“Exploring Engineering Technology” a multi-disciplinary hands-on experience

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ABSTRACT

This paper outlines the merits and challenges of implementing a new introductory course in the Mechanical Engineering program at Sheridan called Exploring Engineering Technology. In this course, students will be introduced to a few introductory engineering skills such as basic measurement, engineering communication, and project management. It includes two hands-on projects, in which students practice these skills, focusing mainly on the implementation and operation pillars within the CDIO framework.

KEYWORDS

Introduction to Engineering, Design-Build project, CDIO Standard 4

INTRODUCTION

The school of Mechanical and Electrical Engineering and Technology (MEET) at Sheridan College in Ontario, Canada initiated a curriculum reform based on the CDIO approach in 2012 as a step toward its adoption of CDIO. The model is a natural fit with Sheridan’s vision to become Ontario’s first undergraduate university dedicated to applied, professional education, built in an environment renowned for creativity and innovation. This paper presents the implementation of the CDIO context within a first year introduction engineering course called “Exploring Engineering Technology”. The objective of this course, which is similarly offered at other institutes [1,2,3], is to attract students to engineering, motivate them to continue in their engineering studies, as well as provide them with a chance to experience a complete project life cycle.

The activities of the course emphasize the major aspects of the engineering practice: Conceive, Design, Implement, and Operate, with the strongest emphasis on the last two elements. In addition, students will learn several introductory engineering skills such as basic measurement, working with spread sheets, and project management, which they will apply in their course project. The course also focuses on the development of essential personal and interpersonal skills such as written and oral communication, team work, and presentation.
OBJECTIVES

Exploring Engineering has been designed based on CDIO standards 1, 4, and 8 [1]. The majority of the course material is delivered and practiced through the two course projects. In both projects, students work in groups of three or four to break down the required tasks of the project and prepare a realistic time schedule based on the project management fundamentals and classic design process steps that were introduced in the course. At the beginning of the term, each group submits a technical proposal, which provides an opportunity to practice written and graphical communication skills. During the course, each group meets regularly with instructors to receive both technical and non-technical advice. Other introductory engineering skills are utilized in different stages of the project such as using spreadsheets to prepare bill of material and basic measurement skills to test performance of prototypes. At the time of delivery, each group writes a technical report that presents their approach to solve the problem. Final reports include an executive summary, problem definition, design process, results, and conclusion. Finally, each group showcases their project in a formal presentation. Through the completion of each project, students practice an engineering approach to solve an open ended problem, interact with team members and supervisors, effectively communicate in oral and written formats, and manage time and other resources.

COURSE PROJECTS

The new Exploring Engineering course offers two design-build projects. In the first project students design, fabricate, and test a truss crane made of 1/16” brass rods with permanent solder joints that is capable of carrying a 2kg static load. The goal of this project is to encourage students to research different truss configurations and create their own design. The evaluation of the project is based on the weight of the structure and the deflection of the crane under the maximum load. Although the project sounds simple, students must complete a thorough design process to select an effective truss type, prepare two dimensional drawings, experience the challenges of fabrication, and acknowledge the trade-off between the weight and robustness of a structure. In this project, students typically work in a group of three, to hone their teamwork and communication skills. Each team participates in a final presentation where they explain the advantages of their design and demonstrate the operation of their crane. The biggest challenges during the initial implementation of the project were related to the fabrication phase. Excessive material waste, lack of fabrication/soldering experience, and limited work space were the most significant issues observed during the first trial of the project. Given that student feedback on this course and learning experience was extremely positive, a larger facility including peer student supervision will be allocated to this project for the upcoming semester.

Figure 1: Design and fabrication of a truss crane
The second, team-based student project centres on automation. This focus aligns with Sheridan’s geographic location in Ontario and the needs of local industry. Sheridan is located in the heart of the manufacturing industry in Ontario, Canada. The results of a survey conducted with local small and medium size industries (SMEs) indicated a high demand for innovative and tailored automated systems required to increase the productivity of SMEs. In order to address this demand, the second project enables students to experience the design-build-operate cycle in the automation field. In this project students design, analyze, fabricate, program, and test an “Autonomous Robotic Arm” capable of detecting and transferring colored objects to a designated location. The multi-disciplinary activities of the project include designing and fabricating a robust and lightweight arm, designing an effective gripper, integrating a color sensor within a motion control system, and developing an object-based program to control the system. The evaluation criteria are based on the weight, cost, accuracy, repeatability, and response time of the system.

In the project, student teams are required to articulate the technical specifications of the project, prepare a time schedule, and report on the status of their project during weekly meetings with their supervisors. A cost report including the cost of each part, fabrication, and programming is also prepared. Finally each team must present their project and submit a formal report.

Difficulties that were experienced include a challenge resulting from a lack of programming and control knowledge. These were overcome with tutorials and/or on-line training material. Lego Mindstorm kits are used as the platform for the project, requiring a modest capital investment while providing countless opportunities for innovation.

![Autonomous Robotic Arm](image)

**Figure 2: Autonomous Robotic Arm**

**CONCLUSION**

*Exploring Engineering* is a project-based course which provides students with an opportunity to experience a complete project life cycle and the four pillars of Conceive, Design, Implement, and Operate. This course helps students to appreciate the multi-disciplinary nature of industrial problems while helping them to develop inter-personal and social skills. The course is designed to address and combine many CDIO syllabus topics while motivating and preparing students for the further pursuit of engineering in academia or the workplace.
REFERENCE


BIOGRAPHICAL INFORMATION

Shaun Ghafari, Ph.D., P.Eng., Shaun (Shahab) Ghafari received BSc. Degree in Mechanical Engineering from University of Tehran, Iran, and his MASc. and Ph.D. in Mechanical engineering from the University of Waterloo, Canada. He joined Sheridan College as Professor in 2011 and became coordinator of applied research in school of Mechanical and Electrical Engineering and Technology (MEET) at Sheridan. His applied research interest includes automation, product and prototype development, vibration analysis, and condition monitoring of rotary machinery.

Farzad Rayegani, Ph.D., P.Eng., FEC is a Professor in Mechanical Engineering and Associate Dean of school of Mechanical and Electrical Engineering & Technology at Sheridan College, Brampton, Canada. As a CDIO collaborator, he is seeking to develop new curriculum structure based on a new philosophy for engineering education, the framework educates students to Conceive, Design, Implement and Operate complex, value-added engineering products, processes and systems in a modern, team-based, global environment.

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