Developing Key Skills through an Authentic Design-Build Project

Dr Geoffrey Cunningham, School of Mechanical and Manufacturing Engineering, Queen's University Belfast

Abstract

The development of key skills using active learning is described. Each year a group of mechanical engineering students at Queen's University Belfast undertake to conceive, design and manufacture a small single-seater racing car for the annual Formula Student competition. The endeavour is undertaken in a similar manner to running an engineering business, with the students undertaking the full range of technical and managerial roles necessary to complete the project successfully. The students interact with a range if internal and external organisations and have the opportunity to develop a range of key skills in an authentic engineering environment. Previous participants have enjoyed a high level of professional success and often cite the experience as a valuable springboard onto the career ladder.

Background

The inclusion of key skills in the engineering curriculum has become an important issue, driven primarily by the growing pressure from government and industry bodies to produce graduates ready for the workplace. Historically key skills have been delivered in a similar didactic manner to the more familiar engineering science subjects, however, the general consensus is that students become disengaged with this approach and often fail to profit from the experience.

Previously, the only opportunity to practice key skills in the School of Mechanical and Manufacturing Engineering at Queen's University Belfast was during the major projects run in the 3rd and 4th years of the programme. These were self-contained one or two person projects and included limited exposure to a full range of key skills. The introduction of group projects as part of SARTOR 3 has overcome many of the previous limitations; however, there is still the feeling that the experience from group projects is somewhat artificial for many of the students.

Methodology

The School is constantly looking for methods to enrich the student experience and a number of years back it became involved in the Formula Student competition; primarily as a method of introducing more interesting projects for 3rd and 4th year students. However, the initial participation quickly proved popular among the students and the involvement has now grown into a multi-year, multi-module team-based project.

The aim of the project is to conceive, design, finance, manufacture, market and compete in a small single-seater racing car. The project runs over two semesters and costs in the region of £15,000. The team consists of a group of approximately fifteen 3rd year BEng/MEng students, and a smaller group of approximately six 4th year MEng students. The 3rd year students undertake the project as part of the Project 3 module, which is worth 25% of the total marks for the year, while the 4th year students undertake the project as part of the Project 4 and Professional Studies 4 modules, which together are worth 33% of the total marks for the year.

The project structure is modelled on a Formula 1 team and the general division of roles is for the 3rd years to undertake the detailed design and development of the car, and the 4th years to undertake the technical and business management of the project.

The team is split into four technical sub-groups responsible for chassis, suspension, unsprung mass and powertrain. Each of these sub-groups contain a number of third year students, each undertaking an individual technical project for their Project 3 module, and one or more 4th year student(s) acting as the sub-group technical manager(s) for their Project 4 module. In addition to the technical roles, the 4th years also take on management roles to fulfil their commitment to their Professional Studies 4 module. These roles are: operations director, technical director, financial director, sponsorship director, marketing director and testing director. The position of managing director is held by the academic supervisor.

Assessment for Project 3 is by individual report, peer assessment, oral presentation and oral examination, while Project 4 is assessed by group report, peer assessment and oral presentation. Professional Studies 4 is assessed by group report and oral presentation.

Issues

Operation – Design-build projects require substantial resources to function effectively. Laboratory space, and financial, technical and manufacturing support are the main issues, although health and safety, and availability of tools, materials and consumables, etc. are also important. Operational issues are overcome through the involvement and support of stakeholders, such as the Head of School, Workshop Manager, Laboratory Manager and Safety Officer.

Students – The student related problems are mostly due to conflicting personalities and poor planning. These can manifest themselves as uneven division of the workload, conflicting goals, general conflict and poor time management. A single compelling project goal, peer assessment and good project planning can mitigate many of these problems.

Academic – The goal of the project can sometimes conflict with the learning outcomes and it is therefore important to monitor student progress on a regular basis. It can also be difficult to 'find a fit' within the existing modules structure because of the unique nature of the project. Careful preparation, including a robust description with clear learning outcomes and solid assessment methods, is essential to the success of a design-build project.

Benefits

The most obvious benefit is the significant increase in student motivation. The effort expended is quite often higher that justifies the academic credit available, although it is still time well spent as the students are operating in an authentic working environment in which they have to display good personal, interpersonal, technical and managerial skills. For those without previous industrial experience it is an excellent introduction to interpersonal relationships.

Evidence of Success

Since its inception, the students and the team have performed very well academically and competitively. Team members regularly place at the top of the class and collect academic awards, while the team has been a consistent top performer at the annual Formula Student competition. However, perhaps the most convincing evidence is from the students themselves: "It has definitely been the highlight of my academic career and a fantastic finish to a long course".

How Can Other Academics Reproduce This?

The success of this project can be attributed to the stimulating focus, the competitive element and the widespread support within the School. The starting point for anyone also seeking to motivate their students in a similar manner would be locate a suitable competition, consider how it could be accommodated in the curriculum and then convince the rest of the department of its merit.

Reflections

Formula Student has been a runaway success in Queen's University Belfast. What started out as an interesting endeavour has turned into an effective method of delivering key personal, professional and technical skills to a large group of students. There have been additional benefits over-and-above increased student motivation; it has increased staff motivation, has been a key promotion and recruitment vehicle for the School, and has led to the development of new ties with a number of Universities across the UK and Europe. Formula Student has been a very positive experience and would certainly encourage me to become involved in other engineering educational competitions.

References

Formula Student website, www.formulastudent.com, 2005.
Queen's Formula Racing website, www.queens-racing.com, 2005.