

Designing an Engineering Entrepreneurship Curriculum for Olin College

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Abstract

This paper presents the initial design of the engineering entrepreneurship curriculum for the Franklin W. Olin College of Engineering. The methods for design, components of the curriculum and how the curriculum is interwoven with mainstream engineering disciplines at Olin College are described. The major elements of the curriculum that is being planned include: (1) a set of modules for learning the basics of entrepreneurship, (2) interaction with several on-campus and distributed hatcheries, (3) a set of in-depth learning interactions (projects, modules, courses) that provide depth of knowledge in engineering entrepreneurship and (4) capstone experiences in entrepreneurship during the sophomore year and the final year of the undergraduate curriculum. New courses/modules specifically targeted on technology entrepreneurship are being designed between Babson College and Olin College. Babson College's number one ranking in entrepreneurship is being fully leveraged by joint appointments of faculty, cross registrations between Olin and Babson and the initiation of many projects between the two schools designed to create the premier engineering/technology entrepreneurship curriculum in the world.

Introduction

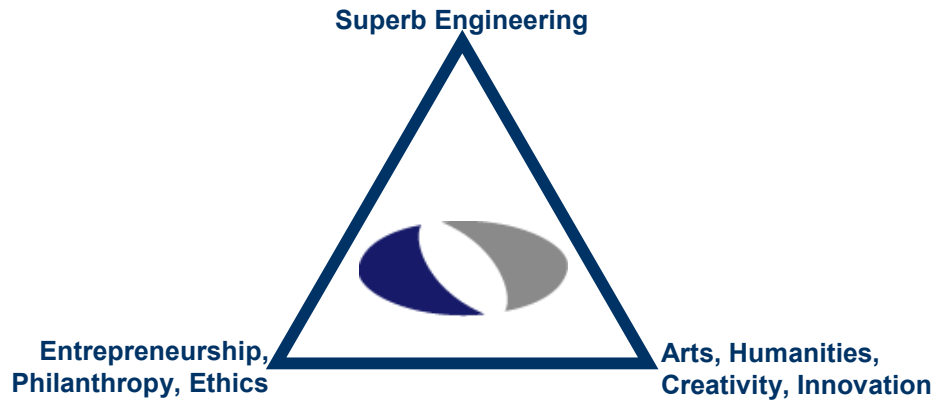
Olin College

The Franklin W. Olin College of Engineering, located in Needham, MA, was founded in 1997 through a generous grant from the Franklin W. Olin Foundation. Scheduled to open in the fall of 2002, the College admitted 30 "Partners", or students, in the fall of 2001 who have helped the faculty design the curricula, co-curricula and other aspects of student life. Along with an additional 46 students, the Partners will become part of the first class. The Olin curriculum centers around "superb

engineering” combined with the arts, business and entrepreneurship. This paper describes the start-up planning and design aspects of the curriculum that deal with entrepreneurship. The authors of this paper – a team of two faculty and five partners that worked during the fall and spring semesters, 2001-2002, accomplished the work described.

The Olin Vision

The overall vision for the creation of Olin College is best described by the Olin triangle:



The Olin triangle is a graphical representation of the academic areas that are the defining elements of Olin College. Superb Engineering is the major element of the triangle, and is thus located at the top. The base of the triangle contains a very significant immersion in (1) Arts, Humanities, Creativity and Innovation, and a focus on (2) Entrepreneurship, Philanthropy and Ethics. All students at Olin College are educated in these latter two areas at the base of the triangle. The providing of education in these areas to support superb engineering is the hallmark of the Olin education. Arts, Humanities, Creativity and Innovation will enable the creation of a humanistically-educated engineer, able to deal with the world in a holistic fashion. Education in Entrepreneurship, Philanthropy and Ethics will position students to always think in the entrepreneurial fashion, guide their perspectives, and position them to optimally utilize their broad-gauged education for the rest of their lives. We believe that the inclusion of these two supporting elements of the curriculum will enable Olin students to apply their engineering education to the real world in ways that are dramatically better than a traditional engineering education.

The Olin curriculum is complex and will not be described in detail in this paper; instead, we focus here on how Entrepreneurship, Philanthropy, and Ethics are treated within the general curriculum structure.

One element of the curriculum that is essential to understanding how entrepreneurship education will work at Olin is something called the “cohort.”

A cohort is a highly integrated block of three courses (in the freshman semesters, it will be a math stream, a science stream, and a project stream). Each course has an assigned faculty member who is responsible for the instruction of specific, clearly defined learning objectives. Beyond that, however, the faculty are encouraged to deliver the information in the format they feel will help the students learn and best complement the project stream. They may deliver content in any format or order that they agree to, so long as the learning objectives are achieved. This allows for tight coordination between the understanding of underlying disciplines and the application of this disciplinary knowledge to real engineering problems. In addition to the learning objectives, it is anticipated that faculty will bring some of their other interests, technical and non-technical, to the cohort block, which may mean that some cohort options have a distinctly entrepreneurial flavor. Three different cohort choices will be offered each of the first three semesters.

Defining Entrepreneurship

To determine what we should teach and learn, our group investigated definitions of entrepreneurship, recognizing that different people have differing viewpoints about the meaning of the word.

- Classic Definition:

The ability to identify opportunities regardless of available resources.

- Our definition:

A motivation to create “wealth” inspired by a sense of adventure and the creation of a better world.

At Olin College entrepreneurship is defined to encompass much more than just the traditional desire to obtain monetary wealth. Olin takes the idea of an entrepreneur one step further, to where the entrepreneur is helping out whomever he or she can. This idea defines wealth not simply in a monetary sense, but also with the idea that someone’s smile has value. In helping people, the Olin entrepreneur is gaining wealth of spirit as well as wealth of currency.

The Olin Vision for Entrepreneurship

In our vision, an optimal engineering education with an entrepreneurship flavor from Olin College ties elements of business and engineering together in a way that a graduate can work easily and naturally in both environments. Rather than training engineers to remain in the traditional mold of working apart from the business aspects of projects, Olin College seeks to educate engineers who can assume leadership in both business and engineering. Typically, to effectively work in a combined environment, engineers have had to secure additional training – for example, an MBA. We feel that in order to take on leadership roles, engineers must have a firm grasp on business and entrepreneurial skills at the outset of their careers. This integration of engineering and business will begin as an undergraduate student at Olin

*Proceedings of the 2002 American Society of Engineering Education Annual Conference & Exhibition
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rather than requiring additional education after graduation. Olin is not just training engineers; indeed, we envision the institution as training the business leaders that propel tomorrow's technologies.

Gauging the reality of the vision

As a first exercise in our curriculum development, we asked many practicing entrepreneurs about why engineers should learn the skills of entrepreneurship. One of these entrepreneurs, George Berbeco, upon being asked about why engineers should learn the skills of an entrepreneur said, "If an engineer is not an entrepreneur, he is just a tool." This statement made an impression upon our study group! We felt that Berbeco's statement meant that if an engineer does not go out and actively use the tools he has been given to innovate or to solve problems, he will only be used as a resource for engineering skills and left out of the larger decision making processes.

Referring to the Olin Vision, it is evident that the founders of Olin College saw these trends in the business world and wanted Olin graduates to have the necessary skills to fulfill these demands, and become the leaders of tomorrow. The importance of entrepreneurship at Olin is displayed by its significant position on the Olin Vision Triangle. Resulting from their years of experience in the business world, the founding board of trustees has enabled the faculty and students of Olin College to become leaders in the field of entrepreneurial engineering through this vision.

Olin will provide multiple levels of entrepreneurship education for the students of the college, understanding that some students want engineering and entrepreneurship to have equal priority, some students want their engineering content to have priority while still achieving a solid grasp of entrepreneurship, and other students only a flavor of entrepreneurship due to their interests in other courses of study. These levels of interest will be addressed in three different entrepreneurship paths. Students following the first path pursue entrepreneurship by pursuing entrepreneurship as their concentration under an Engineering and Applied Sciences degree. This concentration may be known as EASE, Engineering and Applied Sciences with a concentration in Entrepreneurship, and would appear on a student's transcript. Students following a second path may pursue another major, such as Mechanical or Electrical Engineering, but will earn elective credits for a certificate in entrepreneurship. The third path for students may follow will contain only the standard entrepreneurship requirements designed to provide all Olin graduates with a sufficient background in this subject. Details of degrees, accreditation and content of offerings are incomplete as of this writing.

Teaching and Learning Entrepreneurship

The Babson Opportunity

Babson and Olin Colleges are collocated. This physical proximity permits and encourages a deep relationship that would otherwise be impossible. Over thirty years

of teaching entrepreneurship allowed Babson College to be ranked number one by US News and World Report in that category since these rankings commenced in 1995. A rich series of outreach programs, research and teaching provides an almost unmatched educational experience for students studying entrepreneurship. The Arthur M. Blank Center has extensive experience in operating a student hatchery on campus and has been involved in a number of incubator relationships in Boston's Route 128 Technology Corridor. Of special note is the recent creation of the Entrepreneurship Intensity Track (EIT) in which students may receive a degree while starting a new business. This model is very significant because of the ability of the accelerator to potentially extend the track to enable starting new ventures anywhere and at anytime.

What Exists

Prior to defining how entrepreneurship instruction at Olin should be implemented, we looked to see what is offered at other schools. Stanford University and the University of Pennsylvania offer programs similar to what we are trying to develop, and many schools make an effort to bring entrepreneurship into the academic culture.

Stanford's program, known as the Stanford Technology Ventures Program, is an entrepreneurship center within the Stanford University School of Engineering. It offers a significant number of courses for students who are interested in entrepreneurship, as well as an extensive outreach program to encourage the teaching of entrepreneurship at other institutions worldwide. It also serves as a resource that others can use for help in implementing entrepreneurship programs.

The University of Pennsylvania offers two courses in Engineering Entrepreneurship that serve to teach students how to take high-tech ideas and bring them into the marketplace. Focusing specifically on engineers, the program helps students gain entrepreneurial skills that will enable them to enhance their contributions to the business world.

Other schools offer graduate degrees in "Engineering Management" or certificates in "Engineering Entrepreneurship," as well as entrepreneurial organizations on campus that foster entrepreneurial thinking.

There appears to be quite a significant interest in engineering entrepreneurship as a course of study at many institutions. Many of these institutions reported in a special section of the October, 2001 issue of the Journal of Engineering Education of the ASEE. This section was devoted to papers about entrepreneurship in engineering education. These papers were organized by the National Collegiate Inventors and Innovators Alliance (NCIIA), an organization that has been the moving force in the pushing this field forward. The papers in this volume include information about how invention, innovation and entrepreneurship are taught at both the undergraduate and graduate levels at several institutions. For example, Wang and Kleppe⁸ (2001) discuss how entrepreneurship is part of a capstone course at the University of Nevada. Ochs et al.⁴ (2001) discuss the ways that entrepreneurship education can be integrated with specific examples from Lehigh University. Stanford's experiences in cross

disciplinary education is explained by Miller et al.³ (2001) . The NCIIA-sponsored e-team concept is discussed from the viewpoint of University of Nebraska by Adams¹. The University of Arkansas (Vickers et al.⁷, 2001) describes how to change the culture of the institution. Anthony Marchese describes how venture capital funding enables undergraduates to learn about entrepreneurship at Rowan (Marchese², 2001).

Entrepreneurial Thinking

One facet of the Olin curriculum is the injection of both arts and entrepreneurship in the engineering curriculum. The minimum amount of arts, humanities and social sciences will be 24 credits and the minimum amount of entrepreneurship will be 3 credits (one course). Students will have the ability to take 12 credits of the curriculum as completely free electives – hence, students may specialize in entrepreneurship if they so desire. For the minimum requirement, we plan to provide practica (short modules) that provide all students with the capability to undertake entrepreneurial thinking. We will provide modules that will help students understand methods for opportunity assessment and business planning for the minimum requirement.

A quick glance at the numbers can lead one to the wrong conclusion; to say that Olin’s minimum required entrepreneurship is a three-credit course would be a terrible understatement. Much of Olin College’s curriculum is organized around projects that integrate engineering content with application of knowledge. These project streams are designed to support “bolt-on” practica (mini-courses that may be either synchronous, in-class experiences or asynchronous resources). It is anticipated that significant entrepreneurial content will be delivered through practica, such as teaming and opportunity assessment modules in the first and second semesters respectively.

Furthermore, the term “entrepreneurial thinking” is also applicable to the Olin culture as a whole. In order for Olin to achieve its amazing vision, administration, students, faculty, and staff will need to continue to innovate and remain on the cutting edge of this exciting new venture.

Teaching and Learning of Entrepreneurship

We have agreed to conduct most of the teaching and learning of entrepreneurship by actually doing entrepreneurial activities, including starting new businesses, working with start-up ventures and engaging and working with philanthropic organizations. We are specifically not considering the traditional class lecture methodology as a primary learning experience. Many of these entrepreneurial activities will occur in engineering projects, where the credit shown on a transcript will be “engineering,” but the project will undoubtedly require entrepreneurship knowledge to succeed – much like the real world.

Ideas considered

During the design process, we considered the following activities to include the entrepreneurship in the Olin experience:

Case methods, internships, seminars, international experiences, co-op/industrial experiences, hatcheries/incubators, reading and materials, speakers, workshops/practica/skill modules, business creation experiences, interviews with entrepreneurs, and the types of courses that we should create.

Olin Entrepreneurship Curriculum

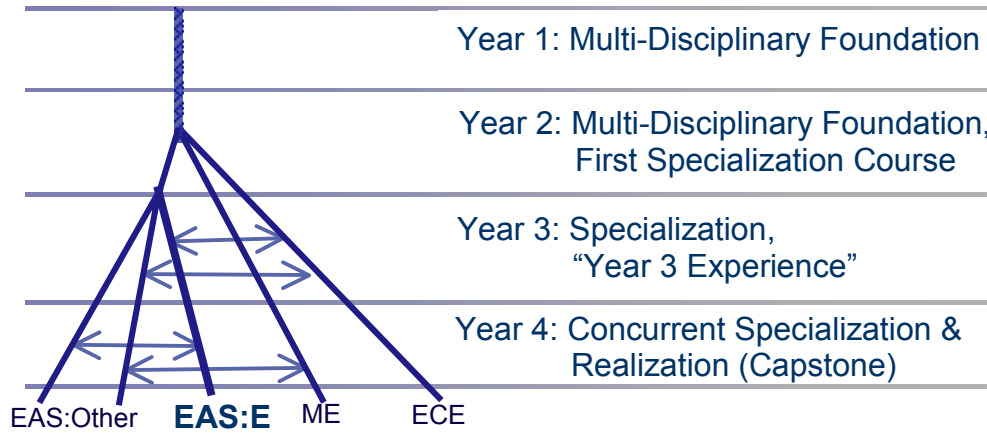
Olin Students excel at math and science, and will leave Olin with an engineering degree. However, Olin students are interested in much more than just engineering and will also focus on entrepreneurship, philanthropy and ethics, and arts, humanities, and social sciences in addition to their non-academic passionate pursuits. They are easily motivated to learn, and will individually seek out the information they need which may not be a formal part of the assignment. This “just in time” learning style is common and will be supported through the design of Olin’s entrepreneurship curriculum. Our goal is to allow students to have easy access to the business material they may need while working on projects and other assignments.

Options

A major goal in designing the curriculum was to allow students to choose the level of entrepreneurship content they take. While a certain minimum will be required; students who desire to go beyond this minimum business foundation might be able to through three options:

- 1) Electives in entrepreneurship
- 2) Certificate/Minor: option available to students of all majors that earn a certain amount of extra entrepreneurship credits
- 3) Engineering and Applied Science: Entrepreneurship Concentration: A possible option under Olin’s general engineering degree that allows students to fully integrate a superb engineering education with a mastery of entrepreneurship skills.

Four Year Curriculum



Olin's current curriculum model consists of three time-specific periods: Foundation, Specialization, and Realization (Capstone). The diagram shows one view of how this might work, with a two-year foundation, one year of specialization, and a one-year capstone experience. The arrows indicate cross-discipline, and possibly cross-year, projects and interaction.

First Entrepreneurship Experience

It is anticipated that Olin students will be exposed to at least one project in their freshman year that requires a core collection of entrepreneurial skills. These skills may include teaming, opportunity assessment, rudimentary accounting, and more.

Fitting need for delivering these entrepreneurial skills together with the intense requirements for front-loading math and science content is a unique challenge. The Olin curriculum does not have room for a required entrepreneurship course until the first semester of a student's sophomore year. How, then, would these needs be met in the interim?

After considering all of the options, it was decided that the best way to deliver the early skill set at the time the skills were needed was in the form of practica that would complement the projects. This fits with the just-in-time learning style employed at Olin and helps students see the need and application for the skills as they learn them.

The "Business Basics"

The initial course of the fundamental entrepreneurship knowledge that is proposed for Olin students is a practicum tentatively entitled "Business Basics."

Business Basics will combine workshops, discussions/lectures, and readings to deliver knowledge in the most efficient method possible. Members of the design group read *The 10-Day MBA* (Sibiger⁵, 1999) and believe that it may adequately cover the topics of accounting, ethics, quantitative analysis, finance, operations, economics, strategy, organizational behavior. “Adequately” in this case refers to providing a basic working knowledge of the subject suitable for freshman engineering students. The reading would be backed up with question & answer review sessions and with online simulations.

Workshops would be used to cover the topics of project organization, negotiation, management & leadership, and public speaking / presentation skills. Additionally, some basic case studies would be completed.

One of the strongest points of this program is that it is modular, so that it can be “attached” to another course or project stream if Olin’s final curriculum model requires this scenario. In order to do this, the entrepreneurship team has investigated online learning and the use of Blackboard, an online classroom organization and education tool. The team determined that such online courses are not only feasible, but also extremely beneficial to students. An online course allows students to seek knowledge as they need it, providing a plethora of resources for business education. An in-class experience, although not essential, would serve as an invaluable compliment to this course. Construction of the actual curriculum for this class was in progress at the time of writing.

Originally intended as a first year, first semester course (before the overall curriculum was specified), the group developing this course is now engaged in determining what skills should be exported from “Business Basics” and introduced as practica earlier in the foundation. Use of practica will also free up class time in the course for exploring some topics in more depth.

The Sophomore Design Project

A key element of the Olin Curriculum is a student-proposed Sophomore Design Project that is similar to the capstone design projects found in other engineering programs in the senior year. The so-called “mini-capstone” design experience is specially formulated to have an entrepreneurship component.

Entrepreneurship Opportunities

Olin College students will have many opportunities to exercise their entrepreneurial spirit. Internships with local companies will be available to students during the school year, and over the summer. Such companies have already expressed a high level of interest in having Olin students as interns. These internships will probably consist of fairly intense, one-project experiences, as students will be encouraged to explore internships at other locations as well. Summer internships would most likely be much more involved, as students can participate in a project full-time, instead of the part-time efforts they can contribute during the school year. Through internships, students learn the dynamics of real-world business, while being able to contribute

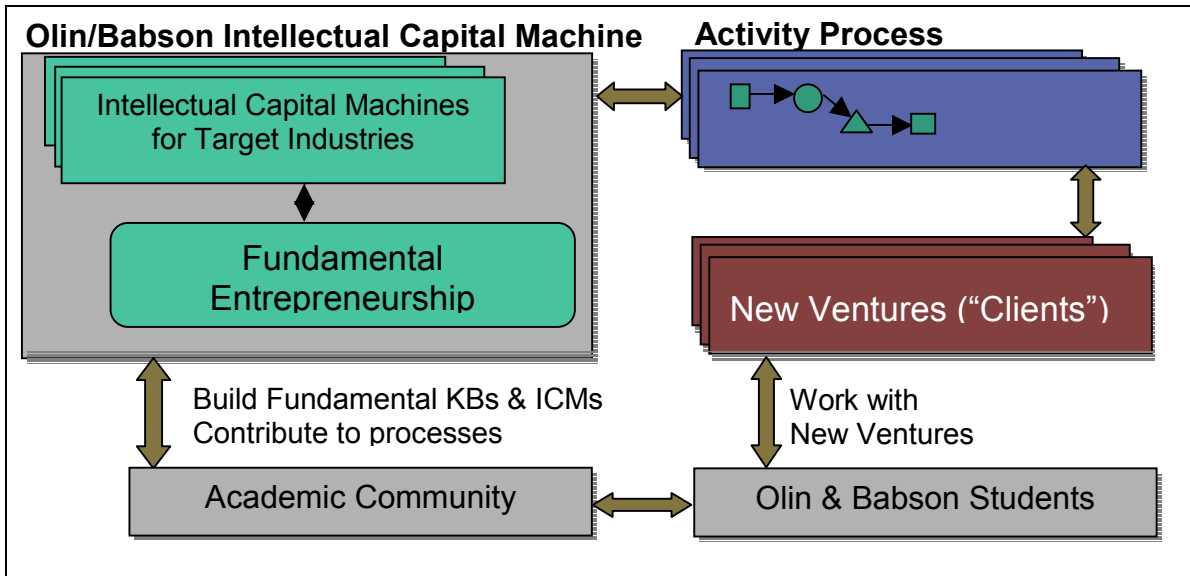
their knowledge and experience to a large project outside of the Olin/Babson community.

Other entrepreneurship opportunities will also be available that would offer students experiences not available in internships. Such opportunities would probably include meaningful projects that would allow students to provide leadership experiences that can contribute to a project. Such projects could be subsets of Olin courses, or could be offered separate from the curriculum. Furthermore, these projects would allow students from different majors and graduating classes to collaborate in an environment not necessarily available through Olin courses. Other opportunities may include participation in startup businesses presented by Babson MBA students. Currently, multiple Olin partners are involved in such ventures.

The Entrepreneurship Accelerator

Olin and Babson colleges are currently seeking funding for the establishment of an Entrepreneurship Accelerator. The Entrepreneurship Accelerator (TEA) overview figure below shows how information can flow from Olin and Babson students into businesses and other entrepreneurial endeavors, allowing both students and an outside businesses to benefit from the process. First, there are databases within TEA on essential entrepreneurship skills and studies of entrepreneurial endeavors that have both succeeded and failed (the Intellectual Capital Machine or ICM), to help learn from decisions from the past experience of other companies. When a new venture (client) wants to utilize the services of TEA, they engage in a series of activities (focus groups, taking educational modules, etc...), and work with Olin and Babson students to evaluate the ideas of the client. This process not only helps the client, who benefits from the wealth of knowledge captured in the Capital Machine, but it also helps the students to gain real world experience working with and improving the ideas of actual companies and small businesses. After working with the students, the client then returns to the community with their ideas. In return for the help given by the students, faculty and staff of TEA, the client provides TEA with their experiences, completing the circle, and expanding the potential and information within the ICM.

This real life interaction will act as a major enabler for many of the entrepreneurship classes offered at Olin.



Analysis of the Curriculum Design

At Olin, we view the integration of entrepreneurship in the curriculum as an essential element of each student's education. In the Olin triangle, a minimum amount of arts and humanities and entrepreneurship is required to permit students significant choice in constructing their own curriculum. In foundation curriculum, the minimum amount of entrepreneurship learning that takes place is on the order of one semester consisting of a total of 3 semester hour credits, in addition elements and experiences included in 13 credit hours of hands-on projects. However, we anticipate that many students will elect to focus on entrepreneurship and take advantage of the rich undergraduate curriculum in the area that we are constructing. Given the tight linkage to Babson College, it is indeed likely that some very significant fraction of the Olin student population will become engaged in the entrepreneurship activities of the college.

Discussion

The simple fact that Olin is creating an entire school, from scratch, was a great challenge in designing the entrepreneurship curriculum. Instead of simply figuring out a space in the curriculum for a few courses, the team had the opportunity to make recommendations so the curriculum could completely integrate entrepreneurship. However, each other disciplinary area made additional requests for curriculum time against the amount of available time, thus producing initially conflicting recommendations. Hence, we initially had a tremendous amount of uncertainty about where it was most important to spend our pedagogical effort.

After making initial recommendations (and assumptions to facilitate further design) in the fall, other experiments in entrepreneurship education continued, mostly with pedagogies and how to best apply them.

Between January and February, a new team began construction of the Business Basics course. Halfway through their design time, the college's Curriculum Decision Making Body unveiled a draft specification for the Olin Curriculum. This allowed the team to begin making more concrete decisions and prepare specifically for next year's freshman class. This process is scheduled to continue throughout spring and summer.

As of this writing, the curriculum framework of Olin College is still tentative. Various characteristics are known - for example, significant amount of foundation content delivered through cohorts, projects take place in each year, there is a core foundation, a specialization phase and a capstone-included realization phase coupled with international and industrial experiences. The EASE curriculum will likely become a concentration within an "Engineering" track that is the same as the foundation tracks of Electrical and Computer Engineering and Mechanical Engineering but differs in the realization and specialization phases (years 3 and 4) of the curriculum. All students will have a minimum grounding in entrepreneurship but will be able to tailor their programs to secure an in-depth education in the area. In 2002, results from offering "Business Basics" to the incoming class will guide our curriculum development for the latter years. Ultimately, we anticipate creating a distinctive graduate who will combine the very best learning in engineering with in-depth knowledge of entrepreneurship.

Can You Try this at Home?

The portability of the curriculum being designed at Olin College is not an easy issue to nail down. There are certain practices, such as projects and activities that require small classes, which are not practical for many institutions. At the same time, Olin is committed to serving as a model for exemplary new engineering education techniques and does hope that its efforts can benefit the education of more than its own students.

The most replicable component of this curriculum is probably the online business modules. These require few resources to implement and a small step can help many engineers quickly gain a working knowledge of business practices.

We would encourage small colleges to form collaborate agreements similar to the one between Olin and Babson wherever possible. This offers a tremendous resource advantage that is mutually beneficial to all parties involved. For large universities, close coordination between their business and engineering colleges, such as what Lehigh has done with its Integrated Business and Engineering program, is also recommended to achieve similar results.

The design process itself has a number of merits as well. The team strongly believes that any college looking to refresh – or revolutionize – its curriculum should involve a team of interested students, faculty, staff, and experts. The combination will be far better than any one group could have produced on its own.

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