Gaining Collaboration and Practical Skills by Building a Vehicle at Taylor's University

The Mechanical Engineering Group Project (MEGP) is a capstone project offered to third-year Mechanical Engineering students at Taylor's University. The project consists of two modules- Mechanical Engineering Group Project I and Mechanical Engineering Group Project II, which are offered in semester 5 and semester 6 respectively. Both modules are carried out based on the Conceive-Design-Implement-Operate (CDIO) educational paradigm in engineering. MEGP I focuses on the conceiving and designing of a human-powered vehicle (HPV), while MEGP II focuses on the implementation and operation of the vehicle. This case study focuses on MEGP II.

Distinctive Features:

- Offering an opportunity to conduct a full-scale engineering project with the CDIO approach in a realistic environment;
- Engaging students with a wide range of innovative assessment methods;
- Stressing on learning by doing and the application of previous engineering knowledge

Designed Learning Outcomes (LO):

I. Produce a functioning prototype based on the design done in MEGP I.
II. Evaluate the prototype and assess its functionality.
III. Evaluate the product design based on performance, cost and sustainability, and optimize the design if necessary.
IV. Ensure all parts of the project are complete.

Source: Tien, D. T. K., & Mohyi, M. H. H. (2016). Assessment in Mechanical Engineering Capstone Project: The Case of Taylor's University

Coursework Teaching & Learning Activities:

- Lectures: carried out during the first half of the semester to explain detailed requirements of the module, assessment methods, project deliverables, timelines and other important areas
- Weekly Discussion Meetings within Teams
- Weekly Discussion Meetings with Supervisor (module coordinator): teams update supervisor with their progress, and show to the supervisor their weekly meeting minutes. Supervisor makes use of these meetings to monitor work progress and provide feedback and affirmations when necessary
- Weekly Team Analysis Forms: each student makes a personal assessment of their team's stage of group development

Assessment Approaches

	Name	Learning Activities	Weight	Aligned LO	Type	Generic Skills
A1	Logbook (and Return-on Failure Analysis)	In the logbook, students record their tasks and learnings from the project fortnightly. Students are expected to showcase reflection on learning activities, attainment of new skills or enhancement of existing skills, and link learnings to relevant LOs. Apart from the logbook, there are also two return-on-failure (ROF) forms to be completed by students. In the ROFs, students identify mistakes and failures made during the project, point out the root cause and suggest ways to improve in the future. Both the logbook and the ROFs are to be discussed with and	10%	I. II. III. IV.	Formative	Communication; Self-management; Critical Thinking

		signed by the supervisor. A compilation of all fortnightly logs and ROFs shall be submitted at the end of the course.				
A2	Interim Report	Students conduct an analysis of the design and prototype of the product, and report the weaknesses and possible improvements compared to the analysis done in MEGP I.	30%	II. III.	Formative/ Summative	Communication; Critical Thinking
A3	Final Report (and Technical Operations and Maintenance Manual)	The Final Report should include a record of all activities related to the project, an in-depth analysis of the activities, an overall description and analysis of the product, possible areas of improvement and appropriate solutions. The analysis should discuss the implication of the design on manufacturability, testability, usability, ease of maintenance, and sustainability. Design decisions, manufacturing options, planning and scheduling judgements should also be analysed. Students should focus on their own contributions to the project in the report. Along with the report, a Technical Operations and Maintenance Manual (TOMM) for the team's vehicle should be submitted. A description of the vehicle's engineering system and a troubleshooting section for common problems should be included in the manual.	30%	I. II. III. IV.	Summative	Communication; Critical Thinking; Problem Solving
A4	Presentation and Peer Assessment	This assessment consists of two parts: a group presentation and a peer assessment. During the group presentation, which takes place at the end-of-semester Engineering Fair, each team member takes turn and introduces their team's artefact. During the Fair, teams also display their artefact at a booth while judges, academic staff, visitors and fellow students might visit the booth and ask questions. Students are expected to deliver a clear presentation, highlight project deliverables as well as recommendations for future improvement. As for the peer assessment, students give each of their fellow team member a rating of 0 to 10 for contributions, problem-solving ability, attitude, focus on tasks and teamwork.	10% (Group presentation: 5%; peer assessment: 5%)	III.	Summative	Communication; Collaboration; Creativity; Critical Thinking

A5	Artefact Assessment and HPV Race	During the Engineering Fair, each team's vehicle is assessed by two judges, one from another university or the engineering industry, and the other one from Taylor's University's School of Engineering (excluding the module coordinator). The assessment criteria include design, innovation, safety and aesthetics. The second part of the artefact assessment- the HPV race is conducted on a different day. Vehicles complete three laps respectively and the fastest vehicle wins.	20%	I. III.	Summative	Creativity; Collaboration

Assessment Type

Formative and summative assessment methods are both employed in this course to evaluate student performance as well as enhance learning experiences through engaged and practical learning activities.

Assessment Focal Areas

Holistic competencies: Focusing on practical learning and group work, this course provides the opportunity for students to develop a wide range of holistic competencies. Critical thinking is emphasized in most of the assessments in this course (A1, A2, A3), as students are encouraged to provide in-depth and critical analysis of their design process and their artefact. Collaboration is another focus in this course because students work in a team of 4-7 members of their own choice. The assessments also require a high level of collaboration between team members especially for the presentation (A4) when students need to take turn to introduce their artefact to the assessor, and for the HPV race (A5) when each team member has to play different roles, for example one is the driver and others have to closely monitor the vehicle and be ready for any emergency.

Knowledge application: This course emphasizes on the application of engineering skills and knowledge through the process of learning by doing. It builds upon and further develops the CDIO concept introduced to students in other group projects or workshops in their junior years. The assessment methods also stress on applying engineering concepts and knowledge on the design and implementation of product. Assessments including the final report (A3) and the presentation (A4) require students to explain and analyze their own product in terms of manufacturability, testability, usability, ease of maintenance, and sustainability; while the HPV race (A5) is an ultimate test to the functionality of the vehicle, and the students' technical knowledge and ability.

Reflection: In the assessment of this course, reflection is an important element and students are encouraged to carry out reflection in different assessments. In the logbook (A1), students are required to reflect on tasks and learnings from time to time, identify causes of mistakes and failures and suggest ways to improve. While for the interim report (A2) and the final report (A3), students need to analyze their own design, point out weaknesses and possible measures for improvement.

Assessment Standards/ Sample Rubrics

Sample rubrics are only available in the module handbook, which is not accessible online.

Teacher's Stories

Mohd Hardie Hidayat Bin Mohyi, Lecturer, School of Engineering, Taylor's University

Professional Engagements

Mohd Hardie Hidayat Bin Mohyi holds a Bachelor of Engineering in Mechanical Engineering and a Masters of Engineering in Mechanical Engineering both from the University of Malaya, Malaysia. His areas of expertise include renewable energy, fuel cell technology and combustion and fuel engineering.

Motivation

As a fuel and renewable energy expert, this course which involves the design, implementation and operation of a Human-Powered Vehicle is in line with Mr. Mohd Hardie Hidayat Bin Mohyi's expertise.

Collaboration

As mentioned above, this capstone project has two modules in total. Mr. Mohd Hardie Hidayat Bin Mohyi teaches the second module while Mr. Douglas Tong Kum Tien is responsible for the first module. Mr. Tong's area of expertise and research interest lies in engineering education. The two lecturers have collaborated to publish an article on assessment in mechanical engineering using the case study of Taylor's University (Tong & Mohyi, 2016).

Featured Video/ Photos

"Taylor's Human Powered Vehicle Race"

July 7

Group Photo of the contestants of the HPV Race.

The third year, second semester students from Taylor's University School of Engineering participated in the inaugural "Taylor's Human Powered Vehicle Race – THPV". Four teams participated in the race, each with their own human powered vehicle. The HPV's were conceived, designed, implemented throughout the year as part of the Mechanical Engineering Capstone Project module; and operated in the race by one of the team members.

The qualifying session of the race consists of the each team completing a lap and locking in the lap time. The best lap time determined the position of the team on the starting grid. Team 1's HPV was piloted by Domonic Ang and completed the qualifying session in first place with a time of 25.3 seconds, 10 seconds ahead of the second place team, Team 2. The HPVs for Team 2, 3 and 4 were piloted by Ahmad Fikri, Mohaymen Khan and Low Kean Peng respectively. The race consisted of 5 laps. Team 1 dominated the race and finished the race a lap ahead of the second place team, Team 2.

Team #1's HPV piloted by Dominic Ang.

Team #2's HPV piloted by Ahmad Fikri.

An article about the HPV race in 2013. (Source: https://university.taylors.edu.my/download/blue-print-newsletter-2013-july-issue.pdf)

Hotachi is a HPV by a group of Taylor's University stuents. It was listed on a crowdfunding platform and successfully raised over 500 Malaysian Ringgit. (Source: https://pozible.com/project/182688)

A Mechanical Engineering student with his HPV which has won the Taylor's Capstone Award 2 in 2017. (Source: https://university.taylors.edu.my/news-events/taylors-engineering-students-applauded-their-innovations)

References

Tong, D. K. T., & Mohyi, M. H. H. (2016). Assessment in Mechanical Engineering Capstone Project: The Case of Taylor's University. In *Assessment for Learning within and Beyond the Classroom* (pp. 295-304). Singapore: Springer.