CREATING A VIRTUAL COMPANY AND KEEPING IT “IN THE BLACK”

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Abstract - The Wireless Communication Enterprise (WCE) is one of 17 “virtual companies” in Michigan Tech’s Enterprise Program, launched in the Fall of 2000. The WCE consists of about 70 second to fourth year students committed to developing their entrepreneurial and R&D contract experience – for credit – in wireless and photonics technologies. While the author is the faculty advisor for the WCE, the students run the company, create their own product development ideas, negotiate contracts, hire and fire “employees,” participate in profit sharing, and build very strong resumes before they graduate. The WCE business model is to create cash flow through R&D contracts with industry, and use the profits for internal product development initiatives. Ownership of the virtual company is very much in the hands of the students. This paper describes both the philosophical and practical aspects of the implementation and sustained growth of our virtual company.

BACKGROUND – MTU’S ENTERPRISE PROGRAM

The Engineering Enterprise Program was established in the Fall of 2000 and included the following objectives:

- Create an environment for students to facilitate the transition from their undergraduate program to the professional work force.
- Provide opportunities for students to develop leadership and entrepreneurial abilities.
- Give the students ownership of a portion of their academic program that connects strongly to career goals.
- Give the students a taste of the rewards and accountability associated with creating new products and working with paying clients.

There are currently 17 Enterprises at MTU which involve about 350 students. We expect these numbers to grow steadily for several years to come. Our students are mostly engineering majors, but include disciplines from across the campus, including business, computer science, scientific and technical communication, physics, engineering technology, forestry, and others. I created the Wireless Communication Enterprise (WCE) to enable students to explore applications in this technology that are growing rapidly in the global economy. Our 70+ students are engaged in a wide variety of product development and contractual R&D projects. In the last year we have expanded the WCE’s theme to include photonics, including optical communications and various optical and infrared sensor applications.

PHILOSOPHY OF OUR VIRTUAL COMPANY

MTU engineering graduates must complete either a 1-year Senior Design project or the Enterprise Program. Enterprise is voluntary and can be joined as early as the sophomore year, which enables a student to accumulate enough credits to fulfill a minor. The 17 Enterprises at MTU can be thought of as fairly autonomous virtual companies, under the “corporate umbrella” of the College of Engineering. The emphasis on entrepreneurship varies from company to company depending on the mission and the personalities of the faculty advisors and the students. The WCE was created with the objective of maximizing entrepreneurship and student ownership. In short, we won’t take on a project unless there is real potential for the students to see cash in their pockets.

How does Enterprise compare with Senior Design? At MTU we work hard on our Senior Design programs to provide engineering students with realistic company-sponsored projects and deliverables. We rely on both Senior Design and Enterprise for assessment of several ABET criteria. In both programs we must work to insure that students cannot avoid their responsibilities to participate in a major teaming and design experience. Although faculty oversight is higher on a week-to-week basis in Senior Design, the documentation requirements levied on the students are more extensive in Enterprise. In brief, we are usually able to discover the shirkers and encourage them back on to a productive path.

The Enterprise experience is intrinsically richer than Senior Design. Senior Design projects are typically defined before the teams form. In Enterprise, the faculty advisor acts as the “Board of Directors,” leaving operations in the hands of the student officers and project managers. The students determine the organizational structure of their “virtual company,” create their own product development ideas, and negotiate R&D contract opportunities with industry. On this last point, some of our projects are brought in by the faculty advisor, but student “profit sharing” is reduced in these cases. Profit shares increase when the students bring in the project.

The WCE business model is to create cash flow through R&D contracts with industry, and use the profits for internal product development initiatives. We typically charge a company $5000 for a 1-year R&D project. MTU has prepared standard simplified contract formats for industry-sponsored undergraduate projects. Half of the funds go to project expendables. Up to sixty percent of the balance is

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available to distribute as cash performance bonuses for the students, based on the company partner’s evaluation of the deliverables. Unused funds go into the WCE’s accounts to use for internal projects and for the continual upgrade of the WCE laboratory. This laboratory’s access is restricted by card swipe to WCE students.

The internal projects cover a variety of product ideas for wireless and photonics applications. In the Spring of 2003 we successfully completed 5 R&D contracts and made substantial progress on 7 product development activities. Some of the R&D work will be described later. The product concepts are proprietary, of course, but include devices for use in outdoor sports and to make life easier in the snow-bound north country (up here in Michigan’s Upper Peninsula).

WCE’S LEARNING MODEL

Students who do not choose Enterprise will complete Senior Design in their last 2 semesters. Theoretically, seniors have accumulated sufficient skills through their coursework to enable them to tackle challenging research and design problems. In practice, our seniors discover that they are fortunate if the technical problems they run into have been dealt with in their core courses. In Enterprise our 2nd and 3rd year students are tackling comparable problems while they are in the beginning or the midst of their core engineering courses. Their learning must be on a just-in-time model. They quickly learn to consult with the more experienced students on their teams, and get to know which faculty members have expertise in relevant areas. Additionally, they rapidly develop their web and library research skills.

We have found it advantageous to establish an internal library of texts, journals, and magazines. We have built the library through purchases funded by profits and from the “castoffs” from our faculty, who regularly receive books from hopeful publishers. A number of quite relevant trade journals are available free of charge, including *Microwave Journal*, *Photonics Spectra*, *Laser Focus*, *Applied Microwave & Wireless*, and *Microwaves & RF*.

Because of just-in-time learning, our WCE students explore many subdisciplines before running into them in their coursework. Our faculty report that Enterprise students ask many questions and generally are more engaged in course material that they have experienced already in product development activities. Most importantly, the students are using the learning model they will employ in professional life. For example, when a project engineer has to pick up a skill quickly, she doesn’t normally ask her supervisor to send her off to take a course.

Since the WCE is a fairly sizable company, there are a number of management positions that must be filled and a number of special duties that must be executed. (Details later.) Nevertheless, our policy is that every individual must have substantial “hands-on” product or R&D responsibilities – with one exception. The WCE President is permitted to work leadership issues full time. Typically the President is a senior who has worked up the ladder for the previous two or three years. “Hands-on” means engineering design, fab, or test for engineering majors, software or computer system design for computer science majors, market research or business development for business majors, etc. Many of our engineering students are heavily involved in the marketing side of their product development work, but we require that engineering students have substantial engineering responsibilities within the WCE.

DOCUMENTATION AND GRADING

There is no grading “curve” in WCE. If teams work hard and document thoroughly, they receive an “A.” Since this is only a virtual company, jobs are not at risk, and technical risks can be taken without a grade suffering.

We strive to achieve a “semi-professional” standard of documentation. Namely, our project teams take documentation very seriously, but given the part-time nature of Enterprise (it’s just one of several courses taken in any term), it would be counterproductive to attempt industry practices.

Project teams typically consist of 4 to 10 people. A key position on each team is Documentation Chief. This person coordinates the documentation efforts of each team – while taking pains to avoid doing all the work himself, given that he also has substantial engineering responsibilities. Each team must compile a binder each semester that documents background research, sketches, designs, calculations, analysis, vendor quotes, and anything substantive associated with the team’s work that semester. An engineering notebook is maintained with pages dated and signed that relate to potential intellectual property. A final report each semester summarizes the work including contributions to intellectual property or recommended profit sharing – by name. The intent is that if a royalty stream begins several years downstream, we can trace contributions back to insure that the right people get their checks. We therefore encourage our alumni to stay in touch in case we owe them residuals. We have already had the pleasure of sending profit sharing checks to several alumni who were on the ground floor of our first engineering services contract.

The semester’s documentation serves as the basis for each team’s grade, determined by the faculty advisor. The author’s philosophy is “if it isn’t documented, it didn’t happen and it doesn’t exist.” Our current WCE students have experienced the value of good documentation from projects completed in previous years. Also, they have noticed that no information survives from a previous project except what is found in the team binder.

With rare exceptions, an individual will not receive a grade higher than the team grade. But individual grades can be lower. Each WCE student receives at least 3 performance evaluations, using a standard form which includes a
recommended letter grade, with text to support the recommendation. The three evals are (1) a self-eval, (2) a peer eval from another team member, and (3) an eval from the Project Manager. The faculty advisor is the sole recipient of the evals and awards individual semester grades accordingly. The principle is that a team member can hide from the faculty, but not from his peers. The Project Manager evaluation is weighted most heavily. In the event of a serious discrepancy among the three evals, the advisor will seek additional information, but this is rarely required. Although self-evals are occasionally inflated, I have had only 2 grades protested (informally in my office) over the last three years, with many hundreds of grades awarded. Interestingly, there are always a number of students who are far harder on themselves than they should be. I feel free in such cases to disregard their low recommendations.

It has been advantageous in the last year to add a midterm eval conducted by each PM for the team members. The faculty advisor does not see the results of this eval, unless the student officers identify "problem employees," defined as those on track to earn less than a “B.” If a team member is not performing well, the midterm eval enables correction or an opportunity to drop the course without a grade at that point.

**COMPANY STRUCTURE AND MANAGEMENT ISSUES**

WCE’s current officers are President, VP – Operations, VP – Finance, VP – Technology, and VP – Intellectual Property. As in many companies, the President and VP – Operations back each other up on most functions. Most officer functions are obvious, so I’ll just mention some non-obvious aspects. VP – Technology is responsible for all the computer and network systems, plus requirements for and calibration of lab instrumentation. VP – Intellectual Property was established to insure common formats for documentation and to serve as a focal point for working the MTU process associated with patent disclosures.

Each of the twelve project teams is led by a Project Manager, along with a Deputy PM who serves as the Management Representative to special meetings called by the officers. The officers meet weekly. Additionally, each team has a Documentation Chief, as described above. Three of our product development projects have considerable technical overlap currently, so it was convenient to appoint a Division Chief over those three projects. The Division Chief, like everyone else, also serves as a project engineer on one of the projects.

A major challenge for the PMs and the officers is to foster communication among the teams. Many projects face common challenges, and our seniors can often identify a solution from a project one or two years before that the sophomores and juniors are unaware of. Thus some modest corporate memory has developed. On the other hand, one of our teams was recently embarrassed by discovering that they had spent two weeks on a filter design that was essentially identical to one done by another team a few weeks before that. We use a weekly company meeting – the regularly scheduled class time – for teams to provide technical and status updates to foster communication and help across the company. Beyond the company meeting, it’s up to project teams to schedule and execute their activities. Students account for their time on a weekly basis. The minimum time required is three hours per week per credit. Seniors enroll for two credits; sophomores and juniors for one.

The academic year’s major event is the Undergraduate Research Exposition in late Spring, which includes poster sessions and formal presentations for Enterprises, Senior Design projects, and other undergraduate research activities across the campus. We invite local media and all of our corporate sponsors for this event. Cash prizes are awarded to outstanding entries in several categories. Preparation for the Expo is a top priority for the WCE officers.

In early Fall term, the Enterprises do a special poster session in conjunction with the MTU Career Fair, which brings many companies to campus to hire our graduates. Additionally, there are many ad hoc presentations to visitors coming through the campus, particularly when there is an opportunity to solicit sponsorship for the Enterprise Program or for a particular R&D project. Our students learn to be responsive and can do ad hoc presentations on very short notice.

**INDUSTRY-SPONSORED R&D PROJECTS**

Our sponsored projects in WCE differ from projects sponsored for Senior Design in significant ways. We look for projects that fit the wireless/photonics theme, of course. More importantly, we look for projects with multi-year potential. A Senior Design project is born, develops, and dies all within a tight academic year. A follow-on project the next year necessarily employs an entirely new team. In the WCE, since students return from year to year, projects can enjoy larger scope and multiple phases, without suffering as much in the low-slope portion of the learning curve. This benefits our sponsors, of course. Also, we have the liberty to begin a project in almost any part of the academic year, and finishing it at any time. When a project terminates, our company is large enough so that we can reassign members to other teams.

Our first Engineering Services contract originated when some of our students discovered that MTU was about to solicit bids from engineering firms to establish a digital wireless link to a remote site. Our students formed a proposal team which was careful to substantially underbid any competitor, won the contract, and performed the work successfully. The bid included engineering labor hours, which resulted in cash in the students’ pockets. The work entailed considerable system engineering, testing of freshly state-of-the-art hardware, installation, and checkout. The
system is still operating contentedly long after the project’s completion.

During the 2002-2003 academic year we delivered on 5 R&D projects. For Rockwell Collins, a team designed and built a robotic 3-D measurement and data acquisition system to analyze multipath communication effects inside commercial aircraft. A second Rockwell Collins project team built a detailed simulation of a mobile satellite communications system. For IR Telemetrics, we developed a new technique which will serve as the basis of the next generation of telemetry transponders to extract operational data from the inside of working automotive engines. For Keweenaw Research Center, a team developed a TV-based control system for the operator of the Streamsweper, a small barge designed to suction sand from stream beds that have deteriorated – in order to bring the streams back to life. Under a grant provided by SBC Ameritech, our largest project this year, we developed a new workshop for MTU’s Summer Youth Program to bring high school students and teachers to campus for an intense short course in wireless and photonics technology. This project’s deliverables include curriculum and lab kits to return with the teachers for use in their science courses. Additionally, we hope to develop these kits for sale in educational and hobbyist markets.

**ORIGINAL PRODUCT DEVELOPMENT PROJECTS**

The challenge in original product development is to identify a niche that will be open for at least two years following the launch of a project. The students are working part time on the projects and are still engineers-in-training. Therefore, even a sharp, well-motivated team is likely two years away from a successful prototype and a patent application. Because of the two year window, we look for applications of existing technology that are off the main path of commercial electronics companies. Namely, any simple extension of technologies or applications already on the market is likely to be captured by our industrial competitors long before we can get to market. In fact, we have had three product development activities terminated several months after start, because competitors announced new products that were very close to our design concepts. Despite the disappointment, there was some encouragement in this, because it indicated that our entrepreneurs were thinking the same thoughts as the “pros.”

Any product development launch necessarily entails considerable market analysis and patent searching. The motivation is high in this phase because of the danger of performing months of design work on a concept already taken. Additionally, we are developing a security consciousness, wherein students are admonished to keep proprietary information inside the company. Our students sign a Proprietary Rights Agreement Form that we have negotiated with MTU that delineates individual responsibilities and principles for sharing royalties among the students and the university.

An interesting case developed last year in which it became clear that one of the product concepts was being discussed outside the company. Because of this, a creative student who wanted to launch a new product team asked if he could keep the new concept covert within the company. We agreed that only his team, the 5 officers, and the faculty advisor would be privy to the details. Therefore, when his team gave status updates at company meetings, the briefings were “sanitized” – appropriate details were left out. More detailed presentations were given to the advisor and the officers. This approach seemed to work effectively.

**INITIAL CAREER BENEFITS FOR STUDENTS**

Although we do not have statistical data, we have considerable anecdotal evidence that our Enterprise graduates enjoy an edge in interviewing for their first jobs. Employers rave about the experience of our students documented on their resumes, plus the real-world engineering stories conveyed during interviews. In fact, the MTU Engineering Enterprise Program was motivated in part by discussion with our industrial advisory boards that encouraged us to bring more real-world experiences into the curriculum.

Just a couple of anecdotes: A recent graduate who held the WCE President’s job was hired by an aerospace firm into a fast-track system engineering position, leapfrogging other entry level hires by several years, specifically because of his WCE experience. Another graduate who served as a PM for a large product team was the lone hire by a defense firm that brought in 17 candidates to its plant, including two MS graduates from major universities.

**CONCLUSIONS AND PROGNOSIS**

Advising the WCE is extremely rewarding as a teaching experience. Within the university, we are still sorting out how Enterprise advising fits into a faculty success model. Advising demands irregular chunks of time, but the integrated average over an academic year should not be excessive. If it is excessive, the advisor is likely violating the principle of student ownership. My Enterprise is two to three times larger than most of those at MTU, but that is my personal choice. A larger company allows more diversity in projects and a wider variety of leadership challenges for the students. My career experience in program management before I came to MTU helps me to find efficiencies in advising a large Enterprise.

The WCE professional culture grows each year, as a new crop of leaders builds on the foundation of their predecessors. The long term goals include spinning off businesses into the local community. The first big step, of course, is to work through the patent, licensing, and royalties process for several current products under development.
We anticipate that the Enterprise Program will grow on campus, creating additional virtual companies and attracting more students. We deliberately want to keep Enterprise as a voluntary academic option, with Senior Design as the default. The Enterprise culture and productivity would only suffer if we pushed every student into the program. Frankly, some students are not ready for the initiative required in a major team project until their senior year.

The key limiting growth factor is finding faculty advisors, which connects back to the faculty success model. For this author, I can’t imagine a better reason to be at a university.