

Building Startup Businesses through Commercializing Student Capstone Project Outcomes

James R. Baker and Robert E. Mark, Michigan Technological University
Jonathan Leinonen, MTEC SmartZone

Abstract

Michigan Technological University, in collaboration with MTEC SmartZone, has developed a program for targeted development of student-led startup companies based on outcomes of engineering capstone design projects. Under the program, called SmartTrac, student teams that include members with a cross-section of business, engineering, and communications skills form companies who conduct the necessary business and technical development activities to commercialize capstone project outcomes. In addition to basic underwriting funding for student stipends, the partners work together to find grant and investment capital from various sources.

This paper presents the SmartTrac model and experiences to date in commercializing a hospital mattress that substantially improves the effectiveness of CPR. The technology was developed in a capstone project and is being commercialized by a student-led company, CPRM Inc., which has attracted nearly \$200,000 in funding to date from various sources to bring the product to the market.

Background of Participating Partners

Michigan Technological University (Michigan Tech) is a growing research university with a strong historical foundation in engineering, technology, innovation, and natural resources. Founded as the Michigan Mining School in 1885 to satisfy the need for trained mining engineers who extracted copper from the region, Michigan Tech has maintained a strong ethic of leveraging its physical and intellectual resources for the benefit of private industry. This principle is even reflected in its governing policies and founding legislation (State of Michigan 1885), which includes statements that the institution shall provide the inhabitants of the state with the means of acquiring a thorough knowledge of the application of science to industry and shall seek to promote the welfare of the industries of the state.

MTEC SmartZone is one of thirteen state-wide SmartZones operating under a program created by the Michigan legislature in the late 1990s. The purpose of SmartZones is to harness technology-centered, community-based resources for entrepreneurs and small businesses in order to diversify Michigan's

economy. SmartZones were established through a competitive application and selection process that authorized community-based awardees to receive initial startup capital and limited annual tax capture through municipal Local Development Finance Authorities. MTEC SmartZone was created through the concerted efforts of Michigan Tech, the neighboring cities of Houghton and Hancock, and a regional economic development organization, the Keweenaw Economic Development Alliance (KEDA). MTEC SmartZone operates four incubator facilities, housing tenants including startup technology companies as well as research and development centers for globally established firms. MTEC SmartZone also provides programs and services for business startup, growth, and attraction, targeting technology based-companies, and maintains a network of service provider specialists in fields including accounting, business law, securities, information technology, and other fields.

The Center for Technological Leadership, Innovation, and Entrepreneurship (CenTILE) is an endowed interdisciplinary program housed within the School of Business and Economics at Michigan Tech. CenTILE is the cornerstone innovation and entrepreneurship support organization at Michigan Tech; its purpose is to foster technological innovation by implementing programs that develop entrepreneurial thinking and drive action across university ranks and disciplines in coordination with complementary programs and organizations on campus and in the community in order to create economic value and meet societal needs. In addition to sponsoring and implementing numerous university-based programs, including the Entrepreneurs and Inventors Club and annual elevator pitch and business plan competitions, CenTILE provides direct business planning and development support for both student entrepreneurs and regional businesses and entrepreneurs external to the university. This support is provided in collaboration with community and university-based partners including MTEC SmartZone, KEDA, and the Michigan Tech office of Technology and Economic Development (TED). The efforts of CenTILE and its partners have resulted in the establishment, growth, and success of a number of regional companies and advancement of a growing culture of innovation and entrepreneurship on campus.

The office of Technology and Economic Development (TED) is primarily responsible for technology transfer and intellectual property licensing at Michigan Tech but embraces the much broader mission of promoting and enabling innovation and discovery at the local, regional, national, and international levels. TED actively supports innovators and the emerging regional innovation economy through direct business development and commercialization planning assistance to university-originated startup technology companies as well as community based innovators and entrepreneurs in close collaboration with MTEC SmartZone, CenTILE, KEDA, and others including the state-wide Michigan Small Business and Technology Development Center (MISBTDC)

MTEC SmartZone, CenTILE, and TED regularly partner on university and community initiatives that leverage their respective expertise and infrastructure to advance their mutual interests and the regional innovation economy. Their collaboration in the establishment and implementation of the SmartTrac program as described in this paper is an example of one such partnership initiative that has been successfully piloted and is directed toward the development of regional technology startup companies based on outputs of capstone student projects.

Commercialization Opportunities from Capstone Design and Enterprise Program Outcomes

In order to provide a culminating opportunity for students to apply the skills they have developed during their education, many undergraduate disciplines include a capstone project experience. In the case of engineering disciplines, institutions commonly require capstone projects in order to satisfy ABET's requirements for a culminating major design experience (ABET 2009; Howe and Wilbarger 2006). At Michigan Tech, a student's capstone experience is achieved either through a year-long departmental senior design project or through participation in the more robust Enterprise Program as described at <http://www.enterprise.mtu.edu/> and in Baker et al. (2007).

Enterprise teams are most accurately described as organizations or "virtual companies" composed of various functional and technical teams. These organizations may consist of students from Arts & Sciences, Business, Engineering, Forestry, and Technology, and range in size from 10-80 students. In these enterprises, a leadership team (i.e., President and Vice President positions) and one or more project sub-teams (i.e., Project Manager and associated team member roles) is a typical organization structure. While capstone projects are generally limited to a single academic year or semester, enterprises continue as operating entities, with students typically entering in their sophomore year and participating through graduation. While graduation timelines impact attrition rates, enterprises are not subject to the annual startup and shutdown cycles experienced in fixed-term capstone projects. Each year, the enterprise recruits new members to keep staffing at the necessary level to maintain a functional organization based on business opportunities available, much like a real-world business.

Capstone project teams and enterprises both create technology innovations that present commercial opportunities. As key evidence of this fact, the proportion of invention disclosures at Michigan Tech that involve undergraduate student inventors has ranged from 20% to more than 30% for most years since formal establishment of both programs over ten years ago. However, commercialization of the inventions described in these disclosures through establishment of student-led startup business is an opportunity for which the potential has not yet been fully realized, due to a number of practical challenges facing interested student entrepreneurs.

Commercialization Challenges for Capstone and Enterprise Project Outcomes

Intellectual property ownership for technologies from capstone and enterprise projects is determined by the contract terms for sponsored projects and the extent of facilities use for non-sponsored projects. Companies sponsoring projects may elect to be able to take ownership of or elect license rights to results of their sponsored projects as described in a previous work (Baker et al. 2007). Projects sponsored under such arrangements have resulted in commercially implemented technologies, but do not offer entrepreneurial opportunities for the participating students. The majority of capstone and enterprise projects have the potential to generate technologies and intellectual products that are not contractually encumbered and present potential business opportunities for the students that, to date, have not been fully realized. Factors contributing to this include:

- Even in times of slow economic growth, graduating students often receive multiple offers for employment with established companies in their field of interest. When faced with the risk of starting a new company with limited experience versus developing business and technical experience through their prospective employer that can be applied to entrepreneurial interests later in their career, most students wisely choose the lower risk option of traditional employment.
- Capstone projects produce proof-of-concept level prototypes that invariably require additional product development and refinement that the academic year time frame does not allow.

- Enterprises do not have the academic year constraints that present challenges for capstone project outcomes, but have limited product development resources and as student-run organizations lack experience with the final stages of product commercialization including manufacturing, production, distribution, sales, and marketing.

SmartTrac Program Overview

In response to these challenges, MTEC SmartZone, CenTILE, and TED collaborated on the development of the SmartTrac program, which is designed to bridge the gap from a point that a capstone or enterprise project creates a potentially viable commercial product through to the establishment of a fully functioning company that can execute and follow through on the commercial opportunity. Under SmartTrac, a team of students is recruited to review outcomes from existing and prior capstone and enterprise projects and select candidate opportunities for commercialization based on technical maturity and market potential. After selecting what it believes to be the most commercially viable project outcomes, the SmartTrac team constructs and implements a detailed assessment of technical and business feasibility. If, upon further review, the opportunity appears to have a reasonable prospect for ultimate commercial success, the team proceeds to develop and ultimately implement detailed product development and commercialization plans and initiates marketing efforts directed toward achieving product sales and intellectual property licensing opportunities.

Through an application and interview process, students are carefully selected for participation in the program, based on experience and entrepreneurial interest. The team is paid a salary, provided with suitable office and laboratory space in the SmartZone incubator, and receives regular guidance from a team of mentors. Under the SmartTrac program, students agree to work a minimum of 10-20 hours per week during the semester under supervision from personnel within MTEC SmartZone, CenTILE, and TED as they develop and execute plans to accomplish the milestones that are necessary to bring their commercial enterprise to fruition.

Under the program, organizational collaboration across university departments and with the MTEC SmartZone results in the availability of a network of complementary resources to students interested in pursuing startup businesses. The ability to demonstrate collaboration across public and private sectors has been crucial to such activities as acting on grant and other funding opportunities that have enabled university technology to use professional business guidance to help develop a viable spin-out a company.

The three primary means of support include:

- MTEC SmartZone – Provides lab workspace for the startup company to complete its prototype development, as well as office space with desks and office equipment including a computer, telephone, printers, and internet access. MTEC SmartZone also provides team coaching and supervision through the initial phase of company organization, including assistance with its business plan and company formation procedures.
- CenTILE – Provides assistance with strategic market analysis and planning and conducting product demonstrations with hospitals and mattress manufacturers, as well as identifying potential investors and assisting in the preparation of securities documents for attracting investors.
- TED – Provides lab and office workspace in an on-campus incubator, secures and provides funding from internal, state, and federal sources, supports detailed commercialization planning, and coordinates patent filing and licensing agreements activity.

By facilitating the strategic integration and deployment of these support resources and others, SmartTrac has become a foundational program supporting commercialization of capstone and enterprise program outcomes. The program provides an umbrella for combining funding, technical opportunities, and business counseling services that is designed and managed by MTEC SmartZone and Michigan Tech. The program also helps maintain momentum by providing students with income comparable to a part-time job and therefore enables them to concentrate on establishing their business as entrepreneurs, while still providing them with a source of funds to cover some of their expenses. In addition to financial support of the program from the university, funding for the program has been provided through grants from the Michigan Universities Commercialization Initiative, Michigan Initiative for Innovation and Entrepreneurship, and the National Science Foundation.

Complementary Student Entrepreneurship Enabling Programs

In addition to the direct implementation and support of the SmartTrac program, related efforts that have advanced student entrepreneurship broadly, including efforts to commercialize capstone and enterprise project outcomes, include:

- An annual Elevator Pitch Competition, which provides students an opportunity to present their business idea and hear how others present their ideas. Cash prizes awarded in this competition provide incentives for students to step forward and begin to promote their business concept.
- CenTILE has hosted the Extreme Entrepreneurship Tour (www.extremetour.org/), a high energy event directed toward inspiring students to consider entrepreneurial career paths and providing specific examples of success stories to learn from and emulate.
- The campus Entrepreneurs and Inventors Club meets regularly to provide a networking and mentoring opportunity for students and community members interested in entrepreneurship and innovation. Establishment of the club has provided a regular forum for entrepreneurs and inventors to share experiences, learn from each other, and engage in formal training and mentoring with established and successful entrepreneurs.
- TED, MTEC SmartZone, and CenTILE regularly offer IP and Commercialization Seminars, including various classroom seminars, evening events, and a comprehensive thirty-hour Kauffman FastTrack TechVenture series focused on writing a business plan and creating an investor presentation and elevator pitch. Activities range in length from one-hour events to semester-long courses and are offered on subjects including market research, business to business pricing, budgeting and forecasting, intellectual property, and leadership.

Pilot SmartTrac Commercialization Project – Tech Initiatives and CPRM Inc.

A pilot SmartTrac project was initiated in the summer of 2007 with a team of two business students, two engineering students, and one technical communication student. After being selected to participate in the pilot, the first class of team members conducted an analysis of all capstone and enterprise project outcomes from the current academic year. The team's analysis was directed toward identifying projects and products that presented actionable, near-term market opportunities that the team could rigorously assess for technical feasibility and market potential. Pending a positive assessment and selection of an appropriate project, the team then focused on the development and implementation of a detailed commercialization strategy.

The first project the team selected for commercialization was a hospital mattress designed to facilitate the delivery of cardiopulmonary resuscitation (CPR) to patients. A prototype of the technology was developed by a student design team in the Department of Biomedical Engineering in collaboration with Portage Health, a local inpatient hospital (Delvaux et al. 2009). A number of studies have identified depth

of chest compression as a critical variable in the effective delivery of CPR (Bellamy et. al 1984; Ornato et. al 1989). When delivering CPR to a patient on a hospital mattress, however, a considerable portion of the compressive energy intended to be delivered to the chest is instead used to compress the mattress on which the patient lies. To address this challenge, the biomedical engineering capstone team developed a technological solution involving a sealed air chamber surrounding the mattress foam connected to an off-the-shelf vacuum pump. When a patient goes into cardiac arrest, the action of the pump withdraws air from the chamber, thereby compressing foam, which stiffens the mattress and provides a rigid surface for the delivery of CPR.

The pilot SmartTrac team continued prototype development based on the capstone team's prototype design and performed subsequent performance testing and market research. As a result, the SmartTrac team, in consultation with its advisors, concluded that the mattress offered potential commercial merit that warranted further effort in the development and implementation of a formal commercialization strategy.

A grant from the National Science Foundation and funding from TED's internal budget provided an initial funding pool to compensate the team as it pursued the ensuing businesses opportunity. Michigan Tech partnered with MTEC SmartZone to supervise the student team as it defined and proceeded with the remaining commercialization activities, including development of a business plan, defining a budget, seeking additional sources of funding, conducting marketing research, developing a commercially viable prototype and detailed plans for manufacturing, sales, marketing, distribution, capitalization through stock-equity investments, and company legal structure. Through these activities, a new company, Tech Initiatives, Inc., was formed with the students as founding members and principals. The company was to be a pipeline for the commercialization of student-developed innovations, whether from capstone or enterprise projects or from other sources. The business model was to create subsidiary organizations for the commercialization of specific products, and the first such subsidiary was CPRM, Inc., directed toward commercial implementation of the CPR Mattress technology.

The company founders were able to collectively address many aspects of the project including refinement of the design, marketing, and business planning and communications with branding and website (<http://www.cpr mattress.com/>) and collateral development. The company utilized additional student capstone project teams at the university to conduct further analysis and development of particular components of the mattress, including design of the electrical systems and manufacturability of the air bladder. The collective changes were incorporated into a revised prototype that the company then demonstrated to hospitals, mattress manufacturers, and investors. As it progressed, the team encountered additional challenges where the resources of CenTILE, TED, and MTEC SmartZone were of critical use. These challenges included numerous detail issues, including starting the process for issuing securities and identification of regulatory consultants that could assist with Premarket Notification 5(10k) preparation for the Food and Drug Administration and compliance with Underwriters Laboratories' specifications for hospital equipment.

CPR Commercialization Status

Turnover is a predictable difficulty in student-run companies. The five student founders of Tech Initiatives have all proceeded to take employment with other companies, with their positions on the SmartTrac team filled with a follow-up team. This second team was hired in 2008 and currently has one remaining team member who is continuing to work toward the milestones of the company's development. Seeing that these transitions were eminent, the first student team took steps to ensure that institutional knowledge would be retained through the staffing replacements. This was facilitated by use of an online collaboration tool that enabled all messages among the team members to be stored in a permanent repository for future team members to review and understand the process followed to establish the company's

strategic direction, as well as for the background analysis to resolve specific technical questions and contact information for collaborating organizations. Additionally, the founding team took on the task of documenting the company's business development trajectory in a comprehensive business plan that the team has updated continuously as new issues and challenges drive adjustments to the plan. Each round of team members was also accountable to a supervisor who served as a business advisor and who provided continuity of institutional knowledge important for retracing the progression of technical as well as business developments from the program's and the company's inception.

In order to accomplish the milestones that were identified by the company in its marketing and business development strategy, the company is preparing to issue a Private Placement Memorandum. Informal attraction by investors to the CPR Mattress has been encouraging, although the company has found that the procedures to actually accept investments to be a complex and rigorous process. The guidance and support of its corporate securities consultant has been invaluable toward completing the documents to be filed with the United States Securities and Exchange Commission, which are currently undergoing final review.

As mentioned earlier, student turnover is inevitable and must be planned for. Originally the authors looked for students who were finishing their junior year, hoping to have them during the summer between the junior and senior year and the summer following graduation. This plan failed, as students received job offers and wanted to start their new jobs immediately following graduation. The second group recruited to the program was finishing their sophomore years, and therefore were in the program for two summers and during two academic years. Even with a two-year window, it is important to find products that can reach the marketplace within a short time frame so that the students will have some viable income opportunities and perhaps be less likely to be lured away by traditional employment opportunities as graduation nears.

Future of the Program

As described earlier, Tech Initiatives Inc. was set up to be a holding company. As new business ideas are pursued, they would become separate companies under Tech Initiatives so that the new students working on them would have the chance for ownership in each individual product company. Tech Initiatives would hold an equity position in each of the new companies started. This would give both the new students and the experienced students with Tech Initiatives the incentive to make the new product successful. In addition, continuity through the parent/subsidiary relationship should be helpful in addressing turnover of students and help in flattening the continually resetting learning curve.

As an additional pilot in the retail/hospitality space, plans are underway to acquire a coffee shop to provide similar experiences to those realized by the Tech Initiatives and CPRM Inc. founders. The Java Shop is an existing coffee shop located in a retail/restaurant plaza at the edge of the Michigan Tech campus. The coffee shop has been in operation for three years and, due to the illness of the owner, it recently came on the market. CenTILE is purchasing it to be a student-run company. This will in effect become a living laboratory for the School of Business. A marketing class could design a new marketing campaign and the students can track its effect on sales seven days, fourteen days, thirty days after implementation, make adjustments and monitor in real time their impact. Profits will be used to provide scholarships to students who contribute to the operation.

Conclusion

Through the creation of student startup during its first pilot, the SmartTrac program has produced preliminary indications that it is a viable and constructive mechanism for establishing student-led companies. Planning for initiation of future teams is underway to replicate the experience and to continue

to develop experience with the model. Lessons learned in the pilot that will direct future implementation efforts include:

- It is important to start working with student teams as early in the academic career as possible in order to provide as much runway as possible for the startup to get off the ground and for the founders to be trained before they begin to be faced with competing job offers from traditional employment avenues.
- Particularly with commercialization projects, it is critically important to focus on opportunities that are as close to the market as possible and carefully assess any potential hurdles or barriers such as regulatory issues and distribution and purchasing dynamics of the target industry sector.
- Focus on opportunities that have actionable goals and relatively short-term measurable milestones so that there is minimal down-time between noticeable events, marking progress of the development of the company in order to maintain momentum of students who have many competing personal, professional, and academic priorities.

References

- ABET. 2009. Criteria for accrediting engineering programs. Engineering Accreditation Commission, Accreditation Board for Engineering and Technology. <http://www.abet.org>.
- Baker, J., M. Raber, and R. Berkey. 2007. Welcome to the “real world”: Balancing practical, legal, and educational issues in implementing industrial sponsored student design experiences. In Proceedings, American Society for Engineering Education Annual Conference.
- Bellamy R. F., L. R. DeGuzman, and D. C. Pedersen. 1984. Coronary blood flow during cardiopulmonary resuscitation in swine. *Circulation* 69:174–180.
- Delvaux, A. B., M. T. Trombley, C. J. Rivet, J. J. Dykla, D. Jensen, M. R. Smith, and R. J. Gilbert. 2009. Design and development of a cardiopulmonary resuscitation mattress. *Journal of Intensive Care Medicine* 24(3): 195-199.
- Howe, Susannah, and Jessica Wilbarger. 2006. 2005 National survey of engineering capstone design courses. In Proceedings, American Society of Engineering Education Annual Conference.
- McKenzie, L., M. Trevisan, D. Davis, and S. Beyerlein. Capstone design courses and assessment of ABET EC 2000: A national survey. Washington State University Transferable Integrated Design Engineering Education Program. <http://www.tidee.wsu.edu/publications/>.
- Ornato J. P., R. L. Levine, D. S. Young, E. M. Racht, A. R. Garnett, and E. R. Gonzalez. 1989. The effect of applied chest compression force on systemic arterial pressure and end-tidal carbon dioxide concentration during CPR in human beings. *Ann Emerg Med* 18: 732–737.
- State of Michigan. Michigan Public Act 70 of 1885. <http://www.admin.mtu.edu/admin/boc/EnablingLegislature.pdf>.