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INVESTIGATION OF USING UNIVERSITY MULTIDISCIPLINARY CAPSTONE DESIGN COURSES TO TEACH SPACE SYSTEMS ENGINEERING, FUNDAMENTAL SPACE SCIENCE, AND HUMAN FACTORS

Abstract

Space plays an important role in STEM (Science, Technology, Engineering, Mathematics) education and in training the next generation of multidisciplinary engineers. Here, we present three space-based projects as case studies of teaching multidisciplinary engineering design in capstone courses at the University of Toronto in Canada. Each project begins with a Statement of Need (SON) prepared by the client that identifies a design problem and the different engineering disciplines needed in the solution. The Faculty of Engineering then matches students and a faculty member to the client's SON. The course runs for 8 months and students have access to Subject Matter Experts (typically faculty members) in each engineering discipline. Furthermore, the capstone course is a part of the Engineering Communications Program at the university thus providing students with guidance in professional engineering communication practices. In addition to working on the design project, the capstone team also prepares a Problem Statement, Project Requirements document, Design Review, Design Critique, Final Report, and present their work at a showcase event open to the public and to mainstream media. The projects leverage funding from the university.

The first case study is a capstone project in fundamental space physical sciences. The client worked with the Canadian Space Agency (CSA) to develop a design project to automate an experiment for a future mission to the International Space Station. The capstone team consisted of four students and they were able to build a new experimental apparatus and demonstrate the feasibility of the project. In the second case study, the same client again worked with the CSA to develop practical applications for discoveries made as part of research into fundamental space physical sciences. The capstone team (another group of four) designed and built an apparatus using technology patented by the client. They additionally met with a CSA scientist at key milestones. In the third case study, the client, Astronauts for Hire (a US-based non-profit company), proposed a design project to build a experimental platform equipped with a video camera, and accelerometer, temperature and humidity sensors for use in parabolic flights and in STEM outreach activities at schools.

The outcomes of the projects will be discussed. We will use each case study to identify lessons-learned and opportunities to teach systems engineering and space science principles to undergraduates. We discuss a framework of to bring similar space-based capstone projects to other institutions.