Integration of Entrepreneurship-TEAM Concept Into Design Classes

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Abstract: *With funding from the National Collegiate Inventors and Innovators Alliance (NCIIA) and the Lemelson Foundation, Entrepreneurship-Teams (E-Teams) were integrated into the Philosophy of Design course at Cal Poly, San Luis Obispo. In this product design and creativity course, where design process, design considerations, and creativity is taught, the addition of E-Teams has created an environment of real world product design. Student are required to design and prototype a new product with commercial potential or social value. 18 teams were formed in Winter Quarter '98, and 18 products were developed. This paper reports on the results and recommendation on future activities.*

Introduction

A proposal submitted to the National Collegiate Inventors and Innovators Alliance (NCIIA) and the Lemelson Foundation[1] in 1997 was funded to modify the Philosophy of Design Course (ME234) in the Mechanical Engineering Department at Cal Poly, San Luis Obispo. The grant was for the integration of E-Teams in the above mentioned course.

An E-Team, as defined by NCIIA and the Lemelson Foundation, is a group of students who perform a design activity in a classroom setting. The product they design is supposed to be commercially viable (hopefully patentable), or socially beneficial. E-Team stands for Entrepreneurship Team or Excellence Team. The concept of Entrepreneurship Teams was integrated into the Philosophy of Design course at Cal Poly in Winter 1998.

The course has been taught in the department since 1984, primarily to mechanical engineering junior students. It covers creative processes and why people are not as creative as they can be. This includes discussion of mental or conceptual blocks[2,3], and how to overcome the blocks[4]. It also covers design process[5], as well as design elements such as patents[6], design communication[7], human factors[8], liability[9], safety, and economics[10], among other things. The course is a junior design course, with three hours of lecture per week, for 10 weeks. Homework projects include simple conceptual design problems involving brain storming and other techniques of idea generation, drawing sketches, problem solving, puzzles, making commercials for non-existent products, a Rube Goldberg type machine, and many others. Prior to the integration of E-Teams, the course also involved the design of a product on paper, where the students picked a project topic from a list, and finished it during the last three weeks of the quarter. The content of the course has remained the same after integration, except that now students are involved in E-Team project from the beginning of the class instead of the final project.

Other institutions have also used the E-Team concept in their curriculum, both in engineering and in business. The results of their experimentation, their integration of the concept into their curriculum, and methods of evaluation of the success of the teams has been presented in the proceedings of the NCIIA Annual Conferences [11].

Methodology

With the aid of the Grant, the course was modified to include 18 E-Teams of 4 each, in two sections of the class during the Winter quarter of 1998, for a total of 72 students. The students are all junior or seniors, and may have had traditional strength of materials and machine design courses. The E-teams were formed on the first day of class, randomly, and were asked to form themselves into a fictitious company, and operate as such. This would include, but not limited to a company name and logo, set of by-laws about the relationship between the group members, the mission of the company, the position of each member within the company, etc. During this first attempt, no additional information was given to the student groups on forming companies or writing a business plan. The intention was for the students to search for this information on their own. In a subsequent class offering, more information was provided, including Small Business Administration's Web Site address as well as tax information. However, this additional information was not helpful to this particular class, since the class was very small, and metamorphosis of ideas did not occur soon enough to be useful to the students. It is believed that the same information will be more useful in the future. Additionally, at the beginning of the course, the ground rules of conduct for the students was spelled out, budgets were given, and final expectations were explained.

Subsequently, each E-Team was asked to follow the design process that was covered in the lecture, from initial

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problem identification to the evaluation of the final product. The design process includes problem identification, preliminary analysis, problem definition, idea generation, idea selection, implementation, and evaluation, with multiple iterations dispersed throughout the process. Following the design process presented in class, each team was asked to find a set of ideas for new products with social significance or possible commercial value. The ideas were discussed between the instructor and the teams, and a final project concept was picked. This became the project or the product that the E-Team worked on. Later, the Teams were asked to completely define the project with all relevant specifications necessary, such as the users, the desired function, the range of final cost, appearance, environment in which the product would be used, etc. Subsequently, students were asked to find solutions for the product, select the best solution through a variety of techniques, design the final product, build it, and test the product. Each team was to follow the ideas discussed in class, and was to incorporate the design elements into their design, including human factors, safety, aesthetics, product liability, economics, manufacturing, etc. The process also involved patent searches to ensure that no patents were infringed, and that the idea may be patentable. The Patent and Trademark Office (PTO) website was extensively used by all teams to perform their patent searches. When necessary, complete patent texts were ordered from the PTO.

All E-teams constructed a prototype of their product or design, and demonstrated the product to the class through an oral presentation during the final week of instruction. Many teams had prepared video clips which were intended for either demonstrating the functions of the product, or for advertising its value. Each team also wrote and submitted a report to the instructor. The reports were used both for grading purposes as well as to document the design process in case any of the products were patented. The reports did include the students' design notebooks. The grant from NCIIA covered the cost of prototyping and supplies. However, it seems that the cost for most groups was about $100 to $150, which when divided between 4 students, is not prohibitive even if no external grant is available. In the future, the intention is to look for other sources of support and grants, or to ask the students to absorb the cost.

The following is a listing of the 18 projects that were undertaken:

1. Washing Machine Water Reclamation Unit: The purpose of the machine is to reclaim the waste water from a dishwasher for use in gardening.
2. Equine Forelimb Knee Joint Angle Measuring Device: The purpose of this device is to measure the angle of a horse's knee joint, when the kid is born, to allow a veterinarian to correct the joint angle if it is incorrect.
3. A Toddler Quad Unit (Stroller, Car Seat, High Chair, Walker Unit): This combination wheelchair, car seat, walker, stroller has a common base with adaptable seats for different purposes.
4. La Pompa, A Better Bike Pump.
5. Personal Shrimp-Peeler/De-veining Tool: This simple device can de-vein and peel a shrimp in one single motion.
6. Design of a Manual Hand-Held Sewing Machine. This machine is now funded for further development and commercialization.
7. Bicycle Lighting System.
8. Personal Beverage Cooling Unit: This cooler is used to cool down a beverage quickly while on the move, such as biking, hiking, or back-packing.
9. C-Cure Security System: This device allows alteration of a regular lock into a lock with an extra latch on the top of the door for added security.
10. Super Saturator Water Gun: This is a toy soaker for adults with high capacity and pressurized water reservoir.
11. Earthquake Gas Shut-off Valve: This valve will shut off a gas line in the event of an earthquake.
12. Student Desk Expander allows expanding a classroom desk to increase its comfort and utility. The expander can be packed into a back-pack, and can be removed or installed very rapidly.
13. Pneumatic Sealant Gun is designed to allow quick dispensing of sealants.
14. Hand-Held Dishwasher allows automatic dispensing of dishwashing liquid and water while washing dishes.
15. Adaptive Oil-Change Device is designed to be installed on most cars, and can collect, drip-free, the used oil during an oil change.
16. Rotating Bookshelf for the Disabled: The bookshelves can move up and down for easy access by the disabled.
17. G7 Grabbing Device for the Disabled is a mechanical grabber for a disabled person in a wheelchair.
18. Pottery Centering Device is used to center the clay on the rotating potter's wheel.

Results

The integration of E-Teams into the course was very successful and enjoyable. The students did enjoy designing and prototyping their own ideas, knowing that it could someday be patented or used commercially. The majority of the prototypes did work satisfactorily. The prototypes that did not work satisfactorily were the projects that were too involved, or the students were not experienced enough in manufacturing (such as the rotating bookshelves for the disabled).

The initial attempt at forming the fictitious companies did not work too well. Although the intention was for the students to get involved in learning about the practice on their own and to "discover" what was needed to form a small company, most groups did not form the company until the end of the Quarter. Most groups cited lack of time for the failure to act on it. In the future, more information and resources will be made available to the student groups at the beginning of the project, and the development and forming of a company will be made a class requirement.

The class and project evaluations indicated that the students enjoyed the exercise as well. Overwhelming number of students indicated that they learned from the experience, that it was a lot of work, and that the projects were enjoyable. Since the students had a limited budget to work with, they had to balance the cost of their design with the budget. Any additional expenditure would be paid by the group members. All groups reported their expenditure to the instructor for reimbursement.

With the support from NCIIA and Lemelson Foundation one of the E-Teams has opted to continue the development of their product. This indicates how some groups enjoyed their design/business adventure.

Discussion

Although a grant supporting the student projects was the initial impetus to integrate E-Teams into a design course, we will continue with the concept in the future even without a grant. The E-Team project has added to the value of the course, and has created a supportive environment for design projects. As a result, it is intended to seek small levels of financial support from our industrial liaisons for supporting student prototype developments. However, even without any external support, student groups of 4 are expected to be able to afford a project expenditure of $100-150. Thus, although other engineering programs may not necessarily have a grant to implement the idea, it is recommended that they request students to underwrite the cost of prototype development.

Most successful teams were the ones that had enthusiastic students with practical experience in making things. These students are generally more interested in inventing new products, and enjoy prototyping their ideas. Personalities also play a role in the teams. Since team members are assigned on the first day, randomly, they may be friends with each other or not. Consequently, depending on their preferences and personality types, the team may or may not work smoothly. No attempt was made to mediate team member behaviors. However, few problems were encountered, as most teams worked well.

NCIIA may be reached at http://hampshire.edu/nciia or at nciia@hampshire.edu.

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