courses beginning in the spring semester, 2005. The minor will consist of five courses totaling 16 credit hours as follows:

1. Eco 1: Principles of Economics (4 credits)
2. Entrepreneurship I: Managing Discovery for Wealth Creation (3 credits)
3. Entrepreneurship II: Entrepreneurship and Enterprise (3 credits)
4. One of the following options (3 credits)
 - Entrepreneurship III: Entrepreneurship Practicum, "The Garage"
 - Integrated Product Development (IPD) Capstone Projects I
 - Integrated Business and Engineering (IBE) Capstone Projects I
 - Lehigh University Management Assistance Counseling (LUMAC)
 - Or other independent, experiential and team project approved by the minor program director.
5. Entrepreneurship IV: Launching Entrepreneurial Ventures (3 credits)

The catalog descriptions for these courses are as follows:

Economics 1. Principles of Economics (4 credits, fall, spring or summer).

A one semester course in the principles of economics. General topics include: supply and demand; pricing and production decisions of firms; role of government in the economy; the determination of national income; money and banking; monetary and fiscal policy; and government finance.

[This is an existing course which is a prerequisite for all the other courses in the minor. Ideally would be taken during the first year or sophomore year. It is also available on the web each summer.]

ENSP 101. Entrepreneurship I: Managing Discovery for Wealth Creation (3 credits)

Introduction to the nature and process of entrepreneurship. Particular emphasis on identifying and seizing entrepreneurial opportunities, on creativity, innovation and vision, and on the process of pursuing those opportunities beyond resources currently controlled. Topics include: alternative concepts of entrepreneurship; personal attributes of entrepreneurs; steps in new venture creation; introduction to entrepreneurial finance and marketing in severely resource-constrained environments;

intellectual property; new venture business planning for both emerging and existing enterprises. Uses case studies, cross-functional student teams, and exposure to successful entrepreneurs through guest speakers. Prerequisite: Eco 1.

ENSP 201. Entrepreneurship II: Entrepreneurship and Enterprise (3 credits)

Investigates skills and steps necessary for entrepreneurial success: the entrepreneurial mindset; entrepreneurial opportunity scanning and screening; informal networking and finding and managing external resources; managing risk by sequential commitment; developing entrepreneurial marketing plans; entrepreneurial sales; family, friends and angel investors, debt and venture capital; horizontal management and developing an entrepreneurial leadership team and creative culture; technology cycles; structuring the new venture; managing change and rapid growth; ethics; exit strategies. Includes articles, case studies and original research. Cross-functional team-based experiential practice of these skills and discussions with successful entrepreneurs are integral parts of the course. Prerequisite: ENSP I or permission of minor program director.

ENSP 211. Entrepreneurship III: Entrepreneurship Practicum, "The Garage" (3 credits)

Students work in cross-disciplinary teams of 4-6 students with faculty advisors and alumni mentors on marketing, financial planning and business and technical feasibility of entrepreneurial products or service concepts. Students may elect to work either on projects related to Lehigh University intellectual property, or ideas brought in by outside entrepreneurs, or on their own entrepreneurial projects. Oral and written presentations and discussions with guest speakers are integral parts of the course. Prerequisite: at least junior standing and ENSP II or permission of minor program director.

ENSP 212. Entrepreneurship IV: Launching Entrepreneurial Ventures (3 credits).

Investigates in detail the critical steps and activities necessary when entrepreneurs seriously considering starting their own businesses. Organizational structure, governance and legal forms of business. Advisory boards. Business and product liability. Intellectual property protection. Sources of capital, establishing credit, seeking angel investors and venture capital. Writing and circulating the Venture Profile. Generating and defending financial projections, revenue streams and expense categories, cost and price estimates, pro-forma financial statements. Negotiating contracts. Licensing. Methods of valuation. Exit strategies. Discussions with successful entrepreneurs are integral to the course. Prerequisites: at least junior standing and ENSP II or permission of minor program director.

Expected Audience

The program aims to prepare students from all undergraduate colleges at Lehigh with the skill sets, attitudes and understanding of the processes to realize their entrepreneurial goals in either an emerging or established company setting. The program is designed to be generally accessible to students from all disciplines with an emphasis upon innovation, the entrepreneurial process, and cross-functional integration. The pedagogy relies upon

the concept that it is critical for entrepreneurs to be able to capitalize on and integrate different functional skill sets.

The program is designed for those interested in all types of entrepreneurship, and because of Lehigh's strengths the program will particularly emphasize the commercialization of technology based businesses and services. Throughout the multi-disciplinary, team-based curriculum, students will be encouraged to work either on projects related to Lehigh University intellectual property, or ideas brought in by outside entrepreneurs, or on their own entrepreneurial projects.

Expected Learning Outcomes

The entrepreneurship minor seeks to complement the functional skills learned within a given major by fostering substantially increased abilities of participating students to:

- Understand and be able to implement the various stages of developing a successful entrepreneurial business.
- Recognize and capitalize on entrepreneurial opportunities.
- Effectively identify, target and capture appropriate emerging marketing opportunities.
- Determine effective positioning of product/concept/services and identify desirable features.
- Recognize the entrepreneurial aspects of managing change and growth within both emerging and established business.
- Understand and leverage the inherent advantages of the entrepreneurial process.
- Prepare a new concept or innovation for launch.
- Understand and develop an entrepreneurial mind-set.

Rationale for the Entrepreneurship Minor Program

This program will enable students in any major to supplement their major with knowledge and skills that increase their ability to realize their entrepreneurial goals and/or make them more marketable upon graduation. It will also help create an environment and campus center of gravity that fosters an entrepreneurial spirit and mindset among students, and also serve as a locus for community building among entrepreneurial students, faculty and alumni. This should attract more high-quality entrepreneurially-oriented undergraduate students. The program will also complement and leverage a rich array of existing resources at Lehigh (e.g. IPD, IBE, graduate MBA vSeries seminars on new venture creation [Ref 10], the undergraduate Computer Science and Business major [Ref 11], the MBA-Engineering joint degree program [Ref 12]; research centers, alumni entrepreneurs, the Ben Franklin Technology Partners, Manufacturer's Resource Center, Small Business Development Center, Office of Technology Transfer, and a newly renovated 17,000 sq. ft. student entrepreneurial projects facility, the Wilbur Powerhouse); give those resources more visibility to prospective and current students; better enable students to take advantage of those resources; increase the potential for the commercialization of Lehigh intellectual property and for the economic growth in the region; and increase the interaction among Lehigh students, faculty, staff and Lehigh's large number of entrepreneurial alumni and friends [Ref 13]. This should make Lehigh more attractive to prospective students, faculty,

recruiters, alumni and other sponsors with an entrepreneurial bent. Lehigh has recently invested heavily in several new programs and infrastructure that promote campus-wide teaching, research, and outreach in entrepreneurship, technical entrepreneurship, innovation and creativity at the undergraduate and graduate level and that support the commercialization of emerging intellectual property.

Resource Requirements

The Entrepreneurship minor will require a number of new resources including faculty, staff support, practicum expenses, teaching assistants, library and facilities support. The total annual expenses are expected to be \$180,000.

Faculty. One new full time faculty member with entrepreneurial experience will be needed to direct the program, develop and teach the new courses (I, II, and IV), and be responsible for advising the teams in course III, “The Garage” practicum, and to fully coordinate with the new tech transfer office. Estimated annual expense including employee benefits is \$100,000.

Practicum Project Expenses. Based on experience in IBE and IPD, we estimate approximately \$2500 of direct expenses and \$2500 in indirect expenses per team of 4-6 students will be needed for prototyping and related activities in “The Garage” practicum projects. In the past, Lehigh entrepreneurial IPD and IBE teams have been quite successful generating their own external funding through national competitions (e.g. National Collegiate Inventors and Innovators Alliance, NCIIA, E-team grants), but we would not recommend counting on this regularly, particularly for those project involving Lehigh intellectual property. Based on an estimated 25 students in the minor annually, we estimate \$25,000 annual expenses. We also suggest funding for half of one teaching assistant (TA) to help with the practicum requirement. This TA could be shared with existing programs.

Facilities and infrastructure support. The entrepreneurship program will contribute to the general operation budget of the Wilbur Powerhouse, the campus’ student project center. We estimate the minor would constitute roughly 10% of regular users, and suggest a line item contribution of \$10,000 for operations of the center which includes support for the operations of the fifty station MAC lab and Prototyping shop and the project areas.

Program Management

The program will be cross-listed in both Lehigh’s College of Business and Economics and its PC Rossin College of Engineering and Applied Sciences, and be open to all undergraduate majors. The program will be managed by a faculty director who will be responsible for the day-to-day administration, student advising and developing and teaching the new courses. The minor program will be report to the deans of business and engineering through the Department of Management and Marketing in the College of Business and Economics.

Based in large part on the purpose of the Pennsylvania opportunity grant to Lehigh to develop a “Model of Entrepreneurship Education,” and to ensure the integration offered by the window of opportunity provided by the yet embryonic stage of the new tech-transfer office, we strongly recommend the initiation of a university-wide coordinating “Entrepreneurship & Commercialization Review Committee” that jointly advise and oversee both the entrepreneurship (and related) curricula and Lehigh’s new technology transfer office. More than 200 universities have technology transfer offices, but we believe Lehigh can truly become an international model by explicitly integrating entrepreneurial curricular and tech transfer operations from the beginning. Committee members would represent the faculty, research centers, industry, alumni, the Office of Research and other interested parts of the community of entrepreneurs. We proposed that this committee have joint oversight responsibility for the newly established tech transfer office and for integrating those activities with curricular activities campus wide.

Time Line

In the fall 2004 the director of the minor was hired and in the spring 2005 the new Entrepreneurship I and III will be offered as pilot courses, with courses II and IV scheduled for Fall 2005. During the fall 2004 and spring 2005 the proposal for this minor is working its way through the department, college and university approval process with a final approval anticipated by June 2005.

Conclusion

Through a challenge grant from the Commonwealth of Pennsylvania, Lehigh University has the opportunity to develop an entrepreneurship minor open to all Lehigh undergraduates. Over the past year an interdisciplinary team of faculty has designed the minor, hired a new director and started the approval and implementation process. By the summer of 2005, we will be at the mid point of the start up. In the summer of 2006 we hope to report on the implementation process, the successes and failures of the pilots and the lessons learned.

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John B. Ochs is Professor of Mechanical Engineering at Lehigh and Director of the Integrated Product Development Program (IPD), which he co-founded with Dr. Watkins in 1994. He is the past chairman the Entrepreneurship division of the American Society for Engineering Education. From 1985-95 Dr. Ochs did extensive industry consulting and was involved in the start up of three companies. In 1996 the pilot courses IPD won the American Society of Mechanical Engineers' curriculum innovation award and in 1997 IPD won the Newcomen Society award for the promotion of America's free-enterprise system. Dr. Ochs holds a MS and Ph.D. from The Pennsylvania State University.

TODD A. WATKINS

Todd A. Watkins is Associate Professor in the College of Business and Economics and Director of the Institute for Regional Political Economy at Lehigh. He holds Ph.D. and M.P.P. degrees from Harvard and a B.S. from the University of Rochester. He previously worked in optical design and optical manufacturing engineering at Eastman Kodak. His research and teaching involves the economics of innovation, manufacturing and new product development. From 1999 to 2002, as the Faculty Fellow to the Provost, he was responsible for promoting innovative, inquiry-based curriculum campus wide. For seven consecutive years, teams advised by Dr. Watkins have won start-up grants in national competitions for collegiate technology entrepreneurship. He chaired the joint committee that developed the entrepreneurship minor described here.

GRAHAM R. MITCHELL

Graham R. Mitchell is a Professor of Practice and Director of the campus-wide Entrepreneurship minor program housed in Lehigh's College of Business and Economics. From 1998 to 2003 Graham Mitchell was the Bladstrom Visiting Professor at the Wharton School of the University of Pennsylvania, and Director of the Wharton Program in Technological Innovation. Between 1993 and 1997 he was United States Assistant Secretary of Commerce for Technology Policy. Prior to that, he was for 12 years with the General Electric. A co-founder of a start up in wireless communication, he is a member of several boards. He is author of over 40 papers and studies on technology, management, and policy. He holds 7 U.S. patents, and is a recipient of several major honors. He holds a B.Sc. and Ph.D. in Electrical Engineering from the University of Westminster, London.