GLOBAL ENGINEERING DESIGN TEAM (GEDT)

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1. Introduction

Industries are becoming more global in nature, especially in their supply chains. Undergraduate engineering students rarely address this trend or have the opportunity to participate in international or non-collocated teaming. Furthermore, international companies have a desire to explore closer global relationships with their current or prospective supply chain companies. For these reasons, Arizona State University (ASU) and the University of Leeds (Leeds) have begun a joint academic year course entitled the Global Engineering Design Team (GEDT). The goal was to create a single team of students on a company-sponsored design project that required continual global teamwork, thinking and communication and would prepare the students for Design in a Global Environment.

2. Educational Need

A context for the educational need is provided by a recent “Year 2010 Engineering Environment Vision” white paper from the Industry-University-Government Roundtable for Enhancing Engineering Education (IUGREE) [1], which looks at product realisation in 2010. The primary drivers of this engineering environment are expected to be:

- Global competition to supply products of superior performance and quality, lower cost, and within society's environmental constraints.
- Product and process technology advancements.

Industry and business requirements within this context are provided in a recent report, 1999, by the Society of Manufacturing Engineers [2]. This report provides an update on work published in 1997, on competency gaps among newly hired Engineering graduates. The 1999 competency gaps are ranked as follows:

1	Business Knowledge/skills	9	Manufacturing systems
2	Project Management	10	Quality
3	Written Communication	11	Problem solving
4	Supply chain management	12	Teamwork/working effectively with others
5	Specific manufacturing processes*	13	Materials
6	Oral communication/listening	14	Product/process design
7	International perspective	15	Engineering fundamentals
8	Manufacturing process control		

*No single process stood apart as especially critical. This was interpreted to indicate a desire that students have some experience in at least one manufacturing process.

A theme that emerges from these needs is the requirement to educate engineers not only in engineering science and processes of engineering design and manufacture but also in so-called "soft skills" that are less of an exact science but are important in the application of engineering knowledge within a business environment [3]. At a recent conference entitled Educating the Engineer for the 21st Century [4], reinforced the above. Whilst there was recognition for the need for technical knowledge and skills there is also a need for a graduate to have a range of personal skills, knowledge and experience. These include:

- Lifelong learning
- Ability to work in a team
- Leadership
- Experience Of Management
- Initiative
- Communication Skills
- Entrepreneurship
- Interdisciplinarity
- Experience of other cultures and languages

The Engineering Council is the national registration authority for professional engineers within the UK. The council's board set standards for education, training, and professional competence, which are published in Standards and Routes to Registration (SARTOR) [5]. SARTOR has recently been revised, in part, because of the move from national to global markets for goods and services and the increasing need for engineers to be able to operate globally. The Accreditation Board for Engineering and Technology (ABET) provides a similar function in the USA where it sets standards for qualifications for Professional Engineers. In general, ABET and SARTOR requirements for engineering qualification encapsulate these needs for a broader education of engineers beyond engineering science, design and manufacture, which includes “soft skills”.

The purpose of the GEDT course is to contribute to the education of future engineers relative to these requirements. In particular it provides a realistic project with cost and time drivers within the context of a global set of organisational relationships. One of the challenges of the course is continuously improving it.

3. Approach to Learning

The basis for student projects is to provide them with an experience through which they learn. More specifically Kolb [6] argues that following an experiential learning model provides a framework for examining and strengthening the critical linkages among education, work, and personal development. Kolb's experiential learning model is shown diagrammatically in Figure 2. Thus the need identified above, to prepare undergraduates for industry, can be addressed by an appropriately designed experience. Furthermore the experience of developing the GEDT course and mentoring projects for the industrial and academic mentors have the potential to provide a valuable learning experience for them. This directly addresses one of Boeing's original requirements of the GEDT course, which was to facilitate the development of the capability of Boeing personnel to operate globally. Key to the GEDT course is the definition of the project by the industrial mentors. Also important is the role of industrial mentors as both customer for the output of the project as well as mentors. This is important to provide as much industrial realism to a particular project as possible. Another key element, that is implicit, is the global nature of the team. With there being 2 remote elements to the GEDT and a limited travel budget the team has to work globally. The above needs and the experiential learning approach have provide the basis for a set of learning objectives. These are defined as follows.

By the end of GEDT course, the student should:

- Have had the experience of a completing a project, which is industrially relevant and broad in scope.
- Have the experience of working in a global team completing an industrially relevant project, tackling issues of communication (both local and global and including written and oral mechanisms), project planning, team working and cultural diversity
- Be able to work with and satisfy the needs of all the stakeholders in the project
- Be able to apply logical reasoning based on a firm knowledge of engineering science, and be able to demonstrate sound professional judgement;
- Be able to demonstrate powers of independent critical judgement;

In a wider context the GEDT strategy includes the adoption of University procedures for course design and review.

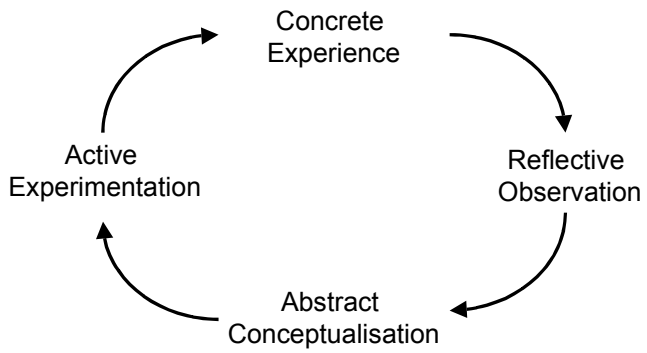

Figure 1. Kolb's Experiential Based Learning Cycle [6].

4. People

Key to the success of the GEDT projects has been the commitment of all the people involved whether they are students, academics or industrialists. Fundamental to the GEDT course is the learning opportunity it affords *all* these people. Student learning is structured through the schedule that is adopted, facilitated through team building activities, focused by the objectives and plans developed for a particular project, recorded through the documentation of meetings, production of assessed reports and presentations and by their keeping of personal development logs. The course enables faculty to fulfil their roles associated with providing and developing a learning environment and to improve their own teaching and mentoring skills. The industrial mentors have the opportunity to directly influence the development of the course to provide the engineers with the competencies needed by industry and to aid in the formation of these engineers whilst they are still undergraduates. Furthermore it affords them the opportunity of doing this with two different cultures.

5. Project Schedule

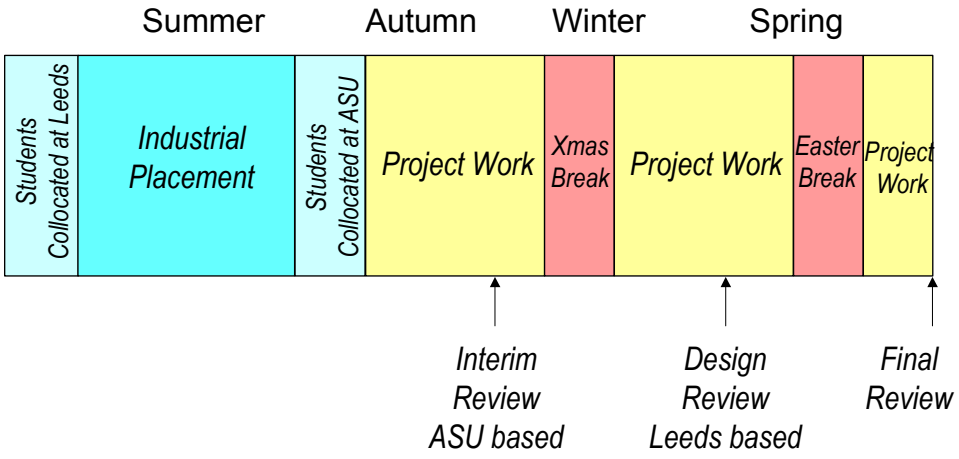

Figure 2. GEDT Course Schedule Overview

The GEDT course schedule has been developed to lead the students through each of the phases of the experiential learning cycle introduced above. An overview the schedule for the project is shown in Figure 4. In each year during the summer break a period of team formation and preparation to undertake that year's GEDT project takes place. During the academic year the students work on the project. It is expected, depending on the course variant taken by a student, that a student will spend between 10 and 13.5 hours a week working on the project during term time, although in reality students spend more time than this working on the project. During the project there are a series of 3 reviews, one before the Christmas Break, one during the US Spring Break and one at the end of the project. These reviews utilise video conferencing to virtually collocate all GEDT members and mentors, both academic and industrial. At the final review meeting the students are required to provide the deliverables they committed to at the out set of the project subject to any concessions that may have been agreed.

6. Results

As a result of participating in a GEDT project students will be able to demonstrate competencies, skills and knowledge they have gained. A measure of this is the classification of the degree that they are awarded. Industrial mentors and faculty will be able to develop their careers. This can be measured in terms of promotions and renewal of contracts. In the USA and UK, emphasis is placed more and more on faculty developing global relationships. There is not typically a reward as such, but it is viewed as the “right thing to do. ”Industry will have a pool of graduates with more appropriate competencies. The measure of performance will be the recruitment of graduates of the GEDT course into their organisations. From a university perspective key to the performance of the schools is their intake and graduates. Measures of successful performance will be the competition of students for places on the GEDT. In the longer term success will be measured in increased numbers applying to engineering programmes and increases in the academic attainment of students both at intake and on graduation

7. Summary

As a result of developing and running GEDT projects the following set of key characteristics have been established that are useful not only in developing the GEDT course but also engineering design team projects in general:

Balancing the needs of all stakeholders. It is necessary to have a view of all the key stakeholders involved in the project. Addressing the needs of all stakeholders is key to the sustainability of courses such as the GEDT course. Stakeholders include: students, student team, mentors, academics, academia in general, Boeing and Rolls-Royce, industry in general, and society, nationally and globally.

Learning objectives that encapsulate the needs of the stakeholders.

Educational strategy - in the case of the GEDT course it is constructing a schedule to facilitate experiential learning of engineering design within a team in a global context.

Schedule - which implements the educational strategy within the constraints of university calendars. The schedule should include elements of: industrial experience both specific to the project and more broad; team training; project planning; project execution; and reporting.

Project - the project should: be realistic in that it is representative of the type of project a graduate may encounter in industry; be supported by industrial data; include a technical aspect that needs the team, as opposed to individual to solve; produce results that are traceable and justified; ideally be interdisciplinary; balance the technical, project management, communication needs of the project, and team formation; be owned by the student team.

The student team, which will need team building, leadership training and project management training as well as specific technical support.

Mentors, both industrial and academic, are needed to provide support form the following perspectives: technical; project management; personnel management, including cultural, team dynamics and leadership; communication. Our experience suggests that one person cannot give such support and that a range of mentors is needed.

Communication facilities - these are essential if the team is to operate as a whole.

Assessment consistency - to provide a level playing field for the whole team, wherever a student is studying, should be assessed using a consistent set of criteria from the outset of a particular project.

Continuous improvement - running the course is itself an experience and the organisation that runs the course. The students should ensure it completes the learning cycle in the same way that the schedule causes the students to.

An integrated whole is key. Experiencing the whole not just the individual elements will cause the students to understand the needs for the competencies listed above and will put them in a position where they have context to better enable them to develop these competencies.

8. Acknowledgements

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9. References

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