AC 2008-485: EMBEDDING BUSINESS STUDENTS INTO EET/TET E4 E-TEAMS

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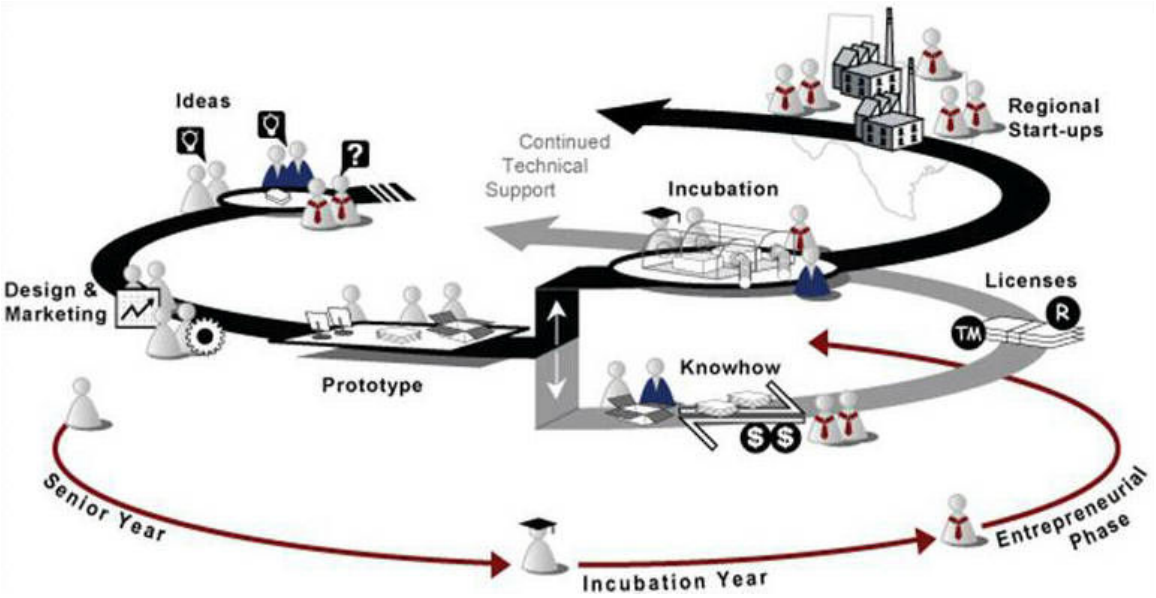
Embedding Business Students into Engineering Entrepreneurship Educational Experience

Introduction. Over the past two years the Electronics and Telecommunications Engineering Technology (EET/TET) Programs at Texas A&M University have been developing a unique approach to providing senior-level students with an opportunity to learn more about innovation and entrepreneurship. In their final year of undergraduate study, groups of three to four students come together as new start up companies that complete the two-semester capstone design requirements by transitioning from an Idea to a fully functional Prototype (I2P). Most of these projects are now externally sponsored by companies that are trying to increase their design bandwidth, jumpstart a new product idea, or in some cases become more involved with students to develop a better pipeline for new hires. Intellectual property developed by these student companies is transferred to the Texas A&M System Office of Technology Commercialization that manages the licensing of the IP to current companies or stimulates new start-up ventures in the local region. Figure 1 contains a conceptual diagram of the Engineering Entrepreneurship Educational Experience (E4) model that begins with the generation of ideas for use by the student teams and continues in a self-sustaining manner through licensing and/or incubation of new technology innovation companies. To date, one



project has culminated in the development of a working prototype that was then licensed by the Office of Technology Commercialization (OTC) to a new venture for commercialization. Royalties from sales of this new product will be paid to Texas A&M, a portion of which will go to the three former students that are listed as inventors of the intellectual property.

With each semester, more facets of the E4 Model are realized. As support from the private sector continues to expand with each interaction and presentation that is made, the

same comments are put forth by companies interested in supporting the E4 Initiative. These are:

1. Who is the customer?
2. How will the product be manufactured, distributed sold and supported?
3. Is there a marketing or business plan available?

In response to these encouragements, the EET/TET Programs worked through its contacts with the Center for New Ventures and Entrepreneurship (CNVE) in the Mays School of Business to identify faculty and undergraduate students who could assist in expanding the scope of the E4 Model. This interaction, supported by the National Collegiate Innovators and Inventors Alliance (NCIIA), was initiated during the Fall 2007 semester as one of the first multidisciplinary undergraduate activities between the business school and engineering college that focuses on innovation and entrepreneurship

Pilot Project. Although a relatively easy concept to envision, the pilot program had several hurdles to overcome. First was to determine the level and format of the interaction. Would the embedding of business students into a technical design process be accomplished through the linking of separate courses in each college with agreements to work collaboratively? Would business students enroll in engineering course work and substitute credits earned? Would master's degree students, undergraduates or both be eligible for involvement? Numerous questions such as these needed to be address prior to embedding the business students into the Electronics and Telecommunications E4 teams.

Through discussions and interactions with Mays Business School faculty and the director of CNVE it was decided to propose the opportunity to the undergraduate honors students within the business school. In addition, the EET/TET faculty made the opportunity available to one undergraduate student in a sister program (Industrial Distribution) within the department. The result of these interactions was three business students and one ID student demonstrated an interest in becoming involved in the E4 Initiative. All faculty members agreed that this number of students would make an excellent pilot study to assess how a replicable interaction could be created. Each business/ID student was permitted to choose a particular E4 capstone design team to work with – thus becoming an embedded team member. In addition, the honor students in the business school would earn three hours of their elective credits through their involvement with an E4 team. One credit of course work would be earned during the first semester course which focuses on project management, idea to prototype (I2P) design, and project planning. The other two credits would then be earned by continuing to participate with the E4 design team in the second semester where the students implement their plan and produce a fully functional prototype that is ready for operational test and evaluation. Although similar melding of business and engineering students has been implemented at other institutions, the E4 initiative seeks to satisfy a series of interrelated objectives. These are:

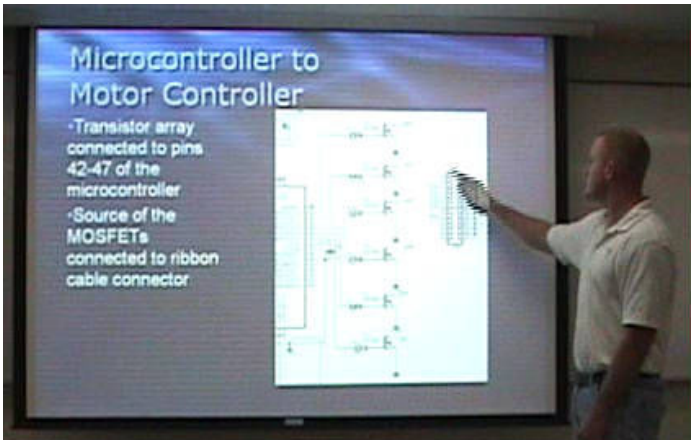
- to integrate engineering and business students into E-teams similar to the real world
- to create a sustainable experiential learning opportunity learning for undergraduate students that is fully integrated into their undergraduate curriculum
- to incorporate prototype requirements and sponsorship from the private sector
- to promote interest in both academia and the private sector for on-campus incubation

- to prepare the teams to take the next major step following graduation – form a start up venture that could be incubated on campus and transitioned to the local, regional or state business community

Student groups electing to continue after graduation would be provided stipends for a period of one year while they continue to develop the company and would earn graduate credit from both the business school and the engineering college for their efforts.

Benefits. Each business student worked with a business faculty advisor who created, reviewed, and graded appropriate assignments that added value to their E4 team. In the early stages of conceptual design, the business students were able to perform research on the intended customer base, and from these studies were able to assist the technical members of the team in defining the feature sets of the envisioned product. Having access to this information and being able to see their product through the eyes of a potential customer added significantly to all aspects of the product requirements definition. As the business students brought suggestions for product enhancements, the engineering technology students evaluated the benefit/cost relationship to determine whether to add or set aside each suggested additional feature. This interaction resulted in a more well-defined product and in addition, a better understanding of the market segments that would be pursued.

One of the first major tasks the student teams undertake is to create and present a white paper that clearly articulates the critical elements of the prototype they will design and deliver. This deliverable begins with a forty-five minute team presentation and concludes with the delivery of the written document. This document and presentation rightfully focus on the technical aspects of the project and include a detailed discussion of the functional design that is reviewed and graded by a team of faculty, members of the private sector, and the other students. This event takes place on the weekend of the sixth class week. For four of the teams, this was the first opportunity to integrate the technical aspects of the project with the business aspects. For these teams, additional sections were added to the white paper format that dealt with a study of the potential customers and a relative ranking of the proposed features. Each of the business students developed a preliminary Strengths, Weakness, Opportunities, and Threats (SWOT) analysis for the proposed project and also described what other research activities were needed for the formal technical proposal that would be delivered in week fourteen of the semester.



This additional information resonated well with the private sector members on the review panel. By comparing and contrasting the six white paper presentations, four with

embedded business/ID students and two without, there was clear agreement concerning the synergistic results achieved through multidisciplinary interaction. A majority of the private sector representatives indicated that embedding a business component in each design team added value and increased their interest in sponsoring and supporting the E4 Initiative.

Throughout the semester, the embedded business students were able to interact with the capstone design teams. This opportunity to be involved in a real-world I2P project sponsored by private industry that results in a fully functional prototype has been motivational to these students. As the business faculty indicated, having their students involved in the development of a potential product was far more valuable than "another restaurant/coffee shop/nail salon". In addition, the business students responded to being part of a real project. Knowing that the work they were doing was adding value to the capstone design teams and their industry sponsors enhanced their learning experiences.

One example of interaction that added significantly to the combined teams learning experience was the opportunity to participate in the Aggie 100 Awards program that is conducted by CNVE. Each year, CNVE recognizes the accomplishments of the top one hundred businesses that are owned or operated by a former student of Texas A&M. As part of the two-day event, one of the capstone design teams was given the opportunity to host two of the winners of this award. This relationship has not only been of value to the individual students, but both of the winners spent time with all six teams during a class session to discuss their entrepreneurial experiences. In addition, one of the winners became actively involved in the E4 Initiative and his company is now a sponsor of a new E4 project. Both of these gentlemen were impressed by the cross fertilization that has come from embedding business students into the capstone design teams.

Another example of the synergy that has come from the embedded student pilot deals with expanding the scope of the ELE Seminar Series. The Ethics, Leadership, and Entrepreneurship, or ELE, Seminar is part of the first course in the capstone design sequence. Student teams must identify, successfully invite, and host a leader from the public or private sector. This guest is the focus of a one-hour round table discussion (Q&A) that is conducted by the student team to create a learning experience for the class. In the past, most guests were from engineering/technical companies, but on one occasion, the embedded student arranged to have a successful entrepreneur from a non-technical environment participate in the session. Allowing the technology students to appreciate more diverse perspectives also has added value to their undergraduate education.

The final deliverable of the first course of the E4/Capstone Design Project is a Formal Technical Proposal (FTP). These documents present the planning activities that have been undertaken by the teams and include project management tools such as Work Breakdown Structures (WBS), Responsibility Assignment Matrices (RAM), Network Logic Diagrams (NLD), Risk Analyses, and Costing Analyses. For the four teams with embedded business student, the FTP was expanded to include a section on Industry Analysis and Marketing Plan. One example of the work accomplished by the embedded business student was reviewed by the sponsoring company. Rarely, if ever, have the

EET/TET students been able to impress the business side of the sponsoring company. Both the president and vice president of marketing of this company were highly laudatory in their review of how well the team had integrated the knowledge and research of their embedded business student into their FTP. The VP of marketing stated that he had learned some things about his market segment that could be used outside the product currently being developed by his E4 team. What has clearly happened through this multidisciplinary project is that the four engineering technology students now have a far better idea as to the potential market that can be served by the product that could stem from the prototype they are developing. Not only have they gained understanding of terms, concepts, and processes used in the world of business, they have become more energized to deliver an exceptional project over the next semester. This energy will translate to increased learning – making their educational experience more relevant and meaningful.

Outcomes. Plans are now being put in place to support the second semester activities. A very positive indicator of success is that all four business/ID students have chosen to continue their involvement in the E4/Capstone Design Projects. The business students will focus most of their activities in developing a comprehensive business plan that can be put in place to attract external funding for a start up venture. As the EET/TET Programs move forward in the implementation of the E4 Model, having such a plan in place will bode well for increased interest from venture capital and business development entities. The EET/TET programs have been approached by the managing director of the newly formed Research Valley Innovation Center (RVIC). Having learned of the capabilities of the multidisciplinary teams, he has proposed two new interactions with his center. First, he proposes that RVIC be the conduit to transition new start up companies from the on-campus incubator to the local community. Second, he sees the E4 Initiative as a resource to attract new entrepreneurs to the Bryan/College Station community.

All four teams are also planning to enter the Ideas Challenge held in April at Texas A&M University. With the product designs and marketing/business components that have been developed by these teams, they will be ready for the university-wide competition and should fair very well. In addition, the Chairman of the EET/TET Industrial Advisory Committee has asked that these teams make a special presentation to the group of industry partners to learn more about the new products that are being developed, the marketing assessments, the business plans, as well as the opportunity to license intellectual property being developed by the student teams.

What will be interesting is to see is whether adding the marketing and business components to the fully functional engineering prototypes will be enough to take any of the teams to the next level of the E4 Model. At the end of the Spring 2008 semester, when the intellectual property package is complete, the business plan is prepared, and the students from the business school and engineering college have graduated, will a new venture be undertaken in the Brazos Valley? Will the first start up company be incubated

on the Texas A&M campus? This is the next logical step in the evolution of the E4 Model.

Lessons Learned. The pilot program that was begun in the Fall 2007 semester has been quite successful. In additions to the successes, there have also been a series of lessons learned. Working collaboratively with the Mays Business School faculty and representatives from OTC, the EET/TET faculty will use the feedback from multiple sources to improve the process for the first course while they continue to monitor the process as it progresses through the second semester. Of paramount importance is to increase the involvement of the business faculty in the multidisciplinary activities. In meetings with the business faculty, all have agreed that in the future, two undergraduate classes should be identified that can be linked together with both the first semester and second semester capstone design courses. In this way, teams of business students can work in a collaborative fashion with the technical student teams to bring more value to the projects. Although in separate classes, each technical team will be linked to a business team which they will work with over the two semester sequence.

A model for this interaction is the team that was assembled by the CNVE director about twelve months ago. This team was composed of four MBA students working with four EET/TET students. Over the course of two semesters this "super team" built a marketing and business plan around the prototype system being developed as part of the capstone design project. The team, under CNVE sponsorship, entered a number of I2P and business plan competitions, winning first place and third place in the six competitions they entered in the Texas / Oklahoma area. The body of work that was produced by the super team will now become the guideline for the joint technical/business teams. Although assignments will be made by business faculty for the business students and engineering faculty for the EET/TET students, they will share a common vision.

Both faculty and students agreed that creating an opportunity early in the semester to facilitate student interaction and team building would be of definite benefit. One suggestion was to have an invited speaker for a dinner meeting following a work session where each student presents their interests and experiences. Another idea that was suggested is to provide the teams with both product business development mentors that can interact with the interdisciplinary student team

As is typical with most new initiatives, the highest degree of success in implementing this new paradigm is to approach the problem at the faculty and course level. The demonstrated success at this level will then draw in support at higher levels.

Continued Implementation of E4 Model. With the successes that has been achieved to date, the E4 Initiative and its "disruptive" model for experiential education have started appearing on the radar screens of more companies that seek to add to their product develop capabilities and resources. Bringing together both technical and business students to work together collaborative fulfills a real need by most of these companies for new hires who need to have a better understanding of all factors involved in the design, development, production, distribution, and support of a new product. In addition to these

interested companies, the E4 model is receiving much more attention by entrepreneurs and venture capitalists. An informal working group of faculty from the engineering and business colleges are meeting regularly with the university's technology commercialization office to develop templates for licensing IP and business packages developed by the student teams.

A major challenge in full implementation of the E4 model is establishing a self-sustaining on-campus incubator. Such a facility can provide first-year support for start-up ventures that will allow for prototype to product development as well as assembling a high-quality management team and securing investment capital. This incubator must become an integrating force to bring together the six primary elements (engineering college, business school, technology commercialization office, private industry, students, and faculty) necessary to respond to this challenge. Both a long-term and short-term approach to standing up the university's Innovation and Entrepreneurial Institute (incubator) are being pursued. An informal working group representing the six elements has been established to move this aspect of the E4 model forward.

To provide long-term support for the institute, the working group is seeking a major industry leader to establish an endowment that would provide the funding necessary to support multiple start-ups on a continuing basis. Information is being provided to companies that have innovation and entrepreneurship in their corporate vision and mission statements. Another approach for endowment is to interest a successful business person/entrepreneur that is a former student to establish a named endowment. Although this concept is in the early stages, there has been interest shown in both areas to invest in this type of development activity.

In the near term, support is focused on individual team/prototype incubation. With the recent success of licensing IP by an external new venture and the transitioning of the prototype to a commercialized product, more interest is being demonstrated by the university system and its technology commercialization office to establish a "pilot" project. The pilot would create a new start-up venture that would include graduating students, faculty, and the private sector. The first-year incubation of the start up would be done on campus and would have the support and mentoring of faculty and staff from the college of engineering, business school, technology commercialization office, and from business and venture capital representatives in the local area.

Another important area for continued implementation of the E4 model is to formalizing the multidisciplinary aspects of the student teams. In discussions with colleagues within the school of business, there is now a desire on their part to create a similar two-course sequence that will directly link their business teams to the technology teams. In so doing, the value proposition to entrepreneurs and established companies will increase. This higher level of involvement will produce better problem statements/ideas on the front end, more interaction by the sponsoring entity throughout the year-long idea to prototype development, and a smoother licensing and transition process. In some cases, the sponsoring company has most or all of the supply chain attributes, but lack the ability to

develop their own products to satisfy needs within their customer base. In these cases, new start up ventures will be possible.

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