WORK IN PROGRESS

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"Crazy Machine" Project Based Learning

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BACKGROUND

Project based learning (PjBL) provides a well established base for improving many of the practicing engineers communications skills and, often, team working experience Chunfang Zhou (2012). The authors have both used PjBL approaches to laboratory projects in their units for several years in which the students worked in teams on a single specified project. This time, students from both units will work on the same project, and the nature of the project forces teams to interact and negotiate. The authors felt that providing projects that gave each team a common base would improve the skills base and student motivation. This would also encourage innovation together with the potential for inter-team negotiation for systems interfacing and allow students to positively comment on and impact upon other teams' developments.

Between the two units (Advanced Digital *Design* 320 -- ADD 320 and Embedded Software Engineering 302 – ESE 302) in which this approach has been implemented we have three distinct cohorts. The cohort of students doing both units needed to address more functionality than required in one unit but it was considered inappropriate to need double so a modified project incorporating the technologies addressed in each unit was implemented.

PURPOSE

PjBL provides students with an effective learning environment and when done in teams adds a number of other skills to their repertoire. Effective teamwork, peer evaluation, reporting and reflection on the project and personal involvement are recognised consequences of this approach to learning (reference). The authors while happy with these results considered that there were two missing factors that could be addressed.

The first factor is *inter-team interaction*. Industrial projects are rarely carried through in isolation. There is a need to communicate with and often negotiate with other teams and/or customers. While all the student teams are addressing a well defined design project with a common requirement, inter-team interaction is often seen (by the students) as non-productive. This proposal aims to create a design scenario with a degree of commonality so all teams were addressing the same learning paradigms but with enough independent initiative to give them ownership of their design. It requires specification and implementation of interfaces between the team designs and, hence, inter-team negotiation and the flexibility for students to provide feedback to other teams because there are each team has an independent design target.

The second factor, and not to be neglected, is *making the projects fun*. Enjoying learning makes it much easier to achieve success.

DESIGN/METHOD

The core to the change was finding a project concept that would support our purpose. One of the authors had seen a "crazy machine" in the National Transport Museum in Switzerland [CM12] and this has been the inspiration for our projects. Consequently we drew up the following requirements for the teams:

Each team's job is to create one section of a machine that moves a steel ball in original ways. The machine must satisfy the following requirements:

1. The dimensions of the machine should be **180 x 90 cm**; divided into 8 modules of **45 x 45 cm**. Each team will be allocated one module at the beginning of the project.

2. Modules should pass the ball to each other. Teams will have to negotiate entry and delivery points with neighbouring modules.
3. Every module must keep the ball in motion for a minimum of 30 seconds and a maximum of 1 minute. Once the mechanism finishes its operation, the ball must be delivered to the next module with no human intervention and the original module state be restored so that it may be retriggered.
4. The ball's trajectory may span for more than one module; in that case teams need to negotiate use of system real estate so that modules do not interfere with each other.
5. Every module must use **at least two different sensors and two different actuators**. Available sensors are: touch switches, tilt sensors, infrared proximity sensors, pressure sensors and current sensors. Available actuators are: servo motors, DC motors with H-bridge controller, LEDs, and small speakers. Other sensors and actuators may be used, but they will be sourced by the design team.
6. Materials for the machine will be sourced by the design team. Cost must be minimum, hence the use of recycled materials is highly recommended. (How many uses can a plastic bottle have?)
7. The machine will be powered with a single 5V power supply.
8. Every module should be controlled by an independent processor (microcontroller or FPGA) supplied by the university.
9. Teams doing both units (ESE and ADD) must use three different sensors, three different actuators, the microcontroller and the FPGA.

Data collection for the projects is through the design and assessment documentation (see Fig 1) together with interviews/discussions with teams and team members.

INTERIM FINDINGS

The project is currently in the middle of its first full implementation. Results to date from students' blogs and team performance are very positive. The authors have seen good teamwork, effective inter-team negotiations taking place and very distinct module designs and students enjoying what they are doing.

FURTHER RESEARCH

The authors will complete collection of the formal documentation and assessment together with the informal interviews and discussions. These results will be analysed to determine the success (or otherwise) of this approach and its sustainability over future years.

CONCLUSIONS & CHALLENGES

The initial student reaction has been extremely positive and we do believe we have been able to introduce a "fun" element into their learning experience. The proposed designs have been diverse and it will be very interesting to see the successes and failures. The authors are confident from the initial responses that it is a learning success independent of the actual outcomes. It is our intent to give a "first penguin" award (Pausch 2008) to the team that may fail the final implementation by the due date but proposed the most ambitious and innovative design.

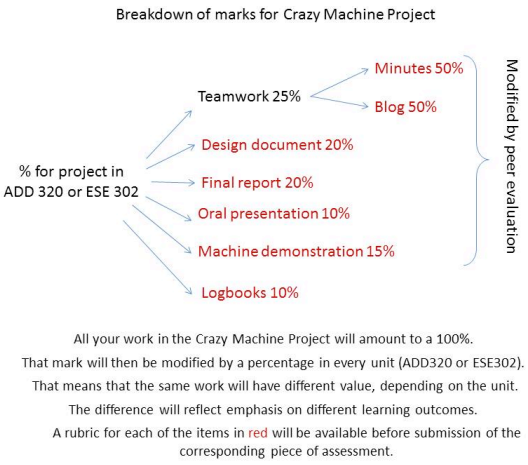

Fig 1. Documentation & assessment

REFERENCES

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Pausch, R (2008). The Last Lecture. *Hachette Australia*

Crazy Machine, NTM, Switzerland. Youtube link: http://youtu.be/a61dY3mrpJA

KEYWORDS

PjBL, Collaboration, peer assessment, negotiation, professional skills.