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CREATING PRACTITIONERS OF DESIGN for QUALITY THROUGH EDUCATION

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1. INTRODUCTION

The WDK Workshop in *Pedagogics in Design Education* provides an ideal opportunity to reflect upon my experiences of teaching engineering design at tertiary level and review some of the fundamental elements of design education practice. In particular, I will reflect upon the design experience provided at Coventry University where I taught until quite recently.

1.1 Coventry University

Coventry University has the unique capability of being able to provide education across all the disciplines of Design through its Schools of Art and Design and of Engineering. This expertise is underpinned by various research activities in the two Schools.

<u>School of Art and Design</u>

The origins of the School of Art and Design can be traced back to 1843. Since then the School has developed a spectrum of design teaching capabilities from visual art, communications and media, information design and industrial design. The industrial design courses and teaching provision are not only unique in the UK but have achieved international acclaim. In particular, recent graduates from the Transport Design courses have been employed by Citroën, Dutch Rail, Mercedes Benz, Nissan International, and Rover Group amongst others.

Design research in the Centre for Visual Information Design (VIDE) is known for its work in the integration of computer visualisation techniques within the product conceptualisation and development process. The role of immersive virtual reality facilities are being investigated in conjunction with the use of the liquid monomer prototyping facilities. Of particular note are two recent research projects funded by the Society of Motor Manufacturers and Traders, in collaboration with various automotive partners, which resulted in a novel lightweight sports car and "Concept 2096" - a futuristic research exercise commissioned to celebrate 100 years of the British Motor Industry. Both projects were exhibited at the 1996 UK Motor Show.

<u>School of Engineering</u>

The School of Engineering is one of largest engineering schools in the UK. The scope of its activity covers various branches of engineering: electronic, systems, design, mechanical systems and engineering management. The industrial links are numerous with some 300 companies allied to the School.

The Engineering Design subject group has academic staff dedicated to teaching and research in Engineering Design assisted by two Royal Academy of Engineering Visiting Professors in the Principles of Engineering Design. The Automotive Engineering Design and Industrial Product Design courses provide specialist education in design and share a common teaching and learning approach which differentiates them from other courses in the School.

1.2 Design for Quality

A characteristic of the Coventry University design education experience is the focus on products and especially products for consumer markets. All product design students are expected to create new or novel design proposals as part of their educational experience. For these design proposals to have any commercial credibility, it is essential that the solutions accommodate the needs of the customer and embody sound strategies for economic manufacture. The guiding design principles are those we would associate with *Design for Quality* [1].

In this paper, I will start to explore the challenges of teaching engineering designers to become practitioners of Design for Quality. The paper will briefly discuss why Design for Quality is being used here as the basis for a reconsidered approach to engineering design education practice.

2. DESIGN for QUALITY

We are all familiar with the notion that a product has quality. The advertising media especially will emphasise the positive qualities of the product they are promoting. Consumers will idly talk about a recent purchase being a “quality product”. But, as designers, it is our responsibility to create and embody quality into a product, i.e. Design for Quality.

However, we are also familiar with the notion that the measure of product quality is highly dependent upon the perceptions of the individual and the needs that have to be satisfied. Individual perceptions derive from a complex interaction of prior knowledge/experience, external influences and newly received perceptions of the product itself. Of these, it is the perception that the product itself creates upon the customer that the designer has the most influence over.

2.1 Understanding Quality

In order to understand how quality can be achieved, it is necessary to understand what quality is, how it is perceived, and how can be embodied in a product.

<u>Locke</u>

I started by looking at some early definitions of quality. In particular, I have found that the 17th century philosopher John Locke (see Ayers [2]) provides, in *“An Essay Concerning Human Understanding”*, a highly relevant discussion of the qualities created by an object and of how they are perceived. Locke defines the quality of an object as its power to stimulate the senses and produce an idea in the mind of the observer. Whilst more informed critics have found ambiguity in Locke's work, for me Locke provides a simple but important definition of quality which can be applied to products.

Thus a fundamental principle of Design for Quality is that product quality is a perception created by what the observer sees, hears, feels, smells and tastes. Additionally, an artefact which stimulates several senses simultaneously will have a much more significant impact than one that merely stimulates one sense. For example, whilst we may derive a great deal of pleasure by merely looking at a Ferrari sports car, the quality of that vehicle will not be fully appreciated until we can experience all the sensations associated with driving the vehicle itself. This implies that a customer will only fully appreciate the quality of a product when all senses are being stimulated. This was recognised by Mørup [1], who states:

> *"Quality is experienced when the customer interacts with the product"*

Interestingly, Locke also appreciated that when a sensory stimulus is coupled with previous experiences or prior knowledge, a more complex idea of the object is created. The implication is that an observer will *anticipate* additional qualities which they cannot, as yet, perceive. For example, if we *see* a chair with what appears to be a leather covering, it will be our prior knowledge and experience of leather coverings which will add to the visual perception and help create a deeper perception about the quality of the chair; in particular how it might *fee*l to the touch. However, it will only be when we sit in the chair that we will be able to fully appreciate its tactile qualities. For it will be then that we will be able to truly sense the feeling of the covering and satisfy ourselves that a prior anticipation of the chair's quality has been truly realised in its manufacture. If we subsequently find out that the chair covering is actually a plastic vinyl simulation, then we will quickly change our perception of the chair's quality. Once again, *quality is experienced when the customer interacts with the product.*

<u>Mørup and QFD</u>

Mørup's work on Design for Quality [1] considers the concept of big Q and little q qualities. Here, the focus of discussion is upon satisfying the customer by provision of Q-quality properties in product design. The QFD "House of Quality" chart [3] provides an excellent way of demonstrating how Q-qualities are being achieved through the embodiment of design features in a product. The relationship matrix will often illustrate the complexity of fulfilling the customer requirements. It shows that any one desired quality usually cannot be created by just one design feature, but by the integration of several.

But drawing upon the influence of Locke once more, we can define primary and secondary Q-qualities as characteristics which can be either *objectively* or *subjectively* evaluated respectively. From the designer's perspective, it is much easier to determine whether the primary Q-qualities have been successfully created in a product, because their existence at the levels demanded can be measured. However, the successful embodiment of the secondary Q-qualities is less easy to determine and once again can only be truly tested *when the customer interacts with the product.*

Kano

The Kano model provides yet more insight into the qualities a product should possess in order to satisfy a customer. The three types of quality provision are defined:

- Basic
- Performance
- Excitement

The customer assumes the Basic level of requirements to exist and does not generally request them. The Performance level of requirements are those requested. The more of these qualities the product possesses, the greater the level of satisfaction the customer will experience. Where a product has Excitement qualities, which the customer has not expected or anticipated, then the level of satisfaction will be significantly improved.

Finally, the model is sensitive to time. It recognises that as time goes on, Excitement qualities, that were once unexpected, in due course become Performance qualities that are demanded by the customer, and ultimately they become Basic qualities which are assumed and expected.

The Kano model thus provides the designer with some clear goals for product design. Firstly, the designer must ensure and anticipate that all the Basic requirements are provided. Secondly, they must strive to satisfy as many of the Performance requirements as possible. And, finally, they must endeavour to *continually* create new Excitement qualities which the customer has not experienced before.

It is this final challenge that particular interests me here. Designers who are able to continually create new, innovative characteristics and qualities are those most likely to continue to create new products that will lead the market and continue to delight customers.

2.2 Summary

The following conclusions can be drawn about Design for Quality:

- Product quality is a perception in the mind of customer.
- Prior knowledge influences perceptions of quality.
- Quality is experienced when the customer interacts with the product.
- Expectations of product quality change with time.
- Designers must be able to continually create new product qualities.
- Designers alone cannot test whether desired levels of product quality have been fully achieved.

3. CREATING PRACTITIONERS OF DESIGN for QUALITY

Engineering and industrial design courses both strive to develop design capabilities in students. However, do these courses create designers who are skilled practitioners of Design for Quality?

3.1 Engineering design teaching practices

On the whole, engineering courses in the UK tend to focus upon the application of scientific and technological knowledge, with design being just one of several core topics of study. The teaching of engineering design often follows the approach suggested by the SEED curriculum for design [4] which embraces the Total Design activity model of Pugh [5]. The widespread adoption of the SEED approach by teachers in design reflects the aptness of this design method for use by student designers. Certainly it is the preferred design approach used in the School of Engineering at Coventry University.

However, from my experience of using this approach, it encourages the design activity to be led by a tightly defined product design specification which has requirements that concentrate upon functionality and which specify objective targets at Basic and Performance levels. Often or not, there is little or no consideration of how to provide quality solutions in which all Q-qualities are developed and Excitement level qualities encouraged. Consequently, engineering students tend to create “me-too” product designs that are functional in nature, the performance of which can be demonstrated using metrics derived from calculation, analysis, simulation or test. Subjective requirements are usually treated with indifference and ignored.

Additionally, the trend in modern engineering courses has been to introduce computer based design processes and cut down the facilities available for students to manufacture their solutions. Consequently, the engineering student’s experience of product design is increasingly more abstract with very little “hands-on” experience of engineering products.

Whilst I appreciate that CAE tools give the student a powerful armoury of visualisation and evaluation capabilities, unless the student is able to physically interact with their solutions they will be unable to fully assess the quality of their own designs. Equally, unless a student is given the opportunity to interact with engineering products, how will they learn to appreciate quality or begin to understand how it is achieved?

3.2 Industrial design teaching practices

By way of contrast, the education of industrial design students is very much customer focused and places a great deal of emphasis on the visualisation of the product and its use in the environment. Concept design is highly creative, with innovative and highly original solutions encouraged. Skills in sketching, drawing, and three-dimensional modelling are well developed. Facilities include studios and workshops where students can build models. Public exhibitions of design work are commonplace and provide a forum for customer feedback on product design proposals.

My observations of the teaching practices at Coventry University have led me to believe that industrial designers are not consciously taught the principles of Design for Quality. However, the design practices that are learnt enable a broad range of product qualities to be embodied into solutions. In particular, great importance is placed on the creation of facsimile models or working prototypes. These models enable the designer and “customers” to interact with the product and assess its quality. The student, thus, learns to understand how people perceive product quality.

I have also observed that concept design is not overly constrained by the needs of a specification, but encouraged to be more searching and to draw upon a wide range of sources to influence and invigorate creativity. Concept selection is frequently based upon what the designer considers to be the most innovative and original ideas - ideas that can be formed into products that will excite and enthuse potential customers.

3.3 Conclusions

The contrast between the two teaching approaches is striking. The conclusion to be drawn is that current engineering design courses do not prepare students to be effective practitioners of Design for Quality. At the very best, engineering designers are able to create product solutions that satisfy primary Q-qualities at the Basic and Performance levels. Whereas, industrial designers are taught to be quality focused, albeit unconscious of Design for Quality principles. They use creative processes that enable the secondary Q-qualities of a solution to be evaluated and are encouraged to create products with new levels of Excitement. Industrial designers are more likely to create products with the unexpected qualities that will delight the customer and ensure its differentiation in the market place

It is evident to me that industrial designers are taught to be champions of Design for Quality, whilst engineering designers have some catching up to do in this design domain.

4. THE WAY FORWARD

If engineering designers are to become effective practitioners of Design for Quality, then aspects of their education need to be revised. Drawing upon the observations made of industrial design education, engineering designers must have more physical contact with engineering products so that they may acquire their own sense of product quality and how it is achieved. More emphasis should be placed upon the sketching, drawing, modelling and manufacture of design solutions to at least the prototype stage so that the quality of solutions can be thoroughly assessed. Finally, the creation of novel and innovative solutions should be encouraged.

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