THE HIGHER EDUCATION ACADEMY ENGINEERING SUBJECT CENTRE TEACHING AWARDS 2005-2006

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The Engineering Subject Centre Teaching Awards provide an opportunity for engineering academics to receive national recognition for the high quality of their learning and teaching practices. Seventeen high quality submissions were received from across the UK and the review panel found it difficult to shortlist these down to six. The shortlisted candidates have worked with members of the Engineering Subject Centre Team over the academic year to develop a case study of their work and the winner will be announced at the EE2006 conference dinner on Tuesday 25 July 2006.

Case studies developed as part of the Teaching Award scheme, and further information about the awards process, may be found on our website at:

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The six candidates and the title of their case studies are:

Nandini Alinier, School of Electronic, Communication and Electrical Engineering, University of Hertfordshire, United Kingdom
Use of an Objective Assessment Tool to Evaluate Students' Basic Electrical Engineering Skills

Christopher Benjamin, School of Design, Engineering and Computing, Bournemouth University, United Kingdom
Problem Based Learning on a Final Year Design Engineering Course: Inspiring the Buzz

Anna Hiley, School of Mechanical, Aerospace and Civil Engineering, University of Manchester, United Kingdom
Developing an understanding of the Design Process, to Promote Creative Problem Identification and Problem-solving

Euan McGookin, Department of Electronics and Electrical Engineering, University of Glasgow, United Kingdom
Teaching Robotics Through Play and Challenge

Kenji Takeda, School of Engineering Sciences, Southampton University, United Kingdom
School of Engineering Sciences Induction Week

Sean Wellington, School of Computing and Digital Communications, Southampton Solent University, United Kingdom
Enhancing the Design and Assessment of Practical Work in the Engineering Curriculum

ENGINEERING EDUCATION IN AN ARTS AND MEDIA CONTEXT

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ABSTRACT

The skills and experiences gained by electronics engineering students offered by educational institutions are biased towards progression employed to core electronics industries and academies. Qualifications frameworks are developed with this more 'traditional' context in mind. Whilst frameworks are generic to accommodate variation in educational programmes, the approach lacks flexibility for catering to more unusual teaching environments.

The 'arts and media' is one such example. Electronics engineering skills are necessary in a whole range of applications; from the construction of a digital recording studio, to the development of esoteric arts installations. Students learn to solve complex problems involving technical equipment, purchasing logistics, and sometimes temperamental artistes! As these engineers progress to higher qualifications they engage in direct technical and project management, with greater emphasis on resources, requirements and people; rather than theoretically complex, detailed and mathematical problem solving.

This paper will examine the skills and competences electronics engineering students require in an arts and media context. The paper then reviews the Irish Engineering Qualifications framework, a country which is very influential in the development of qualifications frameworks across Europe. The paper discusses the arts and media context and finally proposes a suitable amendment to the Irish framework, to accommodate this environment.

INTRODUCTION

A description of the fundamental characteristics of an engineer could often include technical descriptions related to a specific branch. Thus, fundamental descriptions of an electrical or electronic engineer may include such terms as 'design' and 'analyse' as mandatory. Whilst such terms may not be incorrect, they tend to narrow the definition, and do not necessarily reflect the attributes of many professional that utilise a range of other engineering skills. Such a description has often arisen historically from the education, training and experience of electrical and electronic engineers who have established the discipline over the last fifty years or so. As industry has gradually changed in that time, engineers with for instance electronics as a core technical facet are employable in a much wider range of industries than those 'traditional' ones such as manufacturing, design and test.

The television and radio industries employ many engineers of course, to develop broadcasting facilities, telecommunications and studios. Arts and media professionals who dominate these two industries are also involved in a whole range of others, whose needs also include electrical and electronic engineers. Whenever an art exhibition, musical performance or theatre show is mounted, an electrical or electronic engineer would be involved to a greater or lesser extend. Whilst it may appear that her/his skills are peripheral to the event, it is usually the case that the engineer's skills are what 'makes or breaks' the show. The critic for a show on 'Broadway' or in 'Madison Square Gardens' would criticise the technical delivery of a show as much as the performance of the artist; in fact a technical mishap can be the downfall of any performer.

For engineers working in the arts and media environment it can be as high pressured as any of the traditional industries. Artistic flair, innovation and energy are often spontaneous, passionate and unconstrained. The engineer may be working with an artist whose ideas could radically alter without recourse to an original plan.

Engineers in the traditional industries may be used to basing their work on contracts that explicitly state the outcomes, budgets and timescales. Money is not the driving force behind true artistic endeavour, so the artist may not abide by these constraints in the same way. This clash of perspectives can produce conflict between the artist and engineer, unless the engineer has the traits and skills to manage the conflict in a way that suits the artist's aspiration and her/his aims in gaining technical experience. Engineers who have the ability to work in the arts and media context are sought after. It is a niche market, but there is a definite need to educate engineers in this respect. Engineers in the arts need to have more than simply an appreciation for the needs of the artist. An artistic empathy is highly desirable, and often the engineer would already have creative and artistic talents. The notion that engineers should be nurtured in the twin fields is not new. Leonardo Da Vinci(1) and his devotees were both artists and design engineers. Sydney Opera House for instance is a Leonardo Da Vinchi derivative in both its artistic and engineering design content.

On a practical basis, engineers working with artists would need to communicate a broad range of solutions in the manifestation of an artist's work, without unduly constraining her/his creative intentions. This requires broad knowledge of design solutions. Every artist is driven by the need to be original, so 'stock' circuit solutions or equipment may not be appropriate. Aesthetics is of prime importance in the implementation of designs. The need for visually pleasing or hidden engineering solutions may be even greater than for instance in stylish and elegant audio-visual home entertainment systems. The equipment must be reliable so that the senses of the exhibition visitor are continuously conscious within the artistic environment. If the lights suddenly blow or there is a raucous noise on a loudspeaker for instance, the whole effect can be ruined in an instant. If nothing else, the artistic event should present no health and safety danger. The possibilities of the general public being subjected to such incidents are great. This in itself brings artistic and practical conflicts.

The engineer should also recognise that the artist may have skills that can be deemed as engineering, or that close working with the artist could encourage and foster such skills. The engineer should not therefore designate her/himself as the fully knowledgeable expert, but should guide the artist confidently to the most mutually acceptable solutions. Indeed, professional engineers should accept that often artists, uncluttered by convention, can generate the core of a practical and effective solution very easily!

AN EXAMPLE OF ENGINEERING IN AN ARTS INSTALLATION

Consider an artist Lorcan, who wants to make an installation for an exhibition. His wish is to communicate the feeling of being 'trapped'. Lorcan has engaged the services of an electronics based engineer Aoife to design and implement the technical system to interpret this feeling. Aoife has already developed skills and gained the experience needed to work effectively with Lorcan. She develops a working relationship with Lorcan so that she can understand the emotions that drive his work. She is able to help develop his ideas and suggest broad solutions in the first instance that suits Lorcan's aspirations and temperament.

Lorcan has refined his ideas with Aoife's help. He wishes to have an enclosure in which voices can be heard on the edge of the area – voices belonging to people that are out of reach or inaccessible. Lorcan is also interested in blurred images being portrayed on a mock 'window' in the enclosure.

Aoife offers a number of solutions; however they have mutually agreed that one involving loudspeaker drivers embedded on the periphery of the enclosure, and a hidden projection system will best communicate the artistic piece. Lorcan would also like interactivity, so that the voices of the exhibition visitor can be integrated with the other sounds.

Aoife then has a number of detailed design issues to contend with:

- speaker layout design and installation;
- use and configuration of amplifiers;
- interface to the recorded sounds;
- visual display system installation and projection backdrop;
- use of a controller to sequence all sounds and vision;

- electronic blending of sounds from the visitor and the recordings;
- acoustic design of the enclosure;
- microphone placing design.

The controller itself may lead to a more complex design. A computer would not be aesthetically pleasing in this context, so a microcontroller device hidden in the space may be the only solution.

Safety issues may be important, to ensure visitors' hearing is not compromised by acoustic feedback, or to prevent electric shock from wiring in the installation.

There may be other electrical and electronic engineering issues that Aoife has to contend with.

ENGINEERING SKILL-SET FOR ARTS AND MEDIA PROJECTS

Experience in the field suggests that engineers working in arts and media need to develop the following skills:

- Basic engineering principles, for instance in electronics and audio-visual related disciplines this would include circuit development, audio and visual system implementation;
- Management of diverse technologies and resources;
- Empathy with needs in the artistic field;
- Innovation and determination of unique, aesthetic solutions;
- Health/Safety design compliance and reliability engineering.

The demand in arts and media are such that artistic clients expect engineers to have skills and competences as soon as they become involved with projects. It is necessary therefore to provide the opportunities for engineers to be educated and trained to meet these needs.

TECHNICAL PROGRAMMES IN THE ARTS AND MEDIA CONTEXT

Only a small number of educational institutions offer technical or engineering educational programmes within an arts and media context. Noteworthy ones are:

- Institute of Art, Design and Technology - Dún Laoghaire, Republic of Ireland(2): of particular interest are the Higher Certificate in Engineering in Audio Visual Media Technology, Bachelor of Engineering in Digital Media Technology, degrees in Fine Arts, Visual Arts Practice and Model Making that involve engineering to some extent;
- Utrecht School of the Arts – Netherlands(3): this institution has been successful in developing a number of Bachelor of Art/Technology, Media/ Technology and Music/ Technology Programmes. The content of these programmes is applied to niches such as games design, 'image/media technology and 'composition/ music technology';
- The University of Birmingham, UK(4) offers degrees where students can select both arts and technology modules;

A more cohesive approach to the development of programmes involving engineering and the arts is necessary. The ultimate approach would be to develop a sub-discipline, based upon the cross-fertilisation of these two fields. In order to do this, engineering students from existing programmes should be given the opportunity to explore joint projects. Within the programmes available, many of the skills discussed are not identified in curricula.

Current engineering programmes, taking electronics as an example, follow a traditionalist approach. As students progress from one year to the next, their skill-set is expected to become more analytical, design oriented and research based. Whilst these skills may be applicable to the manufacturing industry for example, they do not serve well in the arts and media context.

Considering engineering programmes *en masse*, it is found that governing frameworks at national or state level do not necessarily contain the mechanisms to cater for the arts and media field. An examination of the existing standards is necessary to find the opportunities for the required skills to be met, or to make proposals for the re-orientation of these frameworks.

ENGINEERING EDUCATION FRAMEWORKS OUTSIDE IRELAND

A number of influential educational frameworks and allied research projects (in English speaking countries and Europe) were reviewed, in order to identify opportunities for the skill-sets of engineers in the arts and media environment.

Massachusetts Science and Technology/ Engineering Framework(5)

The Massachusetts Science and Technology/ Engineering Framework was reviewed in this survey, because it provides a guiding ethos in the activities of the highly influential Massachusetts Institute of Technology. The underlying philosophy of the Massachusetts framework document is the importance of science and nature in society, rather than the arts. The perspective is broad within the science context, but relates solely to the clear and rational observation of the natural world. As a consequence, the engineering framework assumes a heuristic approach to problem solving, with a finite set of constraints and solutions, with little recourse to the unpredictability caused by the human condition. The document includes a flow chart of the engineering design process. Such a prescriptive and standard approach would not be appropriate in general for the arts and media context. In particular, the lack of iteration in the process would lead to serious communication issues between the artist and engineer. The engineering ‘problem’ would need to be defined as a ‘vision’ which may evolve and change. For engineering students in the arts and media environment, the more flexible approach is one in which they need to gain skills.

The graduates of higher education programmes within the Massachusetts framework are encouraged to seek employment within the product, services or medical goods industries. The framework is not broad enough to include the use of engineering to fulfil esoteric, aesthetic, creative or emotional needs, but rather concentrates on material and direct sensual requirements. A point of interest is the inclusion of ‘Disney World’ as a place graduates may seek employment if they are looking for an environment encouraging ingenuity. There is however a positive recognition that core practical skills should be gained by students before leaving high-school and during their ‘freshman’ year at university.

Proposed Framework by Purdue University, USA

Research undertaken by Purdue University resulted in a proposal for a ‘New Framework for Academic Reform in Engineering Education’(6). The ethos of the framework is largely business based. Allied themes are the institutional needs of academic bodies themselves and the environment. It is suggested that economics is the ‘engine’ of change. This need influences the proposed framework such that holistic solutions to problems are encouraged. Such solutions, the framework implies, would include consideration of social and psychological factors. It is suggested therefore, that the most employable engineering graduates need such skills, as well as the ability to learn. Many of the ‘thinking’ skills engineering students would in the arts and media context would be fostered by this approach. The framework also provides for the training of higher education teachers to take a holistic approach to teaching such students.

This framework is encouraging in its approach; whilst the economic ethos is not directly compatible with the arts and media context, the ability to think laterally and widely is relevant.

Australian Qualifications Framework (AQF)

There is a single qualifications framework for all the states of Australia; the AQF(7). At post-school levels of the framework, there are two parallel sectors, ‘Vocational Educational and Training (VET)’ and ‘Higher Education (HE)’. VET has many similarities to the Institute of Technology (IoT) sector of education in the Republic of Ireland (where until recently the government conferred all awards). The Australian HE sector relates to the self-governing universities that confer their own awards.

There are clear benefits to the existence of two sectors. VET provides the means for students to undertake certificates and diplomas whose nature is practical, involving the management of resources, leadership and diversity of applications. The HE sector on the other hand directs students to the mathematical, analytical and research based approach, especially at degree level. Engineering in the Arts and Media context is suited to the VET sector.

It should be noted that the qualifications of Diploma and Advanced Diploma can be studied in the VET or HE sectors. One criticism of the detailed framework is the lack of distinction between the learning outcomes of these two qualifications for the two sectors. However the outcomes in both sectors at these award levels do include the ability of students to be self-directing, broad in knowledge seeking, detailed in planning, skilled in dealing with people and aware that there is an element of unpredictability in engineering. These are all useful learning outcomes for engineering students in the arts and media context.

Engineering Education in Europe

The Bologna Declaration in 1999 aimed to align thirty-two higher education systems in Europe by 2010. The Graduate Management Admissions Council (GMAC)(8) considered the higher education institutions with regard to their future autonomy, as a result of the Declaration.

The development of the European Credit Transfer Scheme (ECTS) arising from the declaration increases students' mobility in taking modules within programmes from a variety of higher educational institutions in Europe, and accumulate enough credits for a degree. It is theoretically possible for an engineering student to undertake arts and media modules from another institution and use the credits towards a degree. Thus, the student could gain, via single modules the skills she/he needs to progress in the area of engineering/arts/media. In practice however, there would be issues as to the accreditation of such composite degrees. Very few institutions would currently be able to confer such a degree. This situation will exist until the field of engineering within the arts and media context is established as a single discipline within particular higher educational institutions, or the field is recognised at European level so that conference is possible by a central European body.

The project EUR-ACE(9) in the UK has been involved in accrediting Engineering programmes in European higher education institutions. The extended project phase in 2006 involves the testing of its proposed frameworks at higher education institutes across Europe, and a report is then expected. Current information available regarding the project does not include the assessment framework; however it implies that students' skills should include analysis and research, as well as multidisciplinary approaches and critical awareness. Included also is the need for students to deal with the unfamiliar and ill defined problems in new and emerging areas, using innovative methods. These latter skills are of particular relevance to students solving engineering problems in arts and media. The project also supports the importance of assessment frameworks being valid for all engineering programmes.

ENGINEERING EDUCATION FRAMEWORKS IN IRELAND

Framework and Standards for Engineering Qualifications in Ireland

The Irish Education system(10) consists of a ten level framework. Five of the levels are in higher education (known in the Republic of Ireland as 'third level'). The framework is seen outside of Ireland as being an example of 'good practice' and consequently the country is very influential in the development of frameworks across Europe. Unlike the AQF(7) the framework is integrated in terms of university education (the HE sector in Australia) and amongst its Institutes of Technologies (IoTs), where students can gain higher education qualifications up to doctoral level. The framework has provision for the following undergraduate qualifications, including engineering:

- Higher or Advanced Certificate (Level 6 in the framework);

- Ordinary Bachelor Degree (Level 7);
- Bachelor degree with Honours (Level 8).

Degrees have until recently all been conferred by the Higher Education Training and Awards Council (HETAC), however the IoTs are moving to a 'delegated authority' status, which would give them more flexibility in the programmes they offer. Currently these programmes are predominantly science, technology, business and linguistics based. Engineering programmes mainly follow a 'traditional' model. There are exceptions to the trends in programmes offered, music being one example. The Institute of Art, Design and Technology – Dún Laoghaire is unique amongst the IoTs in offering distinct and well established arts and media programmes up to an MA qualification (Level 9 in the framework), as well as science, technology, engineering, business and humanities degrees.

HETAC Development of Standards in Engineering at Third Level in Ireland

In August 2004, HETAC developed the current standards for third level institutions in the Republic of Ireland(11), for a variety of disciplines such as Engineering, Art and Design, Science, Business and Nursing. It was expected that the Institutes of Technology (IoTs) would use these standards in the review and re-development of their programmes.

The current engineering standards are comprehensive, in that they consider the requirements of students in different dimensions, namely:

- Knowledge areas, e.g. design, mathematics, business;
- Knowledge scope, e.g. breadth, application, competence and sub-categories of range, and selectivity.

The standard framework is very useful in providing commonality across programmes and promoting consensus in determining 'best practice' in the facilitation of learning outcomes amongst students. However, the framework does restrict itself somewhat to the traditionalist model of engineering, prevalent in every other framework surveyed.

As students' progress through the under-graduate years of study, from Level 6 to Level 8, there is a tendency for the scope of their skills become more analytical, mathematical, design and research oriented. The framework implies that heuristic app-roaches to problem solving are preferred. Only in postgraduate Level 9 is there recognition that problems may be ill defined. It is encouraging to find however, that as students progress through the levels they are required to 'learn to learn', and by doing so they gain knowledge of new engineering sub-disciplines, such as engineering for the arts/ media environment. The competences deman-ded of the students, and professional approach that the framework supports, are all valid in the context being discussed. There is recognition that core, traditional engineering skills are necessary, particularly at Levels 6 and 7.

Engineering Ireland (EI), the Republic of Ireland's professional engineering institution held a view on the current standards which generally concurred with HETAC(12). The vast majority of its members are employed in engineering fields associated with the 'traditional' industries such as design and manufacturing. Graduates from third level institutions whose engineering programmes are accredited by EI may join as ordinary members, and it is implied that the institution would only approve those programmes compliant with their standards.

Proposed Amendments to the Current HETAC Engineering Standards

It is recognised that radical changes to the draft standards for the purposes of engineering education in the arts and media context would not be appropriate for such a small sub-discipline of engineering. However it is apparent that the standards should be widened to allow for the development of 'non traditionalist' programmes that may provide employable graduates in engineering sectors yet to emerge.

It is also important to incorporate additional features in the standards that have been well established previously, in order to ensure that they are robust and rooted in teaching pedagogy. For this reason, the other current HETAC standards were consulted.

It became apparent for several reasons that the standards for Nursing (August 2004, unpublished by HETAC, only available in draft) contained many features that are appropriate to the engineering/arts/media context. As nursing students progress from Levels 6 to 8, they are increasingly required to manage people; not only their subordinates, but also the clinical needs of patients or clients. Nurses have to empathise with patients in order to fully recognise how they can be given the best medicare. They are required to take a holistic approach to problem solving, with people and technological resources as the two main aspects. Critical thinking and reflection are two common techniques nurses would use. In addition to this, nurses' communication skills develop as they progress through the levels. There is a recognition that systems involving a diverse range of people cannot be mathematically analysed, designed for or predicted, and that the system can rapidly change.

Following from the review of the Nursing standards, it is proposed that the Engineering standards are broadly modified to include the following themes:

- Skills in understanding the needs of clients, with increasing depth as students transfer to higher levels;
- Consideration of the complex interaction between engineering systems and people;
- Flexibility in approach to solving engineering problems by detailed consultation and agreement with stake-holders;
- Reflective judgement as a complement to 'learning to learn'.

These changes would be beneficial to students aspiring to practice engineering in the arts and media context, but also those graduates entering the new business oriented engineering industries (such as cellular telephony), innovative companies continually seeking a 'market edge' over competitors, and also Small to Medium Enterprises (SMEs) where the engineering service providers have significant levels of direct interaction with clients. Such engineering arenas would welcome graduates with the additional skills identified above.

The changes discussed above would provide more opportunities for Engineering Education in the Arts and Media Context to become established as a discipline in its own right.

CONCLUSIONS DRAWN FROM THE SURVEY AND PROPOSAL

The survey of existing programmes implies that there are three main types of framework, in each case where:

- the ethos for a framework is defined, for instance the Massachusetts framework(5) and the Purdue proposal(6);
- the ethos is implied within the detail of the framework, for instance HETAC in Ireland(11);
- the framework or assessment procedure is flexible enough to accommodate different skill applications, for instance AQF(7) and EUR-ACE(9).

Science and nature form the ethos of the Massachusetts framework(5). Business, with recognition of some human aspects is the main driving force of the Purdue(6) proposal. It is considered that such structures do not allow accommodation of many engineering branches and also divert from trends towards society's synergy with technology.

There are clear advantages to frameworks that facilitate a variety of emerging multidisciplinary approaches, some of which may not currently exist. However many existing structures constrain students to the 'traditional' progression routes.

Frameworks should be tightly defined according to pedagogical considerations, so that quality can be assured. The AQF(7) for instance should be tightened so that there is clearer distinction between VET and HE degrees at diploma and advanced diploma, so that programmes involving engineering and the arts can be better defined in the VET sector. Initial information regarding the EUR-ACE assessment approach implies that its framework is flexible enough to cope with a variety of skills applications. The final report will indicate how clearly the assessment method has been defined.

The Irish HETAC(5) framework for engineering (endorsed by Engineering Ireland) does not specify applications of skills to fields of engineering but by implication constrains students to ‘traditional disciplines’. It is considered that there should be more recognition of human aspects. Interdisciplinary collaboration however is recognised in the framework and more esoteric approaches are implied at qualification level 9. A review of the other HETAC frameworks shows that the frameworks can contribute to each other in their definition. In particular the nursing framework would help ‘soften’ the approach to engineering practice.

Engineering programme structures based upon most frameworks would produce engineering graduates who believe that a problem is well defined from the outset and likely to change very little during the course of a project. This may not be the case with engineering in the arts and media context; in fact it is the continued evolution of ideas that inspires the utmost challenge and satisfaction, from both an engineering and arts perspective.

As an overall conclusion, a point of view is articulated; ‘Engineering’ is driven by human need rather than science or business. Artistic expression is one of those needs, and so graduates from programmes should have the skills to contribute towards such aspirations. Those that set the targets and standards for engineering education should provide the flexibility for such an outcome.

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AN INVESTIGATION INTO AN ENGINEERING LABORATORY

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ABSTRACT

Engineering is inherently a practical subject, but frequently the offered practical courses are formulaic and do little to imbue the sense of this practical nature. It was therefore my desire to change this approach and enable learning of the practical skills of the engineer in an interesting and engaging way. As a starting point the student experiences of traditional laboratory classes were initially considered; and following this they undertook a new module, which involved a problem-based learning (PBL) challenge requiring them to investigate materials and processes used to construct a common artifact (Skateboard, motorcycle helmet, disposable razor etc.) and propose alternative materials/processes that could be used to improve the design. Subsequently the student experience was investigated to see how their perception of the classical laboratory classes, and this new approach, differed. However, it is not only the students who are involved in such a class, but also the demonstrators and the lecturer, and their experiences were also considered. By combining the findings of each of these studies, a full picture of the learning environment was sought, and the overall success of the new approach studied.

INTRODUCTION

The subject of this study is the artifact study which is an extended practical taken by all second year engineering materials students at the University of Sheffield. In this course, students work in groups to study common artifacts such as disposable razors, skateboards and crash helmets to determine their construction and materials, with a view to specifying alternatives that would reduce cost or increase functionality. The students were given the freedom to explore the manufacturing processes and materials selection as they saw fit. They then had to answer a challenge asking them to propose alternative materials/processes to improve the product.

This study arose from a desire to improve the laboratory learning experience, which from my perspective was limited in many engineering disciplines. I was aware of a range of alternative laboratory styles that were proposed, but was unable to find detailed studies of the effect of these alterations from the student perspective. I therefore chose to undertake a study to examine the student and staff opinion of traditional laboratory classes, but also study the effect of an approach that was novel to the students and staff. The following paper details the approach used and the findings of the study.

Many of the practical subjects, including Medicine, Science and Engineering rely not only on theoretical knowledge, but also on practical skills that students are required to learn. In fact definitions of engineering implicitly include both practical and theoretical mastery. For example, Collins English Dictionary(1) contains the following definition '*Engineering: The profession of* ***applying scientific principles*** *to the* ***design, construction and maintenance*** *of engines, cars, machines, buildings, bridges, roads, electrical machines and communications systems, chemical plant and machinery or aircraft*'. It is clear that the application of theory in the practical environment is the key task of engineering, and as such, the teaching of the practical skills appropriate to the discipline are essential in any engineering degree programme.

Practical skills, and demonstrations of aspects of the theoretical knowledge, are generally taught using laboratory classes in which students are required to perform the necessary manipulations. This both teaches the practical manipulations and encourages the development of observational skills necessary in the chosen discipline, or at least that is the theory. In practice, it is often the case that the laboratory classes are dry and formulaic, and the students are instructed in what they should observe at any given time.

Laboratory education has been the subject of discussion and research for many years, with a large number of authors publishing studies and treatise on how improvements could be made (For example 2-4). The consensus appears to be that it is highly questionable as to whether the students gain what was intended from the traditional classes, and that a more open and challenging structure is necessary. More recently, a number of authors have studied ways of making the laboratory classes more involving and interesting for the students, generally employing methods that can loosely be placed in the realms of PBL (5-15). Many of these employ modern technology in an attempt to improve the educational experience.

Much of the work that has been published in peer-reviewed journals in the field of engineering comes from the disciplines of computer science and engineering or electrical and electronic engineering, and often concentrates on programming skills or microprocessor technology (5-13). In these works, it is generally observed that a PBL approach is necessary in order to ensure that the students can progress through what can be a complex subject, at their own pace. The association with laboratory work often appears almost incidental in that it is the only way to teach the subject, and hence a series of laboratory classes that build upon each other are employed in order to cover the necessary syllabus.

Outside of these recent attempts to modernize laboratory classes, a number of reviews of laboratory education have also been published, which have led to guidelines being produced by subject groups falling under the umbrella of the Higher Education Academy (16, 17). Throughout such works, and indeed in the studies dating back over the last few decades, the approach has been to give the student more control over and responsibility for the outcome of the lab, and for the educator simply to pose a challenge and facilitate (but not dictate) its resolution. This was exactly my desire with the artifact study, and therefore to judge the approaches success I sought the opinion of the students regarding both traditional laboratory classes and the approach employed in the artifact study. I also sought the views of the demonstrators who supervise much of the laboratory class, and personally reflected on the study, in order to seek a complete understanding of the learning environment of the laboratory in consultation with all participants.

METHOD

The Students

In order to quickly gauge the views of the students regarding both traditional laboratories and the artifact study, closed questionnaires were prepared and issued to the students. These served to provide a snapshot of the opinions held by the group members, and formed the basis of the interviews that are discussed in this paper. To gauge their opinion of traditional and the alternative laboratory classes considered in this study, the students were interviewed in their laboratory groups during laboratory sessions. This provided the students with space to consider both traditional laboratory classes and the novel problem-based approach in detail. Their answers were recorded by myself, and discussed with them, to ensure that I had the correct context and acceptable wording. The final answers from each group were then compiled and reviewed by volunteer students to determine whether, in their opinions, there were any aspects that were not covered in the answers.

The Demonstrators

The demonstrators employed to assist the students in this class were experienced in demonstration of conventional laboratory classes, and in fact a number of them have been registered on the University of Sheffield postgraduate certificate of education. It was therefore my feeling that these demonstrators were in a very good position to assess the learning activities occurring in the class. As such, I wanted to obtain their views on the success of the class in comparison to the conventional laboratory classes of which they had experience. This was requested in the form of a biography, as in this way I hoped to obtain their authentic views uninfluenced by the form of my questions. In doing so I gave the minimum amount of steer to the instructions, simply asking them for comments on what they thought of the artifact study in comparison to conventional laboratory classes. No guidelines were given on length or form that the biography should take, the way in which each of the demonstrators answered being left up to themselves.

The Lecturer

In order to obtain my own opinion on the success of the artifact study, I chose to write reflective monologues. These were highly focused written reflections specifically about the study and how it compared to conventional laboratories. In this way, I hoped to gain an insight in to my own immediate feelings regarding the class, which could be compared to those obtained from the other participants.

Full transcripts of all of the data obtained in this study can be found in Hayes(18).

FINDINGS

Traditional Laboratory Classes

Several students expressed concern about the amount of hands-on work that they were able to do in traditional laboratory classes. For example, '*It would be better to do more hands-on work, to explore the area oneself*' and '*Hands-on work is best*'. Other students expressed concern over the level of understanding that they had prior to undertaking some laboratory classes, and therefore questioned the amount that they could take from the class having completed it. This is demonstrated by the comments '*There is not always enough help to understand the theory*' and '*All of the labs are trying to demonstrate principles from lectures*'.

Some students also expressed concern that they did not really understand why certain of their laboratory classes were included in the syllabus. A typical example that exemplifies this is '*Knowing why a particular lab is considered to be important for learning is important*'. Without this knowledge, it is clear that the students will not be motivated to learn the content of the class, or to know what background reading to do to support it.

The demonstrators also raised concerns over the level of the tasks and involvement the students have in each class, as indicated by the comments '*Most experiments involve taking readings then interpreting the data using graphs and equations*', and '*Most want to leave as quickly as possible and ask questions about getting results quicker or missing out one reading because they thought they knew what would happen*'.

I also made similar observations in my own reflections. '*In theory the students take this script and read it, noting all of the detail, read background information from other sources and therefore it enhances their learning. However, in my experience, the students often enter the classroom with an attitude that says we are here simply to finish as soon as possible, having gone through a list of instructions*'.

From all of these sources, it is therefore confirmed that traditional laboratory classes are considered to be boring by many students and lacking in depth. This makes the classes seem pointless to the students, who therefore make little effort, as has been observed by both the demonstrators and myself. However, other students express satisfaction with the traditional laboratory classes, '*Most of the labs are good*'. It is therefore clear that the learning experience for some students is what we would desire, but that for others, the limited level of hands-on work and the amount of under-lying theory can prove to be a problem.

It was also clear from the interviews that some students fail to see that the labs can be separated from the lectures and therefore be considered as a learning conduit in their own right. '*Some of the labs are out of date, with questions that are no-longer covered in the lectures. This can make it very difficult to get the answers without hassling the demonstrators*'. It is unfortunate that this is the case, as many of the labs are designed to enable students to explore areas that can not be covered in the lectures themselves. This clearly requires the students to do background reading and also synthesise the knowledge and consolidate it with other learning, but apparently this is not done by all of the students; and perhaps it is the fault of the laboratory structure that this is so, because the students come to expect one particular way of learning by '*hassling the demonstrators*' rather than relying on their own resources.

It also appeared that students were uncomfortable with practical classes when the theory was hitherto unknown. Therefore, it could be said that they felt that theory must precede practical knowledge and the practical classes must simply support other modules, while from my perspective this is unnecessarily limiting as the practical environment can become the key to unlocking the theory when the student recognises their lack of sufficient knowledge, a view which is firmly held in PBL.

Other students did make the connection that laboratory classes which extend their understanding of the subject rather than merely supporting the learning in lectures have a distinct advantage. This shows that some students are taking control of their learning, rather than simply relying on the lecturer to provide the information, as they challenge the world and demand further understanding. This is clearly shown in the following comments '*Labs would be better if they covered stuff that was contained in modules and then went beyond that*' and '*The labs that tie in with lectures are very useful, but it can be interesting to explore the subject more widely*'.

As such it is clear that both laboratory classes that are tied to modules and which are more free-ranging have a benefit and that different students will gain from each type. One student summed up this state-of-affairs eloquently by saying '*Some labs should be closely tied to modules but others can be more free-ranging, both have value*'.

The Artifact Study

The rationale behind the artifact study can be summed up in my reflective comments that the aim was '*to give each student more support as they undertook a more free-form study than they were used to. In a sense I therefore wanted to allow the students the freedom to select their own direction within a study, but to have the support of their colleagues while so-doing*'. It could therefore be said that '*The format of the labs was intended to force the students to make decisions regarding what the important details were, then select appropriate techniques to study them*'. The format was geared to allow the students access to a wide range of analytical equipment available in the department, and also to the literature available through the library and the internet in order to analyse their artifact from a wide range of perspectives.

Considering the changes in style of delivery that exist between the conventional laboratory classes and the artifact study, all participant groups hailed the format as a guarded success. This is clearly shown in the following comments obtained from the students during interviews '*The new lab (artifact study) is more open-ended and much better*', and '*I feel that I have learned as much in the new lab (artifact study) as we did in all of the other ones*'. Other students considered the wider perspectives of the study and looked at the relevance of the new laboratory class in an industrial context, as typified by the comments '*This type of lab (the artifact study) is relevant to careers' and 'Also the new lab improves team working*'.

Both of the demonstrators found the approach employed in the artifact study to be very different from those laboratories that they had been involved with before. One demonstrator observed '*I think it is a good idea to have the artifacts study because it is a good way to prepare for final year projects and future study in the workplace*'. The other demonstrator made a similar observation by saying '*I consider its diversity with standard classes a real benefit for the formation of the students*'. From this it is clear that both of the demonstrators appreciate what I was trying to achieve in designing the artifact study and were supportive of the approach.

Both demonstrators also made a number of significant observations on the learning processes that they observed in the class. One demonstrator made a large number of observations comparing the learning processes that he observed in this laboratory class with those of his other classes. He observed that '*the completion of the course depends and is brought forward by the student himself. Wherever the student has enough practical knowledge to run experimental* *techniques independently, the presence of the lecturer and the demonstrators would be unnecessary for most part of the course itself. Personally I think that this is the most difficult concept for the student to understand*'. In saying this he is clearly identifying one of the issues that gives the students a great deal of trouble in the initial phases of the course, and that some never got to grips with. He further observes that '*Despite its unpopularity many of them come to realise that it was not all wasted time: quite a few information can be obtained thanks to their previous work*'. Finally the demonstrator makes the observation that '*Despite the similarities (with conventional laboratories), students seem to enjoy more Artifacts, probably because in this case, despite they are doing similar things, they do it by their own choice and not because they are told to by the demonstrators*'.

However, many students seemed to feel unsettled by the freedom afforded them and the new responsibility for their own learning that this laboratory placed upon them. This was observed above by the demonstrator and is clearly shown from the student perspective by the comments '*This (new lab) is much more interesting, but more guidance on what we are meant to do would be much better', 'The new lab largely addresses our concerns, but is not well structured*' and '*It is very daunting, because you are thrown in at the deep-end in the beginning*'.

One demonstrator also identified a weakness in the way that the students ultimately behave in the study. '*I thought going into the artifacts study that students might take a more active part in obtaining the results because they will not be presented with them. Giving them more freedom in choosing experiments should have allowed them to use the knowledge they have gained from lectures into a practical situation. While some students did take this opportunity a lot of students didn't seem to know what they had to do and relied heavily on guidance*'.

Another demonstrator made similar observations, with the most noteworthy in this context being '*I thought that after the initial guidance they would carry out work on their own but instead of getting results and coming up with their own ideas they got the results and came straight to the supervisors for explanations. They all said that they like the idea of having more freedom in the experimental classes but didn't seem to know what to do with it even when prompted*'.

My own feelings on the subject of the artifact study, both regarding the method of delivery and the overall success can be summarized in the following quote from my reflective assessment. '*Therefore it appears that the study has been partially successful in changing student thinking on labs, as engagement has improved, and I have seen problem-solving in action. However, the less structured approach has proved too flexible for some students*'.

In analysing all of the responses from all of the participants, this last quote I feel actually sums up the artifact study very well. All participant groups note that the study improves engagement with the subject, and provides an opportunity for greater hands-on work. However it is also readily apparent that the provision of greater freedom leaves many students unsure of how to progress their work efficiently. Conversely other students really come in to their own in this environment and flourish, making excellent progress.

Fundamentally this approach changes the relationship between staff and student, from one of teacher and pupil to one of accompanying guide and investigator, which can be a hard transition for all concerned. The demonstrators noted that students still turn up with results and ask 'what do I do with these?', even though the analyses are performed of their own volition. The level of support that students get is therefore vital, particularly if this is the only study/or the first study of this type that they have done. As they become used to taking responsibility then it will become easier for them. Equally, as the demonstrator and module leader roles have changed dramatically, these participants have to become accustomed to allowing the students to take responsibility for their own learning, thereby giving up control over the learning environment and moving to the position of experienced co-investigators rather than assuming the role of didactic teacher. Both changes to student and staff positions need careful management if the maximum benefit is to be obtained from the changes which are found in this study to be ultimately worthwhile.

CONCLUSIONS OF THE STUDY

From the above study and discussion, it is apparent that the techniques used in the artifact study have been successful from both the pedagogical and vocational view-point. It is also apparent that the format employed can be successfully implemented in a way that can increase student satisfaction, thereby addressing a concern that is affecting higher education establishments at the present time.

In this way it is clear that problem-based learning laboratory schemes can address the desires of teachers (active learning and problem solving), governmental bodies (vocational relevance) and students (satisfaction and subject perception). However, it is necessary to carefully consider aspects such as student support before implementation to prevent students struggling to come to terms with the approach and thereby losing the benefit and rejecting the technique before they see the advantages.

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COLLABORATIVE LEARNING ANALYSIS IN MECHANICAL ENGINEERING DESIGN PROJECT

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ABSTRACT

An evaluation of collaborative learning for students undertaking a highly-challenging mechanical engineering design project is presented.

The approach used – collaborative learning – refers to a group of students working together collaboratively on a challenging design project with a view that a fully functional prototype is materialized. The expected benefits of collaborative learning are evaluated based on the five conditions being met: (i) positive interdependence, (ii) individual accountability, (iii) face-to-face interaction, (iv) technical and interpersonal skills development, and (v) team functioning assessment. In an attempt to developing a working prototype of this product, interesting observations are gathered. The paper concludes that implementing collaborative learning effectively is demanding. It requires knowing how to excite the team and equip them to deal with the problems commonly arise in a team-based project including individual accountability and overcoming hostility.

INTRODUCTION

Improvements are certainly needed in undergraduate's engineering education in order to enhance the roles of local engineers in the society. Many industrial's top players demand better integration of engineering theories and real world practices throughout the engineering curriculum(1). Such integration should be a key component of any education reform now and in the future. The way engineering education is conducted is crucial to the future of the engineering profession in the context of the growing gap between the need for well-trained engineers and the ability of universities to produce such engineers.

As such, the current emphasis on implementing collaborative learning in engineering design is well-documented(2,3). Collaborative learning is known as an endeavor in which individual students act as a team in order to become jointly knowledgeable of some particular subject matters. Collaborative learning enables students to develop interpersonal and communication skills through a cohesive teamwork display. This paper focuses on the '*opportunities*' provided by collaborative learning that allow students to achieve the stated skills in carrying out a mechanical engineering project. These opportunities are:

- Collaborative learning (CL) enables students to develop a common understanding of project requirements.
- CL allows the establishment of quantifiable engineering specifications.
- CL gives the freedom to consider a broad range of concept solutions alternatives.
- CL enables students to converge on a concept solution within a rationale team-based decision process.
- CL allows a development of realistic cost estimates.
- CL promotes an understanding of manufacturing processes and design trade-offs analysis.
- CL enables students to use proper engineering analysis to predict performance and efficiency of the design.

PROJECT DESCRIPTION

One of the successful collaborative learning-led mechanical engineering projects is presented here to highlight the meeting of various opportunities described in the previous section. A group of students were tasked with developing a product or improving an existing design that could be accomplished with the participation of an actual local industry player. The purpose of this design is to collect palm oil fruit seeds which are scattered on the

Critical Design Factors	Specifications
1. Safety	All-weather use
2. Weight	Max. 9 kilograms
3. Cost	500.00 (Malaysia $)
4. Reliability	Effective blowing/suction
5. Anti-corrosion	Plastic housing
6. Noise	Less than 90 decibels
7. Filtering	Filter-out debris
8. Lubrication	Petrol
9. Maintenance	Maintenance-free
10. Control	Throttling system

Table 1: Critical design factors for the project

ground. These palm loose fruit seeds are from the palm oil trees which will fall freely during the harvesting process.

The basis of the design is to reducing the need for the workers to bend down to collect these loose seeds and minimise the chances of getting back pain and injuries.

Developing Design Specification

The students were taught on the use of Product Design Specification (PDS) by Pugh(4). The critical factors for developing the collecting machine were brainstormed and collated rigorously. These factors are shown in **table 1**.

Critical Component Design

A critical component for the design to function effectively is a reliable nozzle system. A reliable and effective nozzle system will allow maximum airflow from the blow air inlet that in turn will generate top rate suction power. This suction power will carry the loose fruit seeds into a collecting bag located at the shoulder of

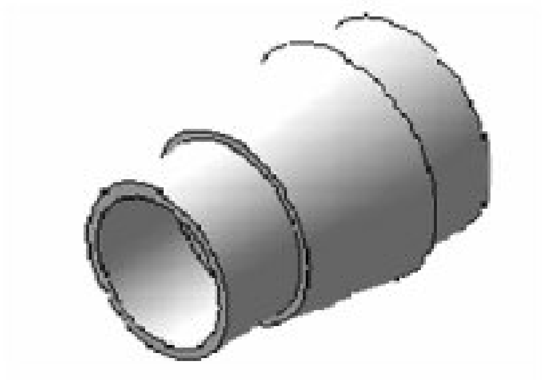

Figure 1: Pressurised Teflon nozzle

the worker. The students were agreed to develop a pressurised teflon nozzle to generate top rate suction power. The design of this nozzle is shown in **figure 1**.

An efficient suction power is achieved by an inclusion of the teflon nozzle. This design enables high velocity of air flow – in the region of 22.2 m/s – to carry the loose seeds until they reach the collecting bag. The flow of air in the nozzle is characterised in **figure 2**.

Weight Consideration Analysis

The initial total prototype machine weight was 12 kilograms, more than 3 kilograms over the proposed design weight. The team went for another round of project meeting to find alternative solutions to reduce the machine

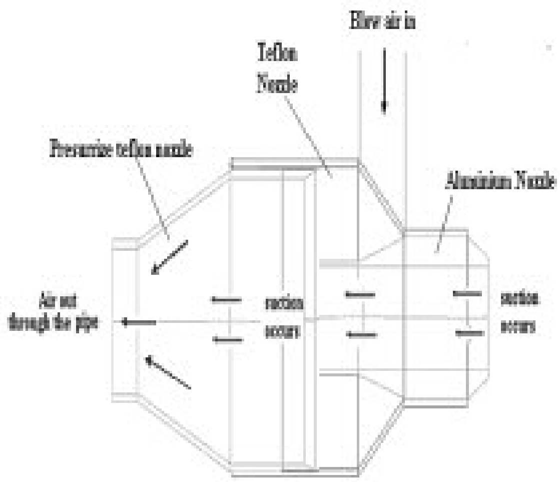

Figure 2 - Suction mechanism using teflon

Figure 3: The prototype palm oil fruit seeds collecting machine.

Figure 4: A test session for the prototype collecting machine at a palm oil plantation site.

actual weight to around 9 kilograms. They have decided to use aluminium bar for the design of machine's housing frame. This has enabled the overall weight to come down to 9.5 kilograms. The completed prototype of the palm oil fruit seeds collecting machine with the aluminium frame and blower housing is shown in **figure 3**.

THE OUTCOMES OF MACHINE TESTS

The prototype machine went through several field test sessions. These sessions were conducted by the team at nearby palm oil plantation site. **Figure 4** shows one of the test sessions being performed by the team. Among the issues to be tested during these test sessions are, (1) the blower performance, (2) collection capability, (3) noise level, (4) reliability, and (4) worker's satisfaction rating.

Findings of the test sessions are summarised as follows:

1. The suction power is poor when the fruit seeds stuck in mud.
2. Suction power is inadequate when the seeds are more than 20 mm from the tip of the nozzle.
3. The worker has indicated that the weight of the machine is manageable.
4. Collection time using the machine is reduced considerably.
5. Further design improvement must be done to reduce the noise level.
6. The machine minimises the worker's chances of getting injured or back pain.

Outcomes of the test sessions have also enabled the team to review several weaknesses in developing the palm oil seeds suction machine. Whilst it is fairly obvious that common skills and methods are employed, such as CAD utilization, brainstorming, solid modeling, engineering-based analysis, nevertheless, other more rigorous techniques are least utilized. These methods and techniques include part features analysis, functional analysis *vis-à-vis* design for assembly (DFA) method, part minimization and ease of assembly.

Poor suction power and *weight* are two critical design factors which required further investigation. The former can be further evaluated and improved if the team can conduct a thermodynamic test and a further weight reduction can be achieved if the product can be assessed using DFA technique.

What have the team achieved in CL?

1. Create a common understanding about the palm oil seeds collecting device. 2. Consider a broad range of concept solution alternatives. 3. Develop a realistic cost estimates. 4. Generate design and manufacturing trade-offs. 5. Establish quantifiable engineering specifications.

What can the team pursue further in CL?

6. Conduct a thermodynamic test to evaluate optimum suction power. 7. Perform a DFA analysis to minimize total weight. 8. Initiate ease of part joining and total part count. 9. Carry-out product's modes of failure and effect analysis, thus, propose corrective actions to prevent injury or damage.

Figure 5 - A comprehensive 'opportunities' in collaborative learning environment for developing a competitive product.

Hence, a further refinement on implementing an effective collaborative learning (CL) environment based on the above outcomes is summarized in **figure 5**.

It is well understood that, eventually, the team members, when progressing beyond formal education, may not need the crutch of process and methods. However, in the period of university application, confidence and competence can be enhanced by the utilization of systematic techniques. This can be achieved in a properly thought-out collaborative learning environment.

THE TEAM'S OVERALL ASSESSMENTS

The team commented on the 'real world' experiences as offered by the mechanical engineering project endeavor. They made the following statements in the critical evaluation survey form:

'We have gained an experience on developing a new product and learn about real life mechanical problem solving and analysis.'

'On-hand experience about product development activities. That's what we like about this project.'

The introduction of real world problems in collaborative learning environment has exposed the students to become more comfortable and gained the confidence with unstructured problems where ideal design parameters may have ill-defined relationships with the actual working conditions. The students also learned how teamwork and communication could strengthen a design team. Three comments are given as follows:

'The group discussion about (re-design) the aluminium frame where we can work as a team.'

'Design the improved nozzle system with my team is what I really appreciated.'

'The design process gives me an early experience how to manage the teamwork.'

Many students alluded to the importance of the mechanical engineering project for their career development as they learned how to deal with a product development process scenario. This is revealed by the following comments:

'Issues like teamwork, design specifications, critical factors for developing a prototype and field tests are very important and related for future (career).'

'Very interesting and useful for my career development.'

'The course has introduced practical skills that can be applied in industry.'

The importance of conducting the field test session is crucial to the success of the overall project. The students enjoyed the field work thoroughly. Doing an assignment away from the usual classroom environment has created an atmosphere of better communication among them. Students were seen to have the freedom to discuss the subject matter rather effectively and confidently when they have a better view of the problems, in this case, identifying possible failures and modes of failure of the nozzle system and further improvement of the suction power capability.

Figure 6: An effective students-instructor interaction is vital in collaborative learning

Student-Instructor Interaction as a key success factor in Collaborative Learning

One of the positive outcomes in this endeavor is that the project was carried out in such a manner as to require frequent and intense interaction between the instructor and the students for communication and engineering-based evaluation of the prototype. The presence of the instructor at early stage of the problem formulation is essential in order for the team to articulate and communicate their ideas and research uncertainties properly. More importantly, the instructor will ensure that the critical design factors for developing the right prototype machine are properly evaluated. **Figure 6** illustrates the important bonding between the instructor and the team in ensuring the success of this project.

CONCLUSION

In this paper the collaborative learning analysis in developing a cohesive team for designing and testing a prototype machine is presented. Allowing students to explore and learn about practical methods in product development process, manufacturing cost savings and reducing human injuries through practical design remove much of the frustration engendered by attempting to learn without doing.

The outcomes of the project and the overall students' assessment have emphasised the benefits of collaborative learning. These benefits include:

- positive interdependence,
- individual accountability,
- face-to-face interaction,
- technical and interpersonal skills development, and
- team functioning capability.

While, clearly, there are still lots more to learn from the collaborative learning experiences, the results have indicated that we are moving in the right direction.

The paper wishes to conclude by highlighting the following crucial points:

1. Development of teamwork, creation of better product design, improvement in visualization skill, and enhancement in problem-solving skill in the collaborative learning environment allow the students to see more tangible results from their work and provide an accompanying feeling of satisfaction.
2. Active participation of each student is seen to provide for a range of activities to explore various knowledge and issues in a context which relates the market being served, the technology of product design and the applications of advanced manufacturing technologies.
3. The '*opportunities*' provided by collaborative learning should be introduced and enlarged in all faculties of engineering at higher learning.
4. There is a distinct need to take on the challenge of bringing in new innovations in collaborative learning environment. It becomes all the more important since the 'opportunities' provided in collaborative learning are appropriate in nurturing and developing competent design engineers with a technical skills and competencies.
5. The university-industry collaboration scheme has enabled the students to correlate effectively their classroom teaching with practical significance in a professional environment, in this case, a palm oil industry in Malaysia.

In long term, the *opportunities* provided in collaborative learning will assist students in taking greater responsibility for their own learning and facilitate a more effective monitoring of students' progress. For the instructor, the aim is to produce engineers with effective workplace skills and an awareness of how their skills relate to the industry's interests.

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FOSTERING CREATIVITY: USING COMPETITIONS TO TEST THE CREATIVE SKILLS OF UNDERGRADUATE PRODUCT DESIGNERS

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INTRODUCTION

Since the early 1990s Product or Industrial Design education, traditionally the domain of Art and Design, has like many other disciplines, become increasingly interdisciplinary in order to develop a richer blend of undergraduate skills between Art and Design, Engineering and IT Technologies. Within this 'concurrent' pedagogic framework, initiating and fostering creative thinking alongside practical design skills is central to the education of the future Product Designer.

The last decade has also been a period of politically driven educational change within the UK. Widening participation has brought a vast increase in student numbers from a broader diversity of backgrounds and prior experience, but with little in practical design skills. Such issues have impacted on all disciplines, but more so on those with a practical base such as Product Design

Compared with other more academic disciplines in Higher Education, where knowledge can be disseminated through lectures and seminars, Product Design because of its practice-based acquisition of skills, has tended to be delivered through individual or small group tuition, which has been expensive. Prior to 1992 governments acknowledged this fact with generous funding, but since that date we have seen tremendous change with academic and financial independence when the former Polytechnics became the new or modern Universities. Within a new institutional climate of cost effective and efficient teaching of large numbers of students, Design had to face new challenges of delivery. Design like Art teaching was historically predicated on 'Sitting with Nellie' (Swann, Cal), a pedagogic concept derived from the craft based industries where practical skills were developed by working alongside the most experienced operative 'Nellie' who trained new operatives by example.

TWO DEGREES, A SHARED CURRICULUM: THE BA(Hons) IN INDUSTRIAL PRODUCT DESIGN AND THE BSc(Hons) IN COMPUTER AIDED PRODUCT DESIGN AT THE UNIVERSITY OF WOLVERHAMPTON

Dealing with large teaching groups was a new experience for Art and Design and in developing modules for this course we had to rethink our teaching and learning strategies both to cope with large numbers as well as a wide range of prior experience, or lack of it, from a broader student intake profile. This has led to the development of two new interdisciplinary modular undergraduate programmes in Product Design across the School of Art and Design and the School of Engineering. The BA(Hons) in Industrial Product Design and the BSc(Hons) in Computer Aided Product Design have a shared modular curriculum.

This paper concentrates on the five modules developed and delivered on these courses, which were conceived as a comprehensive package which balances the theoretical and critical with creative and practical skills aimed at both the Product Design specialist and the generalist taking this modular package as a minor programme in Design.

The five modules cover all three years of the degree with two in the first year (Level 1), two in the second year (Level 2) and one in the final year (Level 3) which tests the skills developed in the previous modules by producing work for a national or international competition. The modules on offer are:

PRODUCT DESIGN STUDIES I (LEVEL 1 SEMESTER 1)

The aim of this module is to introduce the student to the contextual aspects of Product Design through a snapshot approach of the present and the past. The contextual framework is a means by which the individual student, can assess their own practical development in the subject.

As it is an introductory module it is front loaded in terms of teaching and operates through lectures, seminars, tutorials and visits which introduce the following: The module asks the questions, What is Product Design? and What do Product Designers do? It uses a case study approach with videos to look at the work of different types of designer in domestic consumer products, automotive products, engineering products, furniture and interior design.

It Introduces a historical and theoretical background to Product design practice based on the principal that the past informs the present and the present informs the future and considers the conceptual changes in Product Design and the social, moral, economic, political and legal issues that bring about change in this discipline.

Student Centred Learning

As well being encouraged to discuss design issues in seminars and tutorials students are required to produce two written assignments based on individual research in Product Design.

The assignment briefs are issued in the introductory lecture of the module.

Assignment 1: This is based on a critical appraisal of a current marketable product. The assignment is weighted at 30% of the total module.

Assignment 2: The student has a choice of subject for this assignment which includes the work of a designer, a design movement, the historical development of a generic product or the development of a range of products

This assignment has a 70% weighting and requires in depth research.

PRODUCT DESIGN STUDIES II (LEVEL 1 SEMESTER 2)

This module introduces the theory and practice of an actual design project.

Lectures on the theory of design run parallel to an actual project. The theory deals with the individual aspects of a project that the practicing designer would experience including, Project management and costing; Morphology of Design; Creative problem solving and creative practice; Professional Practice; Design specifications; Anthropometrics; Ergonomics. Design protection.

The theory is not only tested in the practice of a project but also in a two hour written paper in which a student is required to answer three questions out of a choice of four.

Student Centred Learning

The project requires each student to produce Preliminary design sheets; a Design specification; Visuals; a Full size block model; Technical drawings; a Project report.

These areas are weighted appropriately according to the project subject matter.

Previous Projects have included, a Garden Tool, a Mechanically Propelled Toy, a Toy that Flies or a Travelling Office for the designer on the move.

DESIGN PRINCIPLES (LEVEL 2 SEMESTER 1)

This module introduces visual rendering and professional presentation skills including verbal presentation. It assumes that students' prior experience of visual presentation is minimal and introduces the basic elements of visual technique including perspective, line, dot, tone, colour and background. Not only does it develop individual presentation abilities but team skills through group projects.

Student Centred Learning

Students are asked to select a small domestic consumer product to be the basis for their visual studies. and produce a series of visual drawings that form the basis of a peer group presentation that explains their selected product.

The module is weighted, Preliminary Drawing Exercises 50%, Presentation Visuals 50%.

THREE DIMENSIONAL REALISATION (LEVEL 2 SEMESTER 2)

This module introduces and develops model making and related three dimensional skills, through product simulation model synthesising weight, scale, colour and finish. The student is asked to pick a small domestic consumer product and simulate it as an exact block model. In undertaking the brief the student learns accuracy and model making skills that are an important part of product design.

Student Centred Learning

Development of model and intermediate stages including computer generated detailed drawings and card mock-ups.

The module is weighted, Preliminary Drawings 25%, Preliminary Mock-Ups 25%, Final Model 50%.

DESIGN COMPETITION (LEVEL 3 SEMESTER 1)

This module is the application of design, visual and model making skills learned in the previous modules to a live externally generated project. It also tests creative thinking and challenges the students professionalism as a designer.

External competitions have included:

1. National Lighting Design Competition Awards
2. Royal Society of Arts (RSA) Design Directions (Bursary) Awards Scheme
3. Chartered Society of Designers (CSD) Student Awards.
4. Plastics on the Road Design ‘Competition organised by the Plastics Institute

Two case studies have been chosen to illustrate this paper, both concern 2005-6 entries made to Competitions 2 and 3.

Case Study 1 - The Royal Society of Arts (RSA) Design Directions (Bursary) Scheme 2005-6

The RSA has run a student Design award scheme since 1924. Over that 80 year period the ‘scheme has been reviewed and refocused to respond to the prevailing demands and concerns of education, industry and society’ (RSA 2005).

The competition aims to, ‘challenge emerging young designers to consider their future professional role and responsibility more broadly in ways that can have meaningful effects on business, public service and wider societal issues.’ (RSA 2005) Design Directions 2005-6 offered 16 areas of entry giving the student ample choice to pursue a personal design interest and test their creative thinking and professional design presentation skills. Winners are not only rewarded with money prizes but the opportunity to work on secondment in professional design practices

This case study is an entry from the School of Art and Design at Wolverhampton in the ‘Inclusive Worlds Project – A multidisciplinary project to create an inclusively designed world’ (RSA 2005). Inclusive design is informed by social issues and takes on board the needs of all users, including specialist groups such as the old, disabled and people with medical conditions. Inclusive Worlds issues 5 challenges to the student designer:

1. How can we make the domestic and public environment more inclusive ?
2. How can access to information limit exclusion ?
3. How can smart wearables change lives ?
4. How can the design of products and the environment make life more fun?
5. How can we make things better? (RSA 2005)

This submission was in response to challenges 4 and 5.

The Wave Water Safety System was submitted to the RSA in December 2005 with the results of the competition expected in the Spring 2006 is the work of Hallstein Horjtland, a third year student on the BA(Hons) in Industrial Product Design in the School of Art and Design.

Hallstein has kindly given us permission to use his work for both case studies in this paper.

The product is predicated on the notion that although water is one of the world's most precious resources, a source of life that is frequently taken for granted it can also be a source of pleasure. The design concept exploits one of the pleasurable aspects of water, 'swimming' with the product designed to make this activity more enjoyable and more safe. The product is a development of an old swimming aid, the flotation wristband, which has been re-designed and incorporates value added technologies bringing it into the twenty first century. The Wave wristband is a combination of management system for use in the Swimming bath environment, a safety device and a teaching aid to learn how to swim. It can also be used for other water activities such as surfing.

The Wave wrist band is an excellent example of the student combining visual and presentation skills learnt on their course with the creative thinking and challenges posed by the RSA.

Case Study 2 – The Chartered Society of Designers (CSD) Student Design Awards 2005

Six student awards are offered annually by the CSD, the main professional body for design in the UK, one award in each of the following design areas – Product, Exhibition, Graphics, Interior, Textiles and Fashion.

This competition does not require the production of any specific work to meet a competition brief set by the CSD, but allows the student to select a project they have worked on or are working on as part of their second year undergraduate design studies. The competition aims at encouraging professionalism in the student designer offering for each award £1000; a CSD student design award medal, Free CSD student membership; a student placement for professional design experience; the student s School receives a CSD plaque for excellence in design teaching

This case study is again based on the work of Hallstein Horjtland who entered and won the CSD Student Product Design Award in 2005 with is design for a radio. This prestigious award was presented to Hallstein, at Wolverhampton on the 16th January 2008 by the Chief Executive of CSD.

STUDENT PERCEPTIONS AND CONCLUSION

This paper outlines an undergraduate educational platform that develops creative critical thinking alongside the practical manual and computer generated visual skills needed by the professional product designer. The modular package described, according to student feedback in module evaluation questionnaires is seen to be the 'most important and challenging part of their undergraduate experience'. For many students it will be the first time that they have engaged in product design as an in depth practice based academic study and for many meeting the accuracy in developing prototypes and high standard visual material for presentations is very demanding It also demonstrates through two case studies how these skills are externally tested in national design competitions .Meeting the requirements of competitions many students feel is the proof of professionalism, particularly when projects win or are commended, a tradition of success that the course has developed.

Copyright

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