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Dedicated Curriculum, Space and Faculty: M.Eng. in Technical Entrepreneurship

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One will find Michael S. Lehman at the intersection of entrepreneurship, science, and higher education. Dr. Lehman is a Professor of Practice at Lehigh University, co-developing and teaching in the Master's of Engineering in Technical Entrepreneurship, which received national recognition for its role in talent development by the University Economic Development Association. The faculty appointment also includes roles with Lehigh's Baker Institute for Creativity, Innovation and Entrepreneurship. Prior to joining the faculty at Lehigh, Dr. Lehman developed and grew new entrepreneurship programs at the University of Pittsburgh and Juniata College. Dr. Lehman holds a B.S. from Juniata College, an M.D. from the Penn State College of Medicine, and an M.B.A. from the Leeds University of Business School in England.

Dedicated Curriculum, Space and Faculty: M.Eng. in Technical Entrepreneurship

Abstract

The Master's of Engineering in Technical Entrepreneurship (TE), offered through the Department of Mechanical Engineering and Mechanics in the P.C. Rossin College of Engineering and Applied Science at Lehigh University, offers a "dedicated approach" to entrepreneurial engineering education. The residential, full-time, twelve-month program is grounded in a dedicated curriculum, a dedicated space and a dedicated faculty. The dedicated curriculum is delivered through 12 courses in which only TE graduate students are able to enroll; 11 of the 12 courses were designed specifically for the new master's program. These courses take place in a dedicated studio/classroom facility that is open 24 hours a day, seven days a week, to which only program students and faculty have access. The TE program is also fortunate to have a dedicated faculty, who were hired specifically to create the collaborative space and develop and deliver the curriculum. The result of this dedicated approach includes three cohorts of graduates who are running their own companies, are working as key team members in start-ups, are innovating in more established companies and are working at organizations that provide support to entrepreneurs. This impact of this dedicated approach has also received national recognition for its role in talent development by the University Economic Development Association (UEDA).

Building a new Master's of Engineering in Technical Entrepreneurship

Lehigh University, a private research university located in Bethlehem, Pennsylvania has a national reputation in engineering, as well as entrepreneurship. Looking back almost two decades, the undergraduate Integrated Product Development (IPD) capstone course sequence in the P.C. Rossin College of Engineering and Applied Science won a curriculum innovation award in 1996 from the American Society of Mechanical Engineers. Over fifteen years later, the National Academy of Engineering of the National Academies selected Lehigh's IPD offerings, and the newly-created Baker Institute for Entrepreneurship, Creativity, and Innovation, as an exemplary real-world engineering education program in 2012.

Based on the years of experience developing these recognized programs at the undergraduate level, Lehigh Professor John Ochs and his colleague Lisa Getzler realized a gap existed in the education space - combining *graduate* engineering education with real life application…in the context of entrepreneurship.

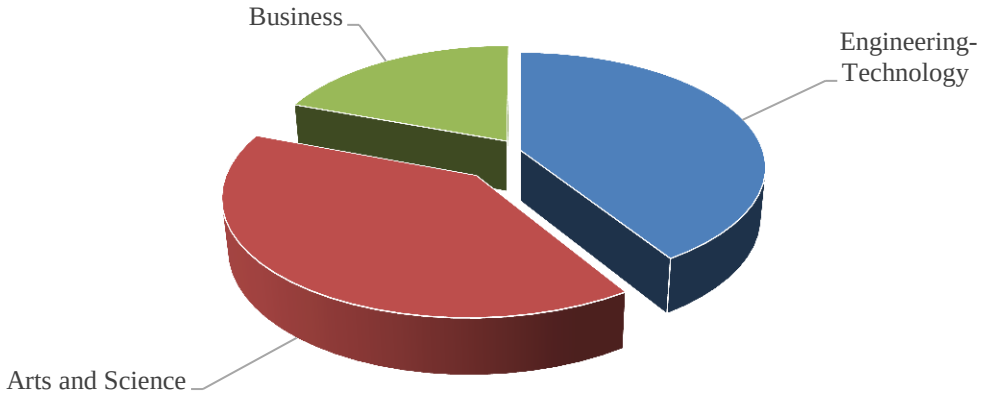
In 2012, the Master's of Engineering in Technical Entrepreneurship (TE) was born, offered through the Department of Mechanical Engineering and Mechanics in the P.C. Rossin College of Engineering and Applied Science, and in collaboration with the Baker Institute for Entrepreneurship, Innovation and Entrepreneurship. Two full-time Professors of Practice, Michael S. Lehman and Marc de Vinck, were hired to develop the curriculum, teach the courses and design the program spaces. A dedicated Program Coordinator, Jodie Johnson, brings over

20 years of experience at Lehigh to TE Of note, Professor Ochs now serves as Program Director of TE and Lisa Getzler serves as Co- Executive Director of the Baker Institute.

This new graduate offering with a focus on innovation is a residential, full-time, twelve-month program that differentiates itself in the market via its "dedicated approach" to entrepreneurial engineering education - a dedicated curriculum, a dedicated space and a dedicated faculty.

This dedicated model, as detailed in the sections below, has been designed as the foundation for educating students with a variety of undergraduate backgrounds in engineering (including mechanical, electrical and chemical), business (including finance, accounting and marketing), and arts and science (such as design, physics, biology, psychology and anthropology) (see Fig. 1).

Figure 1: Undergraduate degrees of students in first three TE cohorts



As of July 2015, a total of 62 students from the first three cohorts had graduated from the program, a fourth cohort of 23 students is set to complete the degree requirements in July 2016 and a fifth cohort is slated to begin classes in the summer of 2016.

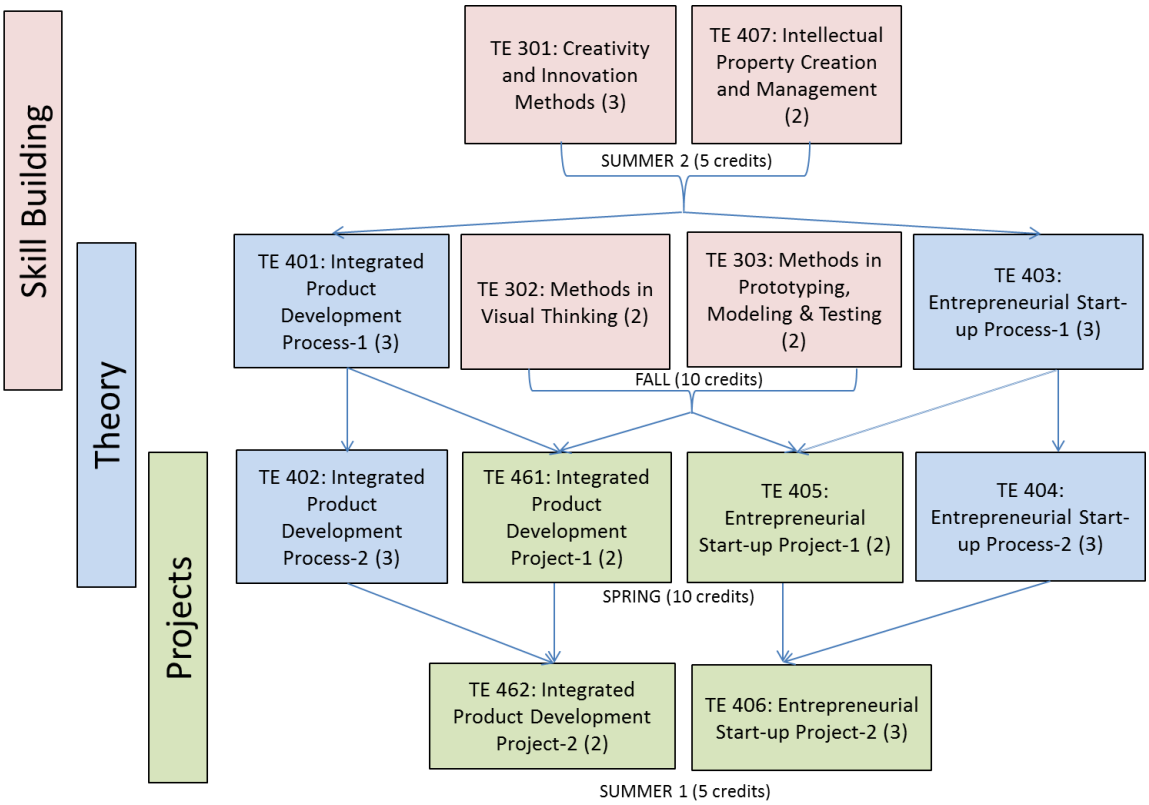
Dedicated curriculum

The first of three value propositions of TE is the dedicated curriculum, with the courses only offered to those graduate students accepted into the full-time program. The cohort progresses through 12 courses together, eleven of which were designed specifically for TE.

As shown in Table 1, the students begin with four skill building courses, the first two offering a balanced approach to innovation - Intellectual Property Strategy and Management, as well as Creativity and Innovation Methods. Students chose an industry or 'space' of interest which is the basis of the assignments in the skill building courses. These courses are followed by Methods in Visual Thinking, as well as Methods in Prototyping, Modeling, and Testing.

From drafting provisional patent and trademark applications, to applying the creativity techniques of biomimicry, Blue Ocean and lateral benchmarking, to building and using their own 3D printers, students develop skills that serve as the foundation for the rest of the curriculum.

Table 1. TE Dedicated Courses



After developing core skills utilized in the innovation process, students then focus on design – design of a product/service and design of an associated business model. Students progress through the levels of Bloom's Taxonomy as they leverage the knowledge and comprehension gained in the (IPD and entrepreneurship) process courses for their own projects, focusing on application, analysis, synthesis and evaluation in the (IPD and entrepreneurship) project courses.[1] Live case studies, class trips and hands-on workshops are crafted to help translate theory to practice.

During the first week of the spring semester, the students engage in an intensive immersion experience referred to as TE Week, an educational model that serves as a platform for collaboration among TE graduate students and faculty, Lehigh's Office of Technology Transfer (OTT), and innovative faculty researchers who have disclosed inventions to OTT. The graduate students apply the knowledge they have gained and the skills they have developed thus far in the M. Eng. in Technical Entrepreneurship program to a technology invented by a Lehigh faculty member. The result? Terms for a proposed licensing agreement, a customer-validated business

model, the framework for a company and team structure, a financial overview of the proposed venture, tangible mock-ups and prototypes and a professional presentation - all based on a Lehigh University-created and IP-protected technology...and all in 5 days.

TE Week was developed specifically for the graduate program by Michael Lehman, Professor of Practice, Department of Mechanical Engineering and Mechanics with primary teaching responsibilities in the Master's Degree in Technical Entrepreneurship program, in collaboration with Yatin Karpe (Associate Director of OTT), Tom Meischeid (Director of Office of Research and Sponsored Programs) and other TE faculty.

At the conclusion of TE Week, the dedicated curriculum then focuses on implementation and launch. Through theory and project courses in IPD and entrepreneurship, second-stage prototypes are developed, manufacturing methods are identified, the new venture team is expanded to include potential subcontractors and advisory board members, and the students address their legal, accounting, insurance and financing aspects of their ventures. Additional live case studies and class trips are embedded throughout the semester.

Dedicated space

In addition to enjoying their own sequence of courses, the TE students have access to a dedicated classroom/studio located in the Wilbur Powerhouse (Fig. 2). Designed by the program faculty, this is an IP-protected space with both individual work stations (each student has their own dedicated desk) and collaborative areas, to which only program students and faculty have access. Any guest speakers or prospective students, per invitation of the program faculty, are required to sign non-disclosure agreements and be accompanied by a professor or staff member from the program.

Figure 2: TE classroom/studio

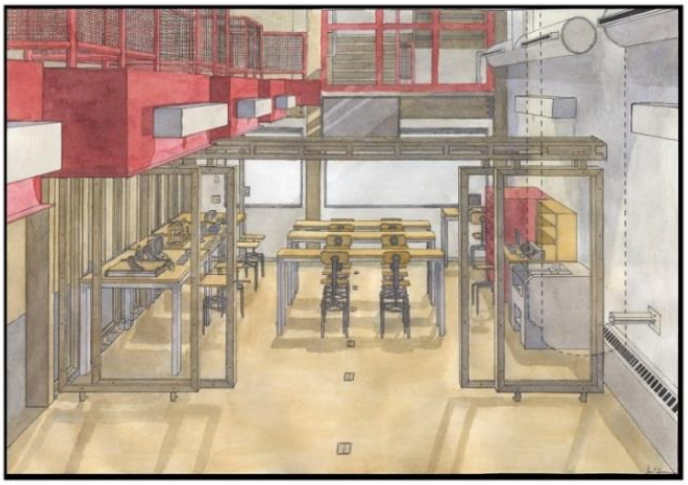


Figure 3: Creativity and Innovation Lab

The hands-on environment is enhanced by Lehigh's first Creativity and Innovation Lab (Fig. 3), a hub of 3-D printing, soldering, photography, electronics and prototyping. This space, a second hub of activity for the TE students, was developed by Marc de Vinck, the Dexter F. Baker Professor of Practice in Creativity, Department of Mechanical Engineering and Mechanics, in collaboration with Brian Slocum, Managing Director of Wilbur Powerhouse and other TE faculty.

Also within the Wilbur Powerhouse is the Lehigh University Additive Manufacturing Lab. The 3D printing technology in this lab, available to students in the TE program as well as others in the Lehigh community, include a Stratasys Objet 30 Pro, Stratasys Dimension 768, 3D Systems ProJet 650, FormLabs Form1+, 7 MakerBot Replicator 2s, 1 MakerBot Replicator 2X, 1 Makerbot Gen 5, and 8 Ultimaker 2s.

Finally, a number of classes are held at Ben Franklin Technology Partners of Northeastern PA's Tech Ventures, a 109,000-square-foot incubator located on Lehigh's campus. Tech Ventures also has garnered a national reputation as the National Incubator of the Year by the National Business Incubation Association (NBIA) in 2001 and 2012.

Dedicated faculty

Many master's programs are an amalgamation of courses and faculty from across different departments, presenting a challenge of coordinating content. The TE model was designed to have a dedicated faculty, hired specifically to create the collaborative space and develop and deliver the curriculum. This approach enhances efficiency, allowing for more robust integration across the courses.

Collectively, Professors Lehman and de Vinck have backgrounds in product development, design, medicine, business, entrepreneurship and education, and provide a multidisciplinary approach and broad network for the students.

In addition to the two full-time faculty in the program, Program Director Professor Ochs teaches the IPD Process course, intellectual property attorneys provide instruction and subject experts are leveraged in areas such as sales, negotiations, design for manufacturing and video development. A dedicated Program Coordinator, Jodie Johnson, brings over 20 years of experience at Lehigh to TE.

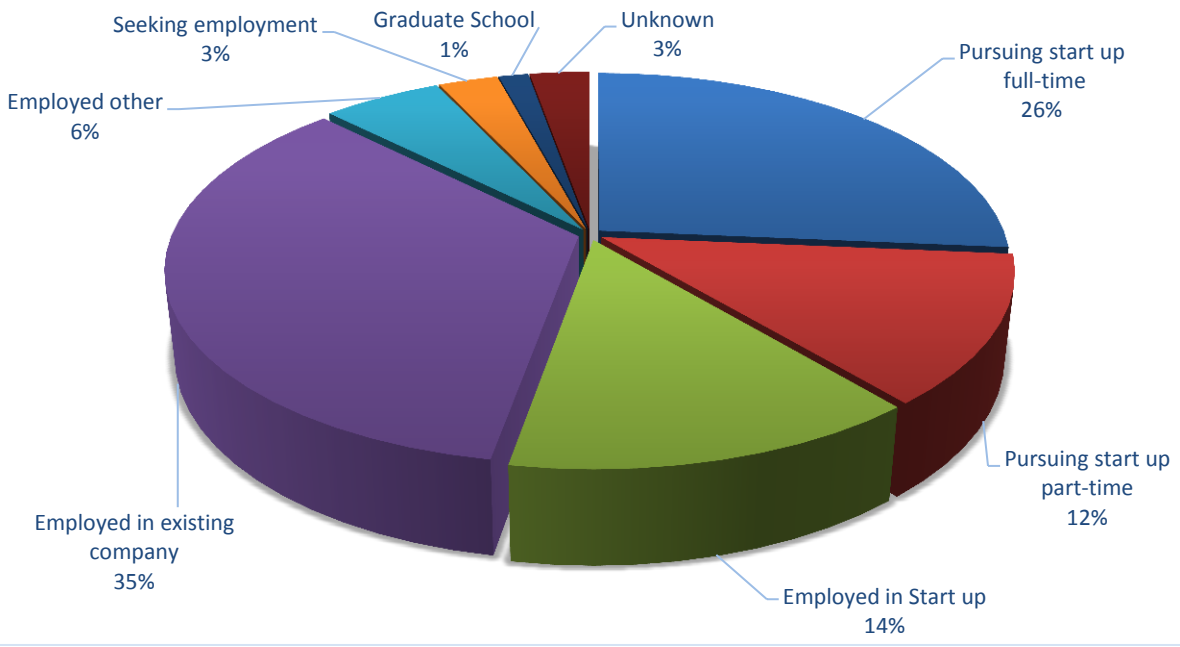
Program impact

As students in the Master's of Engineering in Technical Entrepreneurship program are working on their own products/services and associated business models, across a variety of industries, the "dedicated model" provides a common platform. Through the dedicated curriculum, the theory courses were specifically designed to accommodate students from different undergraduate degrees and real-world experiences. The project courses, tightly integrated with the theory courses, accommodate the variety of directions the students may take. The dedicated space and associated 3D printing technologies were designed and continue to evolve to support the curriculum. And the dedicated faculty are aware of the many moving parts of the program, allowing for "real time" adjustments to reflect what is happening in technical and business arenas.

What types of opportunities are pursued by alumni from the M.Eng. in Technical Entrepreneurship at Lehigh University? With the common thread of entrepreneurship and innovation, graduates have launched and are running their own companies; joined as pivotal members of startup teams (for example, as the third hire at a company for both salary and

equity); joined their family's multi-generation firm; been hired in larger corporations as new product development engineers, as consultants, or in business development roles; and secured positions that provide support to entrepreneurs and innovators or engage in emerging technology research. Figure 2 provides a breakdown of graduate placement of students from first three cohorts of TE.

Figure 2: Graduate placement of students in first three cohorts of TE



This impact of this dedicated approach has also received national recognition for its role in talent development by the University Economic Development Association (UEDA).

The Master's in Technical Entrepreneurship at Lehigh University is promoting innovation by cultivating entrepreneurs through an approach that is "dedicated by design." It will be interesting to see what evolves, both at Lehigh and on other campuses, from the model of a graduate program's dedicated curriculum, dedicated space, and dedicated faculty.

Bibliography

1. Bloom, B. S.; Engelhart, M. D.; Furst, E. J.; Hill, W. H.; Krathwohl, D. R. (1956). Taxonomy of educational objectives: The classification of educational goals. Handbook I: Cognitive domain. New York: David McKay Company.