

Incorporating entrepreneurship into the capstone design project: An across-college approach to product definition and design

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In the 2013 fall semester, the Wichita State University (WSU) Electrical Engineering and Computer Science (EECS) Department's capstone design course was co-taught with the Entrepreneurship (ENTR) program's capstone course, New Venture Development. This combined class facilitated the creation of multidisciplinary teams, where teams of EECS students and ENTR students co-created a novel product aimed at satisfying a particular consumer need. After 11 unique product ideas were identified, engineering student team members labored to create a workable prototype for their product while entrepreneurship student team members validated the product idea with customers and industry experts and developed a viable business model and plan for the new product. The experience from this class revealed that product feasibility emerges over time and that tough decisions need to be made around product selection and team composition in order to maximize the potential of the product development process.

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Introduction

Higher education is under increased scrutiny as much of the public perceives that many university graduates lack real-world experiences and skills that adequately prepare them for their first industrial job and that universities are becoming more of a public resource liability than asset. In response to the first perception, ABET, an agency which accredits technology related programs, requires engineering programs to have multidisciplinary team oriented projects that incorporate realistic constraints and engineering standards in the curriculum. In response to the second perception, many university faculty and administrators are committing themselves to do more than preparing the workforce for industry jobs – but also to be instrumental helping create the jobs.

To help fulfill the need to have realistic capstone design experiences, several university programs are taking advantage of industrial partners, in which

projects are constructed to serve a particular industrial need¹, and multidisciplinary teams are formed to solve that need². Here, with the desire to have realistic capstone experience and at the same time create new businesses, the authors tried a new experiment in capstone design – an across-college collaborative approach that focuses on entrepreneurship and business development.

In this paper, we describe an experiment with two capstone courses at Wichita State University (WSU), one in engineering and one in entrepreneurship, in which we form teams comprising of ENTR (entrepreneurship) and EECS (electrical engineering and computer science) students to develop a product that meets an actual customer need and a corresponding business plan that will lead to the creation of a new venture. Thus, the project will be real-world in nature as it solves a customer need with realistic constraints and engineering standards, and has the potential to create businesses and job growth.

Previous attempts to incorporate entrepreneurship into the EECS capstone course and to incorporate product development into the entrepreneurship capstone course were done with little collaboration between colleges. Although the EECS courses were realistic in nature, the projects were often not in a position to be commercialized because the project teams lacked the business expertise to bring the product to market or the assessment expertise to verify that a customer need was being met. Relatedly, students in the ENTR major capstone course were developing business plans focused on technical products that solved customer problems, but they did not have the technical capability to actually develop the product. From these observations, initial attempts were made to facilitate collaboration among ENTR and senior design EECS students. There were a few successful teams formed from this effort but since the classes were taught at different times most attempts for collaboration were unsuccessful. Thus to achieve the promise of this multi-disciplinary collaboration, in the fall of 2013 the course schedule was rearranged so that these two class would meet at the same time and be co-taught by an EECS and an ENTR faculty member.

The EECS capstone design consists of two two-hour courses, Design I and Design II, taken in sequence during the senior year. The ENTR course is a single three-hour course. The joint course consisted of the ENTR course and the EECS Design I course taught simultaneously. At the end of the fall semester, a business plan and product prototype were developed for each team. For the spring semester, the engineering students, now taking EECS Design II, further develop the prototypes into products. During the spring semester teams also participate in WSU's New Venture Competition and compete for \$25,000 in prize money.

Course Design

While there is growing interest among universities to commercialize university generated technology, there tends to be a wide gap between the resources available for research and technology creation and the resources available to commercialize the technology and launch businesses.³ On university campuses, most of the resources are dedicated to technology research while few are dedicated to

actually starting businesses.³ One source of this gap is a lack of startup knowledge among students and faculty. Thus, the purpose of this capstone course was not to be an academic exercise but an experience where students develop the understanding of and confidence to start a job-creating business around a unique product idea. Indeed, most new startup businesses that actually create new jobs focus on high-tech products and services.⁴

To accomplish this aim the capstone course was designed to incorporate market forces in general and customer problems in particular in the capstone project. Specifically, we followed a stage-gate new product development process⁵ in designing the course where students first engaged in an ideation stage then researched the technical and market feasibility of the idea and finally presented their research in front of a panel of experts who made a decision whether to continue or stop developing the idea. Below we outline the course content.

Ideation

During the first day of class all students were coached on how to identify sources of new ideas that address customer needs and problems and charged to research and identify three product ideas. The sources of innovation taught to the students were based on the writings of Peter Drucker⁶. Each student was required to post their three best ideas on the class blog and then present a 90 second pitch of their best idea in class. All ideas were then evaluated by students and a panel of engineering and entrepreneurship faculty on the degree to which the idea was technically feasible and solved a customer problem. Innovation scoring tools from innographer.com⁷ were used to score the impact and feasibility of the product ideas. From this input, the instructors selected 11 project ideas in which 11 teams would each develop a business plan and product prototype.

Team Formation

Team formation was based upon students' interests on the various product ideas and the required expertise of each product. Each student submitted their top three ideas from those presented and posted in class. The two faculty members then formed teams based upon students' product preferences

around the eleven ideas deemed feasible for further development. For each team, there was an overall team lead, who was an ENTR student, and a technical lead, who was an EECS student. The tech lead led the team of engineers and the ENTR student served as the overall team leader for the fall semester. This provided the ENTR student valuable real-world experience in leading a group of engineers and/or computer scientists. The combined class was comprised of eleven ENTR students and 36 EECS students in the class. Thus, each team had one ENTR student, the team lead, and three or four EECS students. The EECS student that served as tech lead was selected by the team. Each team was charged to construct a code of conduct that outlined how they were to operate as a team.

Product Validation

After teams were organized around the eleven product ideas, they were tasked to further research their ideas in two stages in order to ultimately generate a final product definition that demonstrates value to a customer. First, teams investigated the industry and competitive environment for the new product by conducting a patent search and by researching the internet for possible competitive products. Second, teams examined customer preferences by conducting interviews with potential customers. Here, students conducted a concept test with potential customers. A concept test is a marketing research tool that eliminates potential response bias by displaying a visual rendering of the product and a written description of the product before customer preference opinions are solicited.⁵ After each research stage, teams presented their research findings to their instructors for feedback and assessment. The instructors then made the decision if the product was ready to continue to development or if more research was needed. Student teams that needed more research would come back and present additional research findings until sufficient evidence was gathered to give confidence that the product added sufficient value and impact to a customer.

Prototype Development

Upon receiving the go ahead decision from course instructors that the product definition demonstrated sufficient product novelty and customer impact, team members then focused on unique tasks related to their respective areas of expertise. During the last eight

weeks of the course engineering team members under the direction of the tech lead worked on developing a technical prototype of the product while the ENTR student focused on developing and testing a workable business model with customer and industry expert input. While working on divergent aspects of the project, teams were still required to meet and update each other on their individual progress. To ensure that this was accomplished, each team was required to submit a weekly progress report that was posted on the class blog.

Final Presentations

At the end of the semester all eleven teams developed a working prototype of their product and presented their products in a trade show format at a local science museum to faculty members and interested community members. ENTR students, further, created a business model and plan that was presented in both written and oral formats at the end of the semester for a grade.

Lessons Learned

Student Feedback

During the initial semester, students thought that too much time was dedicated to idea identification. We spent the first eight weeks of class identifying ideas and researching the feasibility of ideas. This left eight weeks to actually develop a prototype or write a business plan. Students felt that this was too little of time to adequately develop these projects. We dedicated half the class on ideation and feasibility because we wanted to identify and select product ideas that had the potential to eventually launch. In hindsight, dedicating this much time in a one-semester course may have been too much.

Non-Aligned Goals and Structure

Part of this issue originated from the fact that the two courses were structured differently. The entrepreneurship students were committed to the project for one semester while the engineering students knew they had two semesters to work on the project. This created different perceptions of urgency to the project. Furthermore, the two classes were evaluated on different aspects of the project: ENTR student were graded on the quality of the business plan and EECS students were evaluated on the quality of their prototype. Consequently, the students had different goals because they were evaluated on

different criteria. This tended to decrease the sharing of information because during the critical points at the end of the semester, when deadlines were approaching, the EECS and ENTR students were each focused on their distinct goals and projects and did not have many incentives to help one another. Consequently, some requests for help between the ENTR to the EECS team members were ignored or responded to late. In addition, the second semester EECS teams did not have the benefit of an ENTR student to help with business development and launch.

Accountability for Sharing Knowledge

Team research suggests that shared mental models or knowledge structures held in common across the team help to coordinate the team's actions, adapt team behaviors to the task demands, and in turn improve performance.⁸ The development of shared mental models is achieved in part through the sharing of information among team members. A key objective of combining the EECS and ENTR classes was to facilitate shared mental models based upon both business and technology expertise. To facilitate this we expected teams to meet regularly and share what they were learning with each other. To hold them accountable for this task they were assigned to, students were required to submit a project update each week and report on their collective accomplishments and challenges. We found that this format did not emphasize the need to share information and therefore students appeared to focus on their own areas of expertise and not develop a shared sense of knowledge.

Future Plans

These lessons resulted in the following plans for future structuring of the two courses:

1. Have both engineers and entrepreneurs be evaluated on the same expectations and criteria to increase shared goals and knowledge.
2. Institute weekly project reports in order to document explicitly what was shared and what knowledge was exchanged between the EECS and ENTR students.
3. Equate the duration and credit hours of the two courses. We plan to offer the ENTR capstone as two three-hour courses and increase the credit hours of the EECS courses to three each. With this change, the first semester will focus on ideation and feasibility

while the second semester will be dedicated to product development and launch for all students. We expect this change in course structure to facilitate better team collaboration across ENTR and EECS students due to working together longer and sharing similar time perspectives (i.e., having the same amount of time to create and develop a new product idea).

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