

**AC 2010-1556: BRINGING SOCIAL AND CULTURAL AWARENESS INTO THE
FIRST YEAR DESIGN EXPERIENCE**

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Abstract

At the Schulich School of Engineering, University of Calgary, 730 first year students are required to take two half courses in Design and Communications. These courses (ENGG 251 and ENGG 253) are project-based, with students participating in 5 real-world design projects each year. The course capstone project is an eight week design challenge that requires students to collaborate with a social agency on developing solutions to current social issues in Calgary and around the world.

The topic of this paper centers on the potential for simultaneous and multiple level learning events by placing design and communication skill development in the social and cultural arena. At the Schulich School of Engineering, the first year design and communication course partners with local and international agencies that welcome the opportunity to benefit from the creative abilities of over 700 students collaborating in 200 teams and to participate in the creation of engineers who are able to see the broad societal and cultural impacts of their work as professional engineers. The design challenges are structured to take advantage of the large class size through project management training and multi-faceted project outcomes.

The Capstone project for the 2009/2010 academic year is a collaboration with The MustardSeed (hereafter MS), a non-profit outreach group that runs shelters, food and clothing banks and education and retraining programs for the homeless. The partnership is aimed at assisting the MS's educational division with GED studies and life skills. As many of the clients of the MS have difficulties with focus and with understanding and relating to material, the students' challenge will be to use their engineering knowledge to develop physical or computer-based aids, based around themes that are relevant to the clients, to assist in skill and knowledge development.

Over the eight week project, each group of 30 students will select a theme to shape their work, then split into groups of four, with each foursome developing a solution for a) an academic challenge, b) a study skill challenge or c) a life skill challenge. Project Management tools, oral and written communication skills and sketching will be emphasized during this project. The challenge will culminate with an open house, where each of the 24 groups of 30 will present their work to the clients for evaluation.

This paper tracks the development of the project, from the initial contact with the organization through the development and refinement of the project and finally through the actual implementation of the project, including a presentation of a selection of the products created by the students.

Introduction

The exponential rate of advancement in every aspect of the modern world has thrust us into a global workplace where everything from clashes of culture to environmental meltdown impact workers on a daily basis. The engineering workforce, in particular, needs people who can step outside of the narrow world of the textbook and develop vision beyond their local environment in order to synthesize the vast amounts of multi-cultural, multi-disciplinary and multi-media information into effective solutions to the pressing engineering problems of the age.

At the University of Calgary's Schulich School of Engineering, a unique initiative to simultaneously address the development of creative problem solving skills as well as raising is in its 8th year. The focus of the initiative is to offer training in creative problem solving through a first year engineering course on design and communication. However, the majority of the projects also contain a significant social and cultural awareness component. The students may be working with Engineers Without Borders to address technological problems in developing countries like Ghana or Zambia. They may be working with the local children's hospital to develop toys for children with significant physical and mental challenges. Most recently, the students have been working with local organizations who have taken on the challenge to eliminate homelessness in the city within the next ten years.

The goal of the course is to challenge developing engineers to significantly expand their vision of the impact of their design solutions as they learn to gather information from multiple sources and "ways of knowing about the world" and then to synthesize that information into an informed and creative response to the challenge put before them⁶. Thus the emphasis on social and cultural awareness.

The approach has been recognized through national and international awards for collaborative education, methodology, and curriculum innovation^{1,2,3} and is the subject of a teacher's manual on creative problem solving published by the Society for Teaching and Learning in Higher Education⁴.

The Course Goals

In his plenary speech at the 2004 conference of the American Society for Engineering Education, Dr. Woody Flowers from MIT put forth the notion that, in the very near future, the kind of mathematical analysis, calculation and number crunching that has been the domain of the traditionally trained engineer will be accomplished to a considerable degree by farming the work out to large, international computer facilities and data entry personnel that will likely not even reside in North America. Such is the global impact of the exponential advancement of computer technology, communication and the internet.

The question then arises: what is the job of the engineering professional in North America going to look like in the future? In the absence of the need for computational facility and expertise, the job of the engineer in particular will be to be a creative problem

solver in a world that is multi-disciplinary, multi-cultural and in a state of constant and rapid change. An engineer will have to be skilled in the creation of effective solutions to complex problems that have local, national, international, social, cultural and environmental components. In addition, those solutions will need to be produced inside an increasingly short time frame and will need to be adaptable to the rapid change and evolution of the original problem.

The skills required to be this kind of high performance, culturally and socially responsive creative problem solver are unlikely to be learned in the traditional university classroom where the emphasis is on repeatedly solving problems in mathematical manipulation that require students to follow a single, common path and arrive at a single common solution that is identical to the solution developed by generations of students before them.

Therefore, the Schulich course is unique in many ways. Students are presented with real world creative problem solving challenges that have no satisfactory solution and are drawn from the worlds of medicine, re-habilitation, base of the pyramid design, solar energy, and homelessness⁷⁻¹⁹. The students are assisted in their creative problem solving skill development by a team of professional artists, writers and engineers. While such an educational endeavour would be a significant challenge for even a small class of students, the fact that this course is run every year for over 700 students and involves instructors and over thirty tutorial assistants from three distinct disciplines, makes it even more remarkable⁵.

A key component of the projects undertaken by the students is the incorporation of a real world business and/or organization which provides meaningful, current and even futuristic creative problem solving challenges from houses and vehicles that rely exclusively on solar energy to technology-appropriate multi-function platforms for the developing world, to developing concepts for affordable housing in the students' own community. Rather than simply producing concepts and ideas on paper, the students are formed into 200 design teams and provided with tools and materials to prototype a functional proof of concept.

Since the inception of the course, we have endeavored to develop lasting connections and interaction with many agencies to ensure that consideration of differing social, cultural and environmental issues become engrained in the design approach of our students. While the demands of the course, and the need for new challenges each semester, have necessitated new partnerships each year, we have maintained strong ties with each of our former partners, often involving them in multiple projects. With a commitment to social change, we have become well-known in the Calgary non-profit sector for our partnerships with community organizations and industrial companies such as Tennant Medical Engineering, Engineers Without Borders, The Calgary Homeless Foundation, Alberta Children's Hospital, the Heart and Stroke Foundation and the Canadian Paraplegic Foundation. In all cases, the course developers and instructors work with the client organization for from eight to fifteen months prior to introducing a project to the students.

The Project

The most recent project focuses on the needs of the homeless community to access upgrading opportunities to assist them in gaining employment, social skills and general life management skills. The MS is a non profit organization that specializes in working with the homeless in the city. They offer food, accommodation many forms of social support, including course work and tutoring for high school upgrades. Based on a previous project working with the Calgary Homeless Foundation^{8, 10, 12, 17, 18, 20}, we approached the MS in the fall of 2008 to investigate the possibility of our students taking on the challenge of developing ways for offering various types of training and upgrading for the MS people

Beginning in fall 2008, instructors from the course, (working with a first year student who won an undergraduate research social sustainability award based on her proposal for developing an educational project for the homeless that involved the first year class) began negotiating with the MS. The goal was to develop a student engineering design project that would provide the students with a significant opportunity to develop viable solutions for a complex social problem within their own community. The benefit for the MS, in addition to increasing the social awareness of an entire class of soon to be engineers, was the very real probability for new and workable solutions to be conceived, researched, modeled and presented.

The instructors met with the MS representatives on two occasions to determine the needs of the MS organization and explain the workings of the design course. Certainly, organizations like the MS are very concerned that the complexities of their client needs are understood and appropriately addressed. The meetings allowed us to enter into their world and learn about the nature of the problems faced by homeless people. The third meeting took place at the design lab in order to familiarize the MS people with the environment they would be working in.

To gain a more in depth understanding, two instructors attended an open house and one instructor took on some tutoring for two of the homeless clients. Following these exchanges of information, the instructors and the MS administrators met to select a focus for the collaboration. It soon became clear that the key consideration for working with homeless people is to recognize that a homeless person is most often dealing with a wide variety of health issues and severe educational, social and cognition deficits. Taken together, these issues make it extremely difficult for many homeless people to concentrate long enough to read even a page of an educational text. However, most of the clients can readily play computer games for long periods of time. The collaborators therefore decided to have the design class look at designing and developing computer games (using internet freeware) that would allow the user to approach the learning challenge (secondary school level upgrading, social skill development, etc) through the computer game environment.

A graduate student with the design course did a trial project with the game design freeware to determine its suitability for first year students. In the spring and summer

session, the undergraduate research student devoted her attention to consolidating the relationships with the MS and developing a course structure around the computer game design concept.

In the fall of 2009, the instructors, summer research student and MS administrators developed a presentation to deliver to a national conference on homelessness. This was the final formative event before the running of the project in the winter session.

The Approach

Prior to being presented with a challenge like the Homeless Education Project in collaboration with the MS, the student design teams are put through a series of smaller projects intended to acquaint them with the experience of working effectively in teams, developing approaches to problems for which there is no current solution, developing, defending and presenting creative solutions and demonstrating a prototype or proof of concept. They learn to negotiate team contracts, to determine individual roles and responsibilities, to document the evolution of their design activities. They learn to express themselves and communicate to many different audiences through gaining written and visual literacy. These skills are learned through direct interaction with instructors and tutorial assistants (we call them “coaches”) who come to them as engineers, artists and writers. The interaction is maintained at as personal a level as possible by breaking the teams down into design labs that have one coach interacting with 8 teams. Each instructor is in charge of four lab rooms that run simultaneously and involves five coaches from art, communication and engineering.

The instructors meet formally once each week and informally throughout the week to strategize for both the short term wrinkles that appear in any first time project and to plan for the projects under negotiation for the following year.

Since the statistical probability for every one of the 200 teams to reach a unique and uniformly successful design outcome is very low (as it is in industry) student teams are assessed and graded on the fullness and effectiveness of their approach to the design problem rather than the final outcome. Still the quality of the end result is of sufficient quality that the public demonstration of the class designs has often caught the interest of local, national and even international media.

The Community Partner

The opportunity to interact with 750 engineering students was an immediate and significant benefit for an organization that must rely on increasing public awareness about homelessness in order to combat the Not In My Back Yard problem that plagues so many potential solutions to social problems. The organization provided a number of well-placed and well-spoken experts from city planners looking for housing solutions to paramedics who deal with the homeless on a daily basis.

These representatives prepared an excellent series of talks and information sessions for the students. The sessions were aimed at impressing upon the students that, far from being lazy and stupid, a homeless person often is dealing with serious, often life threatening issues that few of the students would be able to manage, should they become similarly afflicted (which, they soon realize, could easily happen).

The organization committed to working with the project developers (instructors and students) to ensure appropriate problems, and points of view were addressed and that the project would be a manageable challenge within the available time frame. A key role for the instructors is to manage the expectations of the client organization by keeping the time and facility constraints experienced by the students always in clear view.

One of the advantages of involving 200 teams of students is the tendency of the students to benchmark themselves in relation to the other teams. This almost always results in student performance that goes above and beyond the expectations of the instructors. In fact, in every project, ten to twenty practical, creative and unique solutions emerge that have real world application. According to our past experience, it is very likely that a number of designs presented at the public showing of the project will be able to be directly incorporated into the MS educational and training programs.

What the client organization is often unprepared for is the quality and scope of solutions developed by the students. For the previous affordable housing project, the 200 teams of students were formed into multi-team project groups complete with project management teams. Groups made up of as many as eight teams looked at and synthesized a number of issues surrounding affordable housing solutions: location, adaptability, architecture, sustainability, visual impact, cost, materials, zoning etc.

The computer game project took a similar approach in that the student teams develop a number of different designs that are connected in various ways to the overall computer game training environment. For example, one set of six teams will collaborate on a system of games designed to address math, social studies, science, etc in conjunction with designs that focus on social skills (conversation, eye contact, money management, interview skills).

Preparation for the Working World of the Future

In the final assessment, the work of the students, through their interaction with the client organization (CHF) clearly demonstrated the development of a skill set that has been identified as the path to success in the workplace of the future:

The ability to successfully engage in creative problem solving

The ability to synthesize knowledge from a wide range of people impacted by the problem and by the proposed solution.

The ability to recognize that solutions of the future begin and end with the people involved.

The ability to develop, present and defend solutions.

The ability to work effectively on teams

The ability to manage and work within large, multi-team projects.

The ability to respond effectively and with sensitivity to people whose life experience is different from their own.

The ability to work creatively within a large number of constraints, many of which are in conflict with each other.

The ability to work through a unique and complex problem in a cohesive and effective manner.

From the outset of the course in 2001, the development of these skills has been shown to be clearly in evidence through independent critique and evaluation.

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