MODELING AN ABBREVIATED PRODUCT DESIGN CYCLE IN A FIRST-YEAR ENGINEERING DESIGN COURSE

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1. INTRODUCTION

All Engineering Science students at the University of Toronto take the cornerstone Praxis Sequence of engineering design courses. In the first course in the sequence, Praxis I, students practice three types of engineering design across three distinct design projects. Previously the final design project had the students first frame and then develop conceptual design solutions for a self-identified challenge. While this project succeeded in providing an appropriate foundational design experience, it failed to fully prepare students for the more complex design experience in Praxis II. The project also failed to ingrain the need for clear and concise engineering communication, and the students’ lack of understanding of detail design inhibited their ability to make practical and realistic design decisions.

A revised Product Design project in Praxis I was designed with the primary aims of: (a) pushing students beyond the conceptual design phase of the design process, and (b) simulating a real-world work environment by: (i) increasing the interdependence between student teams and (ii) increasing the students’ perceived value of engineering communication.

2. PRODUCT DESIGN PROJECT

A 5-week Product Design project became the final project in Praxis I, and was divided into three distinct phases: problem identification, conceptual design, and detail design. Each phase was completed in rapid succession by a different team. The teams spent 8, 11, and 13 days on each phase respectively. An anonymized code was used when submitting deliverables at the end of each phase. This allowed the deliverables to serve as a starting point for another team in the next phase.

The initial prompt was “Design a product that enhances personal sustainability suitable for submission to Kickstarter”. The problem identification phase finished with the teams delivering a design brief that reframed the problem to their chosen area of interest, identified stakeholders, and presented preliminary design requirements. In the conceptual design phase, students received another team’s design brief and were required to provide any necessary reframing, complete both ideation and selection activities, and produce a conceptual design and prototype(s). In the detailed design phase teams were required to select, ideate, and document five detailed design decisions in support of the conceptual design, and provide a higher-fidelity prototype, solid models and basic engineering drawings.

The project culminated in a design critique where each team was able to see how their design brief had evolved throughout the project. Each student team was required to present their conceptual design, augmented by the work of the detailed design team, to the team that authored the original design brief. Student teams who worked on the same product across the different phases were grouped together so that students could see how each of their ideas and deliverables had been reframed and redeveloped by the other teams.

3. DISCUSSION

Students indicated that they perceived the structure of the project as having helped them to understand both the nature of design in the engineering profession as well as the different roles played by design engineers. During the project both the course instructors and the student teams found the pace and frequency of cognitive disruptions a significant challenge - the length of the phases within the project were too short and hampered student ability to learn and apply design concepts. The pace and interdependence resulted in a greater appreciation for the importance of engineering communication, as students had to quickly assimilate the previous teams’ work.

As students were always building on the work of other teams of varying abilities, “improvement” had to be factored into assessment. Students who received a poor report and produced a quality one had to be rewarded for the relative improvement in design quality, and vice versa for those who maintained or reduced design quality.

After the project completed, all of the stakeholders reported appreciating both the experience as a whole and the value of participating in each phase of an integrated engineering design project. While many of the student designs were not developed in depth, introducing students to a complete design experience early on in their design curriculum allowed the students to better understand the need for a clear problem definition, quality requirements, rigorous decision making, and clear communication.