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GU + GSA = L + R: Educating the whole: course structure for a human-centred approach in product design engineering

A S Macdonald
Department of Product Design, Glasgow School of Art

Abstract
In Glasgow, an inter-institutional approach to teaching design engineering students is fostered through the particular nature of the teaching and learning environment, the management of students, the structure of the projects, and the content and delivery of the technical and non-technical elements.

These engineering students are encouraged to work in teams, to take a user-orientated approach, to develop an aesthetic as well as a technical intelligence, and to understand the role of human factors in successful product development.

Introduction
In 1987, the aspirations of two separate institutions, to develop better creative synergy in young engineering students, were realised by establishing the B Eng/M Eng Product Design Engineering course, accredited by the Institution of Mechanical Engineers. It is run jointly between the Department of Mechanical Engineering at the University of Glasgow (GU) and the Product Design Department of Glasgow School of Art (GSA).

The inter-institutional educational model for design engineers found in Glasgow illustrates how the relative strengths of two different educational cultures can be exercised coincidentally through the creation of a carefully structured studio ethos to develop a fuller set of abilities within students. The need to address qualitative as well as quantitative issues has called for new ways of teaching and learning through an integrated design project-led approach.

Engineering students have traditionally been recognised for their strengths in computation and analysis. In the Glasgow model, these aspects of engineering continue to be delivered at the University, but their understanding is enhanced by the nature of the design activity at the School of Art. The studio activities are designed to develop capability and allow creativity to flourish by testing the application of engineering design sciences in new situations.

Now that the course is well underway, (it is in the process of undergoing its first comprehensive review) and it is clear that technical subjects and engineering theory are well tested through exams and their application in project activities, it is possible to discuss the human-centred approach to the teaching in terms of the design of the environment, the management of students, the structure of the projects and the content and delivery of the design and non-technical elements.

The studio ethos
The heart of the course, from which the design emerges, is the studio ethos at Glasgow School of Art, where the activity of designing helps form ‘habits of mind’ and develops experience in the practice of design and reflection on this process. It is in this studio that the intellectual and intuitive cultures of ‘thinking’ and ‘doing’ come together to develop a more wholistic, rather than partial, set of skills in the individual.

The creation of the ethos is a collaborative venture. Both University and Art School staff, with their different cultures and disciplines, are to be seen planning, tutoring and assessing side-by-side. This helps develop a more...
complete critical and creative ethos when discussing students' work.

It is this studio ethos which has proved attractive to Groningen who now send some of their students to us. They have been instrumental in helping us develop a European MEng option and a European network of contacts interested in developing a creative design approach within engineering courses. Aalborg in Denmark has been identified as a particularly interesting course model, as it approximates in some ways to our own project orientated course.  

Project content and structure

Studio activity is organised in a variety of ways, but it is primarily project driven. In the first two years basic design skills are input at strategically opportune times to develop visualising and conceptual skills and include presentation and communication techniques - rendering, sketching, BS308 drawing, model and rig-making - design process, and design methods. These are applied and tested, along with the engineering knowledge gained at the university in an environment which increasingly integrates the two cultures.

From the first day onwards students experience both empirical hands-on and theoretical approaches to engineering design. The hands-on approach develops a complementary set of skills or intelligences. They learn about touch, feel and quality, and the action of forces on materials to develop intuitive, spatial thinking and manipulation skills in the process.

Studio exercises range from hands-on problem-solving in first year such as the annual ‘egg race’, to second year ‘robotics’ and ‘human load carrying’ projects which bring technical, ergonomic and aesthetic considerations together in a team work environment in, for example, the design of equipment for the emergency services. The engineering is posed and discussed in a humane and user-centred way.

Year 3 joint (with BA students) transportation design projects have included the development a four-wheel drive vehicle, a 15-metre rigid-hull inflatable lifecraft, snowmobiles, and new concepts for airships. This has further tested the application and integration of the engineering sciences in areas new to the students and the course. For instance, in the design of the airship, the understanding and calculation of drag factors influencing forward thrust, forces on control surfaces, beam bending analysis and load-bearing were just some of the engineering outcomes of this carefully structured programme. As important though, are human factors and marketing considerations. There is little point in great engineering within an unsuccessful or inappropriate product.

Types of activity and learning experience

Activities are practised either individually or in teams. At times it is appropriate to test the ability of the individual. This is a requirement of the I Mech E in fourth year and at the end of first year. At other times, team working can enhance the learning experience for all, permitting experiences and opportunities which would be impossible at an individual level.

Teamwork can take different forms. The usual mode has been teams working in competition with one another, such as in the Robotics project. This year we have tried something more adventurous and introduced the idea of mutually dependent teams. For instance, second year students were required to design a new tram system for Glasgow from the point of view of enhancing the user’s experience. The benchmark for the engineering was the desired quality of the journey designed through appropriate interfaces, from the tram chassis through to the interior, seating, driver’s cab, information and ticketing system. Each group had to take account of the needs and concepts of all other teams, and one brave team had the task of co-ordinating all eight. It resulted in a remarkably coherent set of concept proposals, and from the student responses, a very positive learning experience.

Assessment of teams is a complex task and we ask students to participate through peer review methods which, it has been found, have been most useful with a high degree of openness and honesty in the marking and
comments. This type of team working forms one strand of a design management core which also develops students' business skills to enable them to negotiate the world of business and industry.

Designers utilise available knowledge and understanding to develop a 'sense' of a product - they have a kind of 'fuzzy logic' which does not require possession of all the facts before they proceed. Students are encouraged to develop this partially informed 'risk-taking' route which can then be verified through analysis and calculation. As students begin this activity of designing in the first year, they will have acquired substantial experience of managing projects - six or seven, including the year-long final project - by the time they finish the course. The outcomes have attracted favourable comment from industry with whom the course is in close partnership.

A wholistic design approach

To achieve the desired balance between the technical, the ergonomic and the aesthetic, a curriculum of ergonomic and aesthetic elements has been developed to introduce design engineers to the concerns of human-centred design.

Since 1989, the first and second year curriculum has introduced, within the severe constraints of the timetable, a range of subjects not usually found in engineering courses including the history of design and technology, colour theory and practice, aesthetics and ergonomics. The aim is that this broader range of considerations educates the whole engineer and influences the success and appropriateness of the total product.

Products are often instinctively perceived, and product choice is rarely an exercise in logic. The concept of Aesthetics provides an appreciation of a product or environment which influences one's responses at both a conscious and a subconscious level. It is very much concerned with human perceptions, responses, needs and values. A designer without a developed aesthetic intelligence will be at a severe disadvantage in industry. A complex perceptual process allows one to make value judgements based on experience.

Our hearts and minds are attuned to a whole range of sensory information from which one makes elaborate but often unconscious value judgements about products, - in a walkman, for instance, one can discriminate through touch and feel, by size and weight alone. What value judgements does one make of a car by the type of sound of it's closing door, or the radius of its metal skin? Students begin to develop this aesthetic intelligence and understand how to employ metaphor, allusion, and historical and cultural references in their work.

The study of the human figure has also been very important in this programme in providing a useful reference point for understanding not only the physiological and ergonomic needs of people but the body as a source of analogical inspiration: the body as a metaphor for systems and principles.

Human factors

The desire to develop a more specialised programme option in human factors for our first stream of fifth year M Eng students in the 95/96 session has led to a new programme. Here, the idea of human factors is being developed in a way which attempts to see users as whole persons in the context of their daily lives - how they behave, how they make sense of and make use of the world through their own preferences, habits, and rituals - to embrace in a hopefully coherent way, cultural, aesthetic and traditional ergonomic areas.

It is not possible, nor the intention, to become human factors specialists, but the aim is to provide students with a basic 'orientation map' of the relationship between the various specialisms and disciplines found in the human factors field. This is planned in two ways- firstly, by providing an overview of the field through a lecture and seminar series from visiting specialists, and secondly by providing access to an information resource of useful and accessible techniques appropriate to user-orientated designers, such as role playing and scenario-building in addition to the more traditional techniques used by ergonomists. To understand the specific needs of the students we have a research student documenting the studio
design process in, for example, a project developing product concepts for ‘third agers’ to identify the gaps in our resources.

Specialists from industry and academia will input through case studies to cover general ergonomics methodologies, software systems, cognition, interface design, human computer interaction, physiology, bioengineering, anthropometrics, knowledge delivery, cultural anthropology, value systems, feel-good factors, and standards.

The overall intention of these aesthetic and human factors elements is to allow students to develop more control over the appropriate formal expression of their engineering designs, to develop a process of intent rather than accident. One case study cited is the NovoPen II, used by diabetics to self-administer precise amounts of insulin. Earlier glass and chrome models appeared clinical, but now it alludes to a culturally more acceptable product - the technical pen, which has less unpleasant associations than traditional hypodermic needles, now further coloured in their social meaning by drug misuse. It is this successful blend of the technical (understanding of the use of innovative technology and materials), together with the appropriateness of choice of cultural reference points and human factors considerations which is our aspiration.

Selection of students
What sort of students do we seek for this course? Just as our studio activity demands a one-to-one approach through tutoring, so with our selection process. This is vital to match expectation and ability. Almost all potentially suitable students are interviewed to assess qualities which cannot be determined from the UCAS form alone, e.g. their interpersonal skills, their knowledge and awareness of design, their enthusiasm and aspirations, their willingness to be partners in the educational process. To be proactive is an approach we actively encourage. Perhaps due to our rigorous selection process the percentage uptake of offers for the PDE course is unusually high compared to other engineering courses in the faculty - in 1994 it was 52% and one third of our intake were female. Four years of a young person’s life is a major investment, and it is essential that the two sets of aspirations and expectations match.

Conclusion
The integrated learning environment at GSA fosters the development of an individual with a more complete, rather than partial, set of skills, and the ability to use ‘right-handed’ in addition to the more traditional ‘left-handed’ ways of thinking found in engineering courses. It seeks to develop a process of thinking in qualitative values in addition to quantitative data, a process based on synthesis as well as analysis. The aim is to educate the whole engineer. To use the analogy of the brain, GU could be seen as the left lobe, and GSA as the right.

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