CREATION OF AN INTER-DISCIPLINARY DESIGN CURRICULUM AT NORTHUMBRIA UNIVERSITY

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ABSTRACT

Northumbria University has a well-established Industrial Design provision in its Design for Industry course, however a need has been identified in the design industry for a course with a different philosophy towards the design process. Increasingly the demand from employers is for a designer possessing a good grounding in both the engineering/manufacturing and design aspects of products to satisfy users' demands or to expand a product's market. The problems that were foreseen in such a provision were associated with achieving a balance between the disciplines of the engineering sciences whilst maintaining the creativity, within the student, required by a product designer.

The solution was to design a new curriculum by taking an innovative approach to both the engineering and design provisions that are currently being offered. After careful consideration, and taking into account the needs of industry and the expertise available within the University, it was decided that in both areas of engineering and design a holistic and integrated approach was to be attempted. The primary consideration in the development of the engineering and manufacturing sections within this new curriculum was that the course was to be delivered to design students who have a different outlook and background to engineering students. Similarly the design provision was also to be different from the standard industrial design course in order to accommodate the additional engineering skills input. To produce the type of designers that are true to the broad philosophy of the course, two complementary strands of design were integrated in an attempt to develop the students design flair as with a traditional design course whilst also developing the discipline of questioning the functionality of the product they are designing.

A number of innovative methodologies were used to achieve this integration of disciplines, drawing upon cross-school collaboration in order to meet the demands imposed by such an approach. The result of this approach has been the establishment and successful delivery of a new undergraduate course, Product Design and Technology, the demand for which illustrates and justifies the novel steps taken in its development.

1 INTRODUCTION

At the University of Northumbria the School of Design offers high quality design provision and has done so for a number of decades. The courses offered are of a traditional design nature in that the emphasis is on creative design and intellectual development of design ideas. The important aspect of this design approach is the form, shape and aesthetics of the articles being designed. At the opposite end of the design spectrum there is the approach used in undergraduate teaching in the School of

Engineering and Technology. Design in the form of problem solving is an important element in almost all courses offered by the School of Engineering and Technology. The design process is seen here as a need to solve a particular physical problem. For example the design specification for a particular vehicle may state that it needs to follow a white line around a factory delivering small items as it travels. The design effort here would involve such activities as calculating and selecting the direction guidance system, correct drive system, ensuring the framework of the vehicle has sufficient strength, selecting bearings for the wheels etc.

Often students from either of the design traditions felt uncomfortable when facing a problem outside their particular domains. The engineering designer would resist any effort to change their "dull gray block" to an attractive, user friendly product and the industrial design student wastes days trying to find someone to "do the engineering" when an hour or so of logical thinking would give them the answers they needed.

With these tensions between the two design approaches, why was the decision made to attempt to marry them together in a new design degree course? A number of factors had come to the attention of the academic staff in both areas. From contact with employers it was noted that small to medium sized enterprises were expecting their new graduate designers to function over a much wider range of disciplines than in the past. They were looking to employ future graduates whose university experience included, as well as design practice, some grounding in sciences, management and computer skills. The engineering teaching staff had also noted that an increasing number of the universities engineering graduates were being recruited into companies who in the past would have employed industrial designers. They were students who had shown great expertise in problem solving design skills and their industrial design skills were being developed during employment.

Once it was decided that a demand exists for a hybrid degree course, positioned somewhere between industrial design and engineering design, a philosophy for this new course needed to be developed. It could be in essence an industrial design degree with just a flavor of problem solving or a design degree with a full diet of engineering science and seeking accreditation with one or more Engineering Institutes.

As the proposal course, Product Design & Technology, is to be a collaborative course between the School of Engineering and Technology and the School of Design the course team included both industrial designers and design engineers. The consensus was that graduates coming from the new degree should be product designers who have had a taught grounding in general engineering. The course should also be flexible enough to accommodate students who may develop more into the area of pure design or conversely those who may show promise in the area of invention and problem solving.

2 DESIGNING THE NEW COURSE

A degree course that runs as a joint venture between two different Schools within a university faces many problems. First there is the question of ownership: for the course to run successfully an entity must have an overall responsibility for the day to day running of the course and in this case the entity was to be the School of Engineering and Technology. Once the "administrative" ownership had been decided the next issue was to ensure that staff members in the School of Design as well as the School of Engineering and Technology felt an academic ownership of the course. This is not something that can be achieved by signing "Memorandum of Cooperation" or other such paperwork. It is important that all the main players are involved in the design of the course from the very beginning. If they buy into the idea at the start and help in all the phases during the design stage of the course then the course will be as much "theirs" course as anyone's.

For the product design course to be successful everyone involved needs to change the way they do things. After all, the teaching style, treatment of students and assessment strategy of the two Schools are radically different from each other. In the School of Design, for the core items of provision, the work is studio based and assessment is essentially a continuous process. With the studio comes a much more interactive process between the student body, with the staff playing the part of design mentor. The School of Engineering and Technology approach is to have a student body that is classroom and laboratory based with the core curricula being formally taught and augmented by experimentation and formal assessments.

In order to fulfill the philosophy of the new course the best parts of two complementary approaches must be captured, so that the student would cultivate the skills necessary for the modern innovative professional design whist developing a broad knowledge base of production, engineering and materials. If this objective is to be achieved one needs to look critically into the development and delivery of a new curriculum on the basis of the two existing complementary disciplines.

In writing the curriculum for the engineering science section, which covers a number of modules with theories, concepts, lectures, tutorials and students' self-study, was built around the design process. This was a liberating process for the people writing the syllabus, in that they needed to ask why any topic or any subject is needed be taught to the student. The resultant curriculum for the engineering section contains only topics and information that helps the designer to understand the design process more thoroughly. The key idea is that design must guide what would be taught.

To model and predict the physical world requires an understanding of mathematics, yet this is a problem area for a number of prospective design students. However, for the proposed product design degree it was impossible or even desirable to "write out" mathematics altogether. The tactic taken for mathematical based units was to keep it simple and where needed, teach the necessary mathematics within the unit.

The industrial design aspect of the course was also attempting to develop design with a different style to that of the more traditional design course. Not only did the students need to develop innovation and design flair but they are required to understand the working of the products being designed. The emphasis of the engineering design strand is on the production of working prototypes and this would encourage and develop the students' inventiveness and problem solving skills. The industrial design strand would be of a far more traditional nature, encouraging students to be creative and to think about shape, form, ergonomics and product/human interaction.

The existence of two separate complementary design strands does not imply they have to be taught in isolation from each other. It was important that even if the two strands were taught at different time and on different days that the staff where aware of the complementary nature of the strands. This was achieved by proposing design exercises that provide opportunities for the students to develop skills in both types of design approach.

3 PRACTICAL ASPECTS OF TEACHING THE COURSE

Three years of practical experience has been gained through the implementation of the course, integrating expertise from two very different disciplines: industrial design and engineering (both mechanical and electrical/electronic engineering). The general experience is not too dissimilar to those reported in the literature [1] as pedagogical issues in product design course involve engineering and industrial design education. Some aspects of teaching the course, which requires further work from the teaching staff, arising from this limited experience are reported in this section.

3.1 Limitations of students' mathematical skills

In general, the students of this course demonstrate a high degree of self-motivation during the pre-course selection interview. Due to the nature of the course, students from a diverse background have been recruited and the majority of them, though eager to design and "make things happen", lack mathematical skills necessary to pursue even the very basic engineering knowledge.

All the engineering related modules are therefore delivered at the right pace and right level in accordance to the needs of designers. For example, bending theory in mechanics is taught from a very visual and intuitive manner with appropriate teaching aids. Tutorial questions are then set around practical design problems so that the students could see the practical application of the theory and prepare them for the final examination. In a similar fashion, modules related to electrical and electronic engineering are delivered in the same practical oriented manner that relate theory directly to practical application projects that form the continuous assessments.

The approach taken works reasonably well with the majority of the students. In addition, additional mathematical workshops are held weekly to ensure that students do lack understanding in some very basic mathematical skills get the help they need in tackling problems encountered within the engineering modules.

3.2 Resistance to the disciplines of science

Product and Industrial designers tend to be relatively less rigorous in applying scientific computations during design [2]. For the product design students it would not be difficult to infer the fact that a lack in mathematical skills leads naturally to resistance to the disciplines of sciences. A significant number of students tend to proceed from initial ideas to preliminary designs without looking at the feasibility or limitations arising from scientific understanding of material properties or the underlying mechanisms associated with the initial ideas. An attempt to soften or even overcome this resistance comes in the form of closely linked design briefs from the two disciplines of industrial design and engineering. For example, a linked industrial design brief and engineering product design brief for the students to work on the design of fire extinguishers guide the students to perform the necessary engineering design calculations so as to meet a given set of technical specification before proceeding to consider other aspects of design such as aesthetics, ergonomics and design philosophy. The result is a holistic design exercise integrating engineering product design and industrial design.

3.3 Lack of vision in design

As young designers the students would like to be seen as creative and are keen to design artifacts and products. The learning experience of a discipline such as design is not unlike that of an exploratory process. Initially one has to learn the ropes by emulating other well-established products and from then on the exploratory process takes over. The learner needs to explore so as to learn from experience and eventually develop a vision or individual style. A commonly observed problem with the students is the perception that the art or skill of design can be taught mechanistically. Much emphasis has been placed in stressing the importance of a continuous development of designers' flair through observation, exploration and regular discussion with members of academic staff. A system, which includes mandatory signing-in and allocation of marks to progress meeting, has been established to ensure that students discuss their design projects with staff members on a regular basis. The closely linked design briefs between industrial design and engineering product design, industrial collaborations and regular meetings and critical discussion with academic staff and clients form an experiential education in product design [3].

3.4 Practical skills

Students need practical skills to work with machinery and tools to produce prototypes or models. With the reduction of technical staff members, which is a common trend observed in many UK universities, training the students to be reasonably competent operators of workshop machinery and equipment becomes an issue. The solution to this problem is out sourcing for external bodies to provide this training. In addition, UK's Health and Safety regulation requires that students be supervised by qualified technical staff when power tools or machinery are involved. With limited resources of technical staff members this requirement can only be met by pooling the resources and careful advanced planning of all workshop activities.

3.5 Dislike of design theory

Keen as they are in pursuing a course and a career in design, it is indeed surprising to observe that many students dislike design theory such as contemporary influence in design which is essential for industrial designers. The year-end results from the past three years have revealed that a number of students who performed brilliantly in almost every module achieved less than ideal results (i.e. marginal pass or failed) for modules relating to design theory.

4 FUTURE DIRECTION OF THE COURSE

The Product Design Technology course has thus been operating in its present guise for a period of three years, and several important lessons have been learned. These lessons have enabled the programme to evolve and mature in ways that are appropriate for the development of product designers that satisfy the needs of industry both today and in the near future.

4.1 Issues to be addressed

One of the key issues that have arisen from this experience is the level of mathematical skills possessed by the current intake and likely future intakes of students. The majority of students wishing to apply for this course, whilst having excellent qualifications that exceed the required 200 UCAS points, tend not to have heavily science or maths based experience. UK Government investigations regarding the present standards of A level and post 14 mathematics [4][5] cannot address current difficulties encountered by students currently embarked on the programme.

To address this issue, several simultaneous approaches have been taken. Firstly, a number of additional support lessons have been built into the programme, allowing those with weaker skills, as identified by formative assessment, to be given supplementary assistance in particular areas of difficulty. Secondly, a number of external agencies, having recognised such problems on a wider scale, have been identified as being able to offer suitable background and additional reading material. One such service is the excellent Mathcentre initiative (www.mathcentre.ac.uk) that provides materials for both staff and students. This centre provides online learning resources including study leaflets, self-learning materials and video tutorials amongst others. The third approach taken has been to review the maths content of the course, both in terms of level and application. The technology section of the course that includes both the mathematics and electronics portions (another problem area to a lesser degree) have been re-evaluated and adjusted in order to provide clearer applications of the use of such techniques within a design environment. This has been accomplished by moving towards a more problem based learning approach, with a number of case study style projects being used to enable such learning. The appropriateness and benefits of such project-based work has been demonstrated elsewhere [6] and it is believed these changes will prove very successful.

4.2 Need to stretch students design ability

One of the key considerations in the existing and future development of this course has been to explore ways in which students design experience can be broadened and extended. One of the major methods employed to achieve this has been to focus on practical themed problems, allowing the students the opportunity to develop designs that are relevant to the sort of typical design problems that are of importance in today's commercial environment. This has been achieved by bringing in outside organisations and individuals as "customers", setting realistic and economically credible design briefs for projects undertaken by the students.

This will in future be supported by the addition of several additional design briefs that the students may wish to undertake purely to extend and develop their design capabilities. These may be based upon and draw their inspiration from the various design competition briefs that have been an are set every year for design students, with adaptation where necessary. A series of formative assessment dates will be set for these projects, and tutorial support and advice scheduled and available throughout this time. These projects may be used to develop and expand the students' personal portfolio, allowing them to further push themselves in a formative and supportive environment. Extensive use is made of the shaping and travelling methods of teaching and learning in order to assist such student development.

4.3 Give students pride in their engineering achievements

One of the prime motivating factors in encouraging student development and learning is appropriate feedback sessions. One of the main aims of our feedback sessions has been to engender some pride in the students' achievements, especially when they have done something that is particularly successful. One such case is in engineering design, a subject area in which it is not always easy for a product designer to feel a great deal of satisfaction in, as the resulting designs are not always aesthetically developed as much as the students wish. Importance is put on the fact that a working model has been fabricated, and its context as forming the basis around which further activity could add value emphasised. This has been successfully demonstrated in a recent project, where the students were asked to fabricate working models of car systems suitable for use in an educational context. At the end of the project, the design teams were asked to demonstrate these models to their peers. This resulted in an extremely lively and interactive session, in which each groups pride in being able to explain and illustrate the principles they had set out to mimic really shone through. Whilst these models were not visually stunning, they had the desired effect of demonstration principles. This was achieved by regular evaluation and critical review by both academic tutors and peers, enabling them to develop and build confidence in the expertise they were amassing and appreciate the learning experience they had undertaken.

4.4 Make students think before designing

Another aspect that the course has endeavoured to instill is the notion that designers cannot just go ahead and design without considering the effects and consequences of their actions. Students are made to realize that they will not always be given a blank canvas with few restraints in briefs, but that there may be a number of limitations and restrictions upon their designs from a variety of external sources. The designs that they suggest may have further implications in the marketing and manufacturing chain for example, and these facets are demonstrated by a variety of means. Students are asked to consider the design problem from a variety of angles, not only from the users perspective but also from other viewpoints and must consider the economic, technical and other factors involved that could influence making such a design a reality.

Mind maps [7] are a technique that is regularly employed, and in order to support such actions the University has purchased software that enables and assists in the documentation of such activities.

For many projects students are asked to estimate and record the likely production costs of their designs, both for prototype production and actual future manufacture. They must take account of materials, suitable technologies, and various manufacturing methods to achieve this.

4.5 Integration but keep separate the two styles of design

It is acknowledged that two very distinct styles of design exist and are both taught on this course: Engineering Design and Industrial Design. These methodologies have significantly different aims and dynamics, such as looking at design from the user viewpoint and the functional viewpoint, each placing more or less emphasis on one than the other. However, in developing a capable product designer an understanding of the importance of both, whilst recognising the different elements of each approach, is vital.

This has been achieved on the course by developing joint briefs, which utilise elements of both engineering and industrial design. This has required very close integration of the course team from both Schools, and has resulted in the development of several joint project briefs. For example, a large project may be broken down into two components, one of which concentrates on obtaining a functional and operational design, the other concentrating on user interaction and perception. The two elements may be run simultaneously, or one component may be scheduled prior to another to build upon the achievements of the first.

This approach is intended to be developed even further in future, addressing student concerns regarding integration of the two design styles and stressing even more strongly the link between them and the relevance of each to an all round designer. One such project shall involve developing an appearance model based upon the prior work performed in engineering design developing a functional model within boundaries that are used as criteria within the aesthetic model brief.

4.6 Possible future developments

The course has been very successful in attracting and recruiting students, however there are a number of new directions and features that the course may need to consider in future in order to remain relevant and attractive to potential students and employers.

One such element is the addition of several new modules that concentrate more upon the use of computer aided design tools, whilst still maintaining the focus and original intentions of the course. A new programme, derived from the original course would be an option offered as a distinctly separate course, sharing a common first year. The core aspects of the course would thus remain, however new topics such as collaborative product development and the use of new media (such as the internet and virtual reality systems) to distribute ideas and designs would be added to generate a new stream of students, placing more emphasis on these activities. The further addition of subject matter on issues such as Rapid Prototyping, Rapid Tooling, Reverse Engineering and other such contemporary design tools will also ensure the validity of the course.

Another factor influencing the future development of the course is the changing face of the student population at Northumbria. Evidence [8] shows that more and more students are taking up employment to fund their studies, resulting in the need for modifications to several aspects of course delivery. One consequence may be the increased use of electronic media such as the Blackboard e-education system used at Northumbria.

The change in student skill profiles will also exert internal changes to course content, as demonstrated by the modification of maths teaching. Whilst a deficiency in this area has been noted and acted upon, at the same time the student profile indicates more proficiency in topics such as electronic image editing and manipulation. This will provide opportunities for the reduction of some teaching topics and the extension of others or the addition of entirely new areas of study.

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