

## **2006-487: ENGINEERING ENTREPRENEURSHIP EDUCATIONAL EXPERIENCE (E4) INITIATIVE: BRINGING ENTREPRENEURSHIP TO THE UNDERGRADUATE CLASSROOM**

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# **Engineering Entrepreneurship Educational Experience (E4) Initiative: Bringing Entrepreneurship to the Undergraduate Classroom**

## **Abstract**

Currently, internships and co-operative education agreements are used to move the student's experience from the university to the private sector. This allows the students to gain some amount of experience in the private sector before graduation through short stays with industry. We are currently creating an alternate model. The Engineering Entrepreneurship Educational Experience (E4) initiative will bring private enterprise knowledge into the university. To this end, the Electronics and Telecommunications Engineering Technology programs at Texas A&M University are partnering with a small, local company to establish an initiative that will create an undergraduate entrepreneurial experience within the EET/TET curricula and stimulate collaboration between public and private sectors. The goal of E4 is to allow students to create product prototypes that can then be commercialized by an entity external to the University.

Using the current senior project sequence, the Electronics and Telecommunications Engineering Technology programs, through their faculty and student workforce, will be responsible for the "idea to prototype" phase of product/system development. The proof-of-concept prototype can then be transferred to the private industry partner who will be responsible for the "prototype to profit" phase. Because the partner is local, interested students can continue to participate in the process. Thus, students will be able to participate in all aspects of the "productization" cycle. The first phase of this project is complete and includes the conceptual design and planning activities. This paper presents the work that has been accomplished and discusses ongoing activities associated with E4.

## **Introduction**

Several different avenues currently exist to augment the education of undergraduate students within the private sector. Internships and co-operative agreements are two of the more common interactions that provide students a preliminary look at the world they will be working in after graduation. However, these avenues do little to provide young, energetic and capable men and women the opportunity to experience the challenges and rewards of entrepreneurship, especially in small start-up environments. To address this issue, several institutions have begun offering coursework designed to introduce students to entrepreneurial concepts.<sup>1,2</sup> However, while coursework is a good start, to effectively teach entrepreneurship to students the private sector must become an integral part of the educational curriculum with a long-term, vested interest in creating such an educational experience. One example where this methodology is being employed is at Brown University.<sup>3</sup> Another more recent example, and the focus of this paper, involves the faculty and students of the Mobile Integrated Solutions Laboratory (MISL) at Texas A&M University where they have undertaken the Engineering Entrepreneurship Educational Experience (E4) initiative. This initiative includes a partnership between MISL and a newly formed, locally-based company. For purposes of this paper, this company will be called

NEWCO. The initiative defines the structure that allows students in the Electronics and Telecommunications Engineering Technology programs to transform a product idea into a proof-of-concept prototype as part of their undergraduate education. These same students will then participate in the potential transformation of their prototype into a profitable commercialized product. The E4 partnership will:

- Create an entrepreneurial experience within the EET/TET curricula;
- Stimulate collaboration between public and private sectors;
- Produce new ideas that lead to new products;
- Generate opportunities to help start-up technology firms;
- Attract high-tech companies to the local area around the University; and
- Establish a leadership position for the University and the State in developing new strategies to secure job growth in high-tech industries.

## **Background**

The Electronics and Telecommunications Engineering Technology (EET/TET) programs' faculty established MISL in 2002 to enhance the senior project design experience for the undergraduate students. The single semester, “trashcan” project model typically employed in academia was expanded to a two-semester sequence for (1) project planning and (2) project execution.<sup>4,5</sup> This resulted in three key benefits to the curriculum. First, because the students were given an additional semester to complete their project, the faculty noticed a significant increase in the quantity and quality of effort by the students. Second, this increase in quality has resulted in more interest in the design and innovation process by the EET/TET faculty. Before the change, one faculty member was typically responsible for coordinating all student projects. Now, most of the EET/TET faculty share the responsibility for advising and working with student teams. Finally, increased participation by the faculty has resulted in more interest and involvement from other departments and the private sector.

Since 2002 the undergraduate process in the EET/TET Programs has been refined so students entering their senior year of coursework are expected to:

- Form a team that will function as a start-up venture;
- Develop a new product idea;
- Identify sponsorship and secure a technical advisor;
- Plan their design and development efforts using the principles of project management;
- Execute and control the design and development of a proof-of-concept prototype and associated design package; and
- Conduct a marketing presentation for commercialization.

This course sequence no longer generates just a breadboard version of a “works-once” design. Through support of the sponsor and guidance provided by the technical assistance team, the students are able to design, fabricate, test, and deliver a “product” ready for beta testing. MISL provides the resources necessary to support the idea to the prototype portion of a new product development cycle. This new process has generated several successful projects achieved through the motivation and support of the undergraduate teams, including products for the consumer and industry markets as well as systems to be used by the public and private sectors. One such success is the development of a product known as CELLink. CELLink (Figure 1) allows the

user of a Bluetooth cell phone to automatically link the cellular phone to the home phone system. Once connected, the cellular and home phone systems are linked together so that cell phone calls are not missed and free long distance calls using cellular service are available. The CeLLink project was briefed and demonstrated to local industry partners to determine whether it had potential as a product and the results were overwhelmingly positive.

With projects such as CeLLink resulting in commercially viable prototypes, the next step was to find ways of working with students to take successful ideas to the next level. To this end, MISL has worked to find a company external to the University that can provide the other critical element to the innovation and entrepreneurial process. Whereas MISL brings a highly motivated and educated workforce to move projects from idea to prototype, this new entity would have the responsibility of transitioning the prototype to a profitable product.

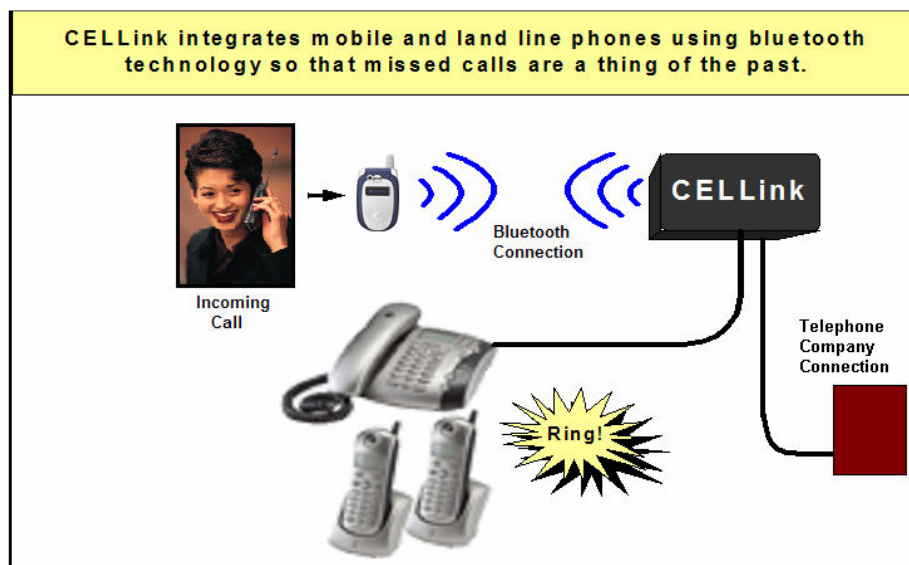


Figure 1. CELLink product diagram.

This entity has been identified as NEWCO, a new start-up company local to the University. MISL and NEWCO have formed the Engineering Entrepreneurship Educational Experience (E4) initiative to merge academia and private enterprise in a formalized, fully integrated partnership. By fusing these two critical elements into a long-term alliance, undergraduate education will be significantly enhanced while the private sector becomes more engaged in the education of young men and women interested in innovation. Although the basic framework is in place, significant funding is required for the initiative to be successful. EET/TET faculty members have recently visited and briefed the National Science Foundation to solicit feedback on the E4 concept. Based on feedback received, the faculty believes the E4 initiative fits well within the NSF's vision and goals. The EET/TET faculty has been encouraged to submit a funding proposal for the FY 2006 cycle.

## **E4 Initiative**

### *Vision and Major Objectives*

The overriding focus of the E4 initiative will be integrating a real-world, innovative and entrepreneurial experience into undergraduate education. To this end, the vision of the E4 initiative is to integrate “design spirit” into the educational experience creating a stimulating educational environment for undergraduate students; to create a win-win-win experience for all participants (students, faculty, industry); and to establish a leadership position in engineering entrepreneurial education.

To successfully realize the above vision, the E4 initiative has adopted the following major objectives:

- Integrate the knowledge and resources of regional and underrepresented academic institutions, local governments and industry to contribute to innovation and entrepreneurial education;
- Enable small- and medium-sized businesses to utilize the resources and capabilities of academic institutions as a workforce multiplier;
- Create and validate a new model that integrates applied research and education to establish and expand the technological innovation in the local area around the University; and;
- Propagate the new model to strengthen capabilities of academic institutions to contribute to the innovation process.

### *Concept*

E4 provides the framework necessary to create and maintain a long-term partnership between academia and the private sector for successful product development and commercialization. Academia will have primary responsibility for the idea-to-prototype phase of development due to its ability to create and manage teams of undergraduate students. These students comprise the technical workforce required to plan, execute, and control the design and development activities. The output from the academic partner will be proof-of-concept prototypes ready for evaluation by the partnership. For those prototypes selected, the private sector partner will have primary responsibility for prototype-to-profit activities.

The partners will meet regularly for brainstorming and idea generation as well as prototype evaluation and selection for commercialization. When fully implemented, the partnership creates resources from its new innovative products and system development activities creating funding for future projects. The academic-private sector partnership, shown in Figure 2, supports the free flow of ideas while capitalizing on the strengths of both partners.

### *Benefits*

Benefits will be derived by all participants in the E4 initiative including students, the University, the local community, and other educational institutions.

*Students.* The EET/TET students will benefit as few incentives are more motivational to an undergraduate student than the opportunity to participate in real-world activities, especially those

dealing with private enterprise. Becoming aware of the E4 process early in their educational career will add invaluable to the students' interest and participation in course work. E4 can create the vehicle necessary to educate and equip this motivated workforce of undergraduate student teams so they are not only able to apply the technical skills and knowledge they have learned, but to augment their education by engaging in the entrepreneurial process. It is conceivable some of these students will continue in masters level work while they assist NEWCO in commercializing the product/system their team developed. These same students could potentially form the technical nucleus for a local spin-off company.

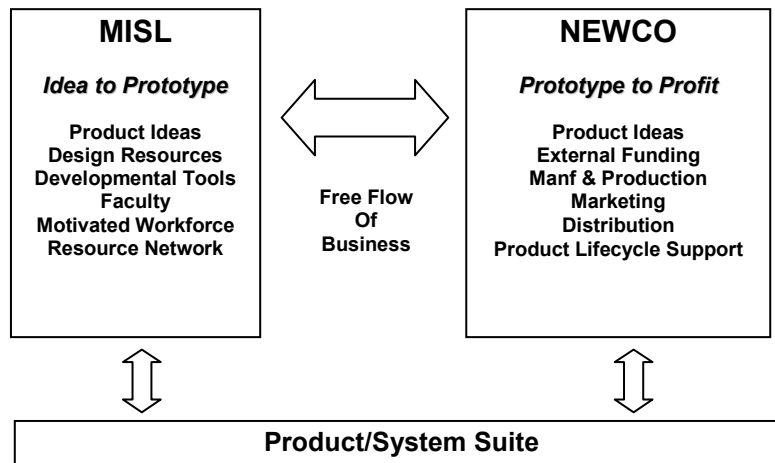


Figure 2. MISL and NEWCO interaction.

*The University.* The E4 initiative will create an innovative curriculum that can be recognized as a new approach in entrepreneurial education. In addition, E4 will become an excellent opportunity for professional development of the faculty who form the technological catalyst for innovation and design. As E4 becomes successful, revenue will be generated from intellectual property (IP) and products. A portion of this revenue stream will be used to sustain the initiative, acquire resources and support other university initiatives and functions. While faculty members throughout Texas A&M University develop IP and basic proof-of-concept systems, E4 will be an outlet for allowing University IP to go from ideas to prototypes and beyond. One of the goals of E4 is to help students develop their own businesses in the local area around the University, and hopefully result in a pool of successful alumni who remain near the campus.

*The State.* Yearly, Texas loses talented young men and women who graduate from the public universities and accept jobs across the nation. E4 provides a mechanism for retaining and attracting bright individuals who are likely to have long term, successful careers. Due to location and other factors, our university and its surrounding areas have traditionally been unable to capitalize on one of its most valued products, educated men and women who have the ability to create technology-based products, businesses and jobs. Through NEWCO and other spin-off companies, E4 can result in the economic growth of the surrounding region and the state.

*Other Institutions.* The establishment and operation of E4 will be documented through the presentation of papers at professional societies and technical conferences. As success is achieved within the EET/TET Programs, the plan will be to incorporate more disciplines within the College of Engineering and to solicit involvement and participation from the College of Business. The documentation of lessons learned and success of E4 will allow for the model to be replicated at other educational institutions.

Current Support

The underpinnings of E4 are in place within the EET/TET Programs. Through establishment of the MISL, projects have been identified and underwritten so the methodology and examples of the “idea to prototype” could be developed. These preliminary activities have identified the required resources (facilities, equipment, and processes) to conduct a successful prototype development project. Over 700 sq ft of applied research laboratory space has been earmarked by the EET/TET Programs for this initiative, including hardware and software development tools, test equipment, and prototyping support. Industry support has been identified and multiple companies have formed a joint venture – NEWCO – that will act as the industrial partner to MISL.

E4 Process

Of major importance is the ongoing interaction between MISL and NEWCO. With the interest in developing a long-term partnership between MISL and the private sector, the critical element of moving demonstrable prototypes to profitable products can now be undertaken by NEWCO. Figure 3 illustrates the development process that has been established through meetings between MISL and NEWCO.

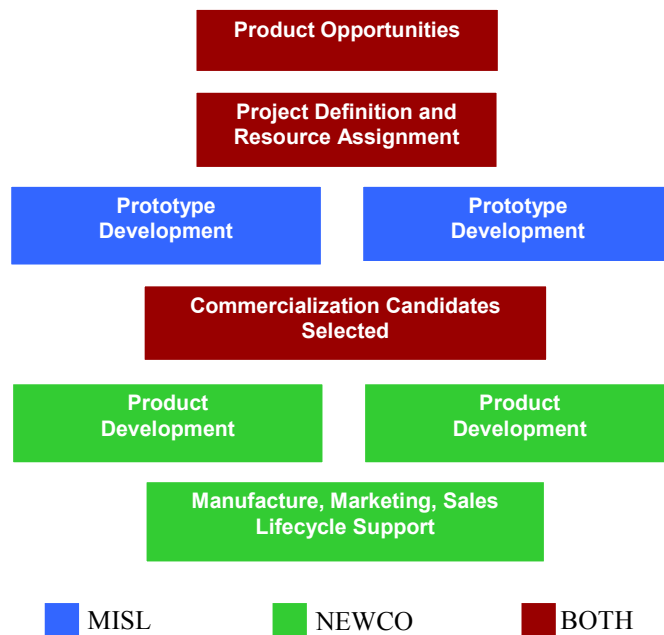


Figure 3. E4 developmental process.

The process will be initiated by a semi-annual meeting among representatives from MISL and NEWCO. During this meeting, suggestions for new products and systems will be presented by faculty, students, and industry. The goal is to establish a pool of product ideas. From this set of potential development projects, a series of problem statements will be generated. The problem statements, together with the necessary financial support, will be made available to EET/TET undergraduate students entering their senior year of classes.

In the Technical Project Management course, students will form teams, select projects, and secure technical advising that will be used in the planning of their project. Employing the principles and tools of project management, the teams will perform the tasks that lead to a Preliminary Design Review where a conceptual design, project scope, timeline, and budget will be presented and approved. In the following semester's course, Senior Project Design, the student teams will undertake the execution of the project which will result in a proof-of-concept prototype and marketing plan that will be presented in a Critical Design Review (CDR).

The CDR's will be attended by members of the MISL-NEWCO partnership. From those projects presented by the student teams, a judgment will be made as to which products/systems are ready for transfer to the private sector for commercialization, which projects require additional development, and which projects should be set aside. The goal is to establish a suite of viable products/systems that are ready for transfer to the private sector through the NEWCO partnership.

NEWCO will then take possession of the intellectual property that has been created by the faculty and students of the EET/TET Programs and develop the appropriate business plan to transfer the technology to the private sector. This process may result in NEWCO directly developing the project, NEWCO transferring the IP to another company, or the establishment of a spin-off company to facilitate the "productization" of the prototype. The underlying stimulus for this unique process is that faculty and students involved in the development of a product/system will share, as University inventors, in the sales and/or profits that are generated from its commercialization, further encouraging development and innovation. Through internships and student worker positions, these same students can become more involved in the entrepreneurial process. Students can also continue to be involved in the development process through graduate school and/or employment opportunities that arise from their efforts.

### **Initial Experiences with Intellectual Property**

As a first attempt at establishing a process for intellectual property, the faculty in MISL chose a completed senior design project to move to the private sector. This project, discussed previously, was CellLink. In this particular case, the idea for the project was developed by the faculty and a group of three senior project students was responsible for the development of the prototype. The students presented the prototype to members of NEWCO to determine their level of interest in commercializing the idea. NEWCO, in turn, made Texas A&M University an offer to purchase the prototype and "know-how." The "know-how" includes all written documentation on the development and implementation of the prototype. The offer included a lump sum payment and royalties on future product sales derived from the idea.



The offer is currently being considered by the University's Technology Licensing Office. If accepted, standard University policy will determine the split of income between the University and the inventors. From this initial attempt at selling intellectual property, two issues have been discovered. First, it is MISL's responsibility to determine the breakdown of participation for each inventor or "inventorship". The faculty members in MISL are currently trying to develop a rubric to determine if and at what level a person is an inventor. For this initial project, it has been decided to split inventorship equally among the two faculty and the three students who participated in the development of the prototype. Second, while the University has the legal right to represent the faculty in all intellectual property matters, undergraduate students have to elect to let the University represent them. In this current project, the students are being asked to grant permission so they can be represented.

### **Conclusion and Next Steps**

The establishment of the Engineering Entrepreneurship Educational Experience initiative with the Electronics and Telecommunications programs is well underway. The programs have established both the educational processes necessary to generate ideas and prototypes, as well as a laboratory with the resources necessary for the students to be successful. NEWCO has also been established and has a local presence near the University. Finally, an intellectual property test case is currently being negotiated to create a prototype contract between the University and NEWCO for future products.

Now that the basic building blocks for creating E4 have been put in place, several additional steps should be undertaken. These include:

- The Electronics and Telecommunications programs will work with the University's Technology Licensing Office to formalize a ceiling-based, multi-year IP agreement with NEWCO.
- The Electronics and Telecommunications will work within the College of Engineering and NEWCO to prepare a funding proposal to the NSF Partnerships For Innovation Program.
- NEWCO will build business plans to secure funding for product commercialization.

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