THE ELEPHANT IN THE DESIGN OFFICE

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ABSTRACT
This paper aims to confront the problem of the apparent division in the design field and show ways for product designers and design engineers to understand each other better. In doing so, the common ground will be exposed and the underlying reality of the design process brought out. This can benefit the education of both and hence improve design co-operation in practice. When the common ground is properly appreciated, it can be expressed in more general language, making design methods available for other areas of project management, where similar types of risk and uncertainty must be accommodated.

Keywords: Form function, co-operation, methods

1 INTRODUCTION

"The elephant in the room" is a phrase which appeared in the early 1950s to refer to "an important and obvious topic, which everyone present is aware of, but which isn't discussed, as such discussion is considered to be uncomfortable."[1] It has been used to refer to uncomfortable topics in various discussions and was the theme of a 2006 "Banksy" exhibition bringing attention to global poverty. In this context, the "elephant" is the apparent difference between product and engineering design; a topic which is avoided by either assuming it doesn't really exist or that it is so obvious there is no point in discussing it. My intent is to show that there are differences, but good design results by both approaches working together, with each type of designer appreciating the other.

"Form ever follows function" was coined by the American architect Louis Sullivan almost a century ago and has been quoted many times since. Yet those designers most concerned with form, the product designers, are often naive when considering function. Similarly, those most concerned with function, the engineering designers, are usually uncomfortable when considering form. This is very apparent in their education, which can make it difficult for them to work together in later life. For some years, the author has had a growing reason to consider the common ground between these two faces of design and finds far more similarities than differences hidden under the jargon. The methods that have evolved for making sense of the complex and risky field of design are beginning to be appreciated in other areas of management, where innovation is now regarded as "a good thing"[2]. If design methods are going to be used elsewhere, we have to be able to express them in ways that are jargon and context free, logical and appealing to non-designers, and in a generalized form, which can be adapted to match other situations.

We must acknowledge these two major schools of thought in the product design and the engineering design approaches. They have different origins and histories, which vary between cultures, and industries. These differences can be seen in the division between architects and masons, which pre-dates the pyramids. They have been close at times and far apart at others, but have much in common, even if this is not always appreciated. Part of the problem lies in the language and jargon used. Another part is both sides' attempts to rationalize their methods, which have emphasised different aspects of the design process. In fact both are considerable simplifications, which hide significant commonality.

2 A BRIEF UK HISTORY

Engineering is a term we now use technically in English to imply forethought in constructing some artefact to perform a specific range of functions safely, reliably and economically. In everyday language the word implies ingenuity and contrivance. Indeed "ingenuity" comes from the same language source as "engineering". (The parallels with beavers building dams, birds and ants making nests, or badgers digging setts could lead to philosophical discussions of where engineering and design began.) Ingenuity has been apparent since the earliest fossil records of human behaviour. The word "engineer" itself has only been in general use as a job title for a few hundred years, but has been variously applied both to those who plan functional works and manufacture, and to those who operate machines, particularly railway locomotives and ships engines. It began to be used professionally, with the construction of the canal system in the UK in the late 18^{th} century, to define non-military engineers, hence the term "civil engineers". Socially, engineering was seen as a natural extension of craft skills and hence related to the arts. "Art" was then used as an all encompassing term for those activities, which produced goods to satisfy human needs. This had been recognized in the founding of the Royal Society for the encouragement of Arts, Manufactures and Commerce (RSA) in 1754. Art was very different from science, which explored and analysed the world around us to find the underlying forces of nature, which made the world behave as it did. The world of intellectual activity was seen as divided into arts and sciences, with engineering clearly in the arts camp.

Although the industrial revolution can be traced back to the division of labour in pin making, the earliest industry to move to large scale production was weaving. The invention of the Jacquard loom in 1801 meant that cloth could not only be produced cheaply in quantity, but also in a huge variety of designs. The need, for "applied artists" to generate complex and aesthetically pleasing patterns for the Jacquard process, kick-started the concept of an "industrial designer". Previously, designers of furniture had been furniture makers, designers of ironwork had been metal smiths, buildings were designed by architects, and so on. Now there was a need for more generally based designers, who could work with a variety of materials and manufacturing technologies to produce a range of pleasing products. The link with arts and crafts gave them a similar social acceptability to engineers. It was said that design was a way for gentlemen to be involved in manufacture without getting their hands dirty.

Thus, in Victorian times, engineers and industrial designers were seen as being closely related, one focussed mainly on society's functional requirements, the other mainly on the individuals' desire to impress and feel comfortable and secure in their world. Both used an understanding of material behaviour and manufacturing processes to define products. Engineers often embellished their bridges and tunnels to match the expectations of the day and industrial designers used the latest manufacturing techniques and basic technologies to produce the products appreciated by the growing markets.

As time passed, engineers achieved success, first with the canal system, then the railways and the extensive mechanization of the means of production. The Great Exhibition of 1851 can be seen as a display of British engineering success, although some noted that the small section devoted to foreign products contained some of the more elegant exhibits. The belief was that anything that could be imagined by a practical mind could be achieved. Ambition was rapidly turned to realism, when a series of failures made it apparent that superior intellect was not enough. A railway bridge across the river Tay in Scotland opened in 1878 and collapsed one stormy night in the following year with the loss of 75 lives. Locomotive boiler pressures were increased to meet the demand to pull larger trains at higher speeds resulting in several explosions. Engineers realized that they did not know enough and, in the 1880s, a number of engineering laboratories were set up to test materials, structural configurations, and mechanical systems to find the underlying factors which separated success from failure. A new railway bridge across the Tay was opened in 1887, the first structural design to take account of wind pressures. It still stands today alongside the stumps of the piers of the original bridge.

Although the laboratory work was focussed on application rather than exploration, their methodologies were borrowed from science. These laboratories were absorbed into the rapid growth of "redbrick" universities towards the end of the nineteenth century. They gained academic respectability by fully adopting the science approach, with a similar research structure publishing peer reviewed papers. The research laid the foundations for modern engineering, with analysis and understanding, which allowed the new industries of the twentieth century to evolve, aided by the needs of two world wars and expanding world economies. By mid-century, engineering degrees were teaching fundamental engineering analysis, frequently referred to as engineering science, but this scientific approach was not paralleled in industry. Courses then made little reference to design, project management, team-working, costing, or other areas of engineering practice, in which there was little research interest or grant money available. Experienced engineers remarked that it took several years of training and experience in industry before engineering graduates were any use.

Over the same period, industrial design developed in very different ways. While engineers were looking up to Telford, the Stevensons, Brunel, Mitchell and Barnes-Wallis, industrial designers were being influenced by architects, furniture and interior designers, ceramicists and painters. Morris, Rennie MacIntosh, Buckminster-Fuller, Eames and more turned the non-engineering designers into an interactive community exchanging concepts and styles between industries and markets to meet the human needs. Art Deco in the twenties and the Utility range of products of the post-war austerity period allowed the industrial designers to come into their own leading to an explosion of new ideas in the more relaxed era of the fifties and sixties. They even began to reject the word "industrial" and prefer to be known as product designers.

In 1959, C P Snow[3] divided the cultural world into sciences and humanities, with engineering now clearly in with the sciences. That point has often been quoted to emphasise the divide, but the main theme of Snow's lecture was the over emphasis on the humanities in British education, which he expected to lead to a shortage of engineers and scientists, a forecast which became true over the next 50 years. The perception of the cultural divide, with little acknowledgement of the commonality of the design process to engineers and product designers, was accepted by most of the general public and the two design communities, with engineers usually regarded as applied scientists; a complete contrast with the situation a century earlier.

3 THE LAST 50 YEARS

The 1960s were the period when the recovery from the Second World War ceased to dominate and new ideas began to flourish. For product designers, new materials and manufacturing capacity, and a more open and receptive market unleashed a wave of experimental styles, colours, and shapes in graphics, fashion, furniture, interiors, and architecture. Much of it was short lived, but it brought product design to the awareness of the general public as never before. People flocked to the Design Centre in London to see the latest design trends, with whole rooms furnished with well designed British products. In the same period, the Apollo program, Concorde, colour television and video recorders, Mini cars and more showed that engineering design could open up whole new fields of products with their own functional aesthetic. Products became more complex bringing in the term "multi-disciplinary" to describe them. (This was more a reflection of the Victorian era academic discipline divisions, than the reality of industrial teamwork.) All this pushed product and engineering designers to work more closely together in many areas.

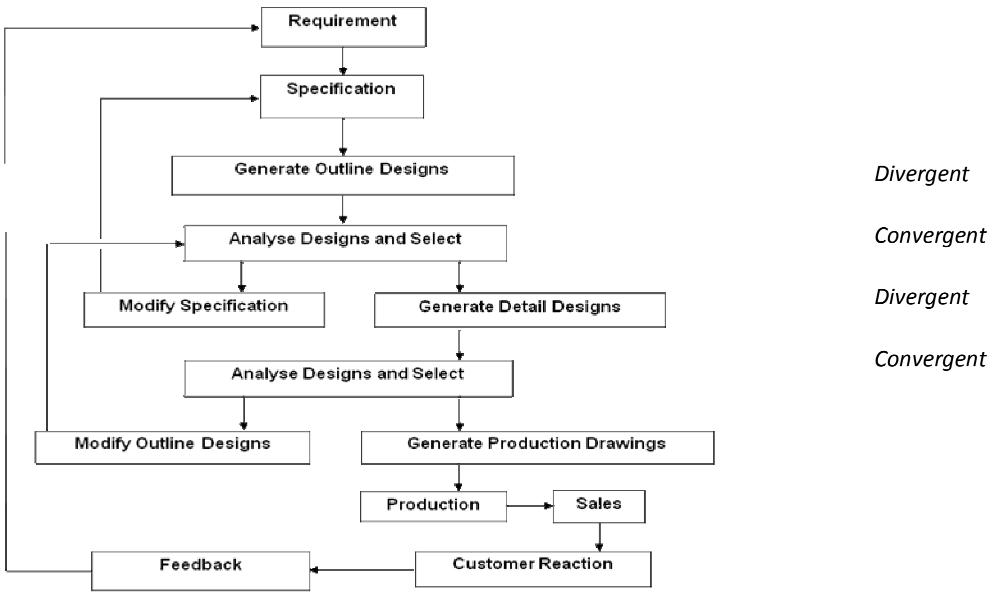
It was unfortunate timing that the Finniston Report[4] of 1980 persuaded the UK government to set up the Engineering Council, which in turn gave a greater definition to the engineering profession and established an accreditation system which divided those academic degrees for engineers from other design related courses. For all the benefits within the engineering profession, it re-defined the academic gap between the two as courses changed either to become accredited or distance themselves from the accreditation constraints. Despite this trend, a few courses remained firmly focussed on product design with a strong technical content. The pioneering post-graduate Product Design Engineering course run jointly by Imperial College London and the Royal College of Art, and the similarly named joint undergraduate course by Glasgow School of Art and Glasgow University, produced engineers with the skills of a product designer. Undergraduate courses at Bournemouth, South Bank, Brunel, Coventry, De Montfort, and elsewhere became popular, not only with students, but also with employers, encouraging more courses to become established.

This movement has encouraged a number of engineering schools to take on a product design component or share workshop and other facilities with product design schools. Industry is beginning to benefit from this influx of new graduates with a broader and more relaxed view of design and engineering. Thus, even though the UK manufacturing industries are still sadly reduced from their historic position, a high proportion of the worlds design activity still takes place in the UK. Thus product design and engineering are moving closer and each is beginning to appreciate the other's role, although there is still some way to go and they are likely to remain distinct for the foreseeable future. (This was covered in more detail in a paper I gave at the E&PDE'05 conference[5].)

4 COMMON GROUND

One major area of common ground is almost taken for granted by both groups. Major design projects require a considerable amount of organization and management, with a high degree of uncertainty and risk. Even so designers usually see that as a necessary extension of the novelty and predictive heart of design thinking. If you knew exactly what you were going to do, there would be no novelty and hence no need for design, only organization of the task. This long history of acceptance of uncertainty and

risk is in clear contrast to most other fields on management, where a major aim is to minimise risk. A new European initiative on Innovation Management[6] has identified design management as a useful basis for more general guidance. However, product designers and engineers have very different ways of expressing their management expertise with different jargon, different ways of expressing the design process and a different way of setting priorities. There is an urgent need to unify and generalize the design management experience to meet the broader European initiative requirements.
Despite those differences in the ways they are expressed, the underlying design methods are broadly similar with detailed differences mainly depending on the industry, market, and materials involved. Product designers with a customer focus tend to see the product as a whole, and embed its requirements into the environment in which it will be used. Engineering designers tend to break down the product requirement into various functions, which can then be considered separately, with the overall result often dependent on their interfaces and the space available. Although they approach the product from opposite directions, they both adopt a divergent/convergent pattern, which may be repeated several times at several levels of hierarchy for more complex products. It is common to all types of design with a final stage of the selection of detail geometry and materials, resulting in the communication of the requirements to a manufacturer, usually by drawings and other documentation. The figure shows a typical design cycle.



The loop closer is the feedback of the customer reaction into the next generation of similar products.

5 THE WAY FORWARD

Products across the range from bridges to bicycles are becoming more complex with more capabilities. Even so many of the new technologies, particularly those which are computer based, are more accessible and do not require an engineering depth of understanding to use them efficiently, thus the role of product designers is expanding into new areas. At the same time the ability of computers to analyze and optimize a far wider range of potential design solutions is allowing engineers to find functional solutions, which make more efficient use of energy and materials and give lower whole life costs. Within engineering education, the slow take up of design as a "thread running through the course"[7] has received a boost with the introduction of the CDIO (Conceive, Design, Implement, Operate) courses in a number of engineering departments around the world.[8]
A number of rapid prototyping machines are now cheap enough to be available for the home market, costing little more than a printer. A growing range of ready programmed products are available, but the ability to interface with cheap 3D modelling software puts significant design and manufacturing capability into the hands of the general public. This is a long way from a "Star Trek replicator", but demand will surely grow. Some markets already have problems with counterfeit spare parts and we can expect this to spread to other areas. Soon it may be necessary for legislation to define who can

design certain types of safety critical parts and licenses for designers and engineers could quickly follow.

The growing external appreciation of the blend of functional necessity with user compatibility, which the full design spectrum represents, is beginning to penetrate into management thinking. This will soon promote co-operation between university engineering and design departments and business schools, with a whole new field of research work to generalize design thinking for wider use. To meet these challenges, designers from all parts of the spectrum need to work together to anticipate predictable changes and organize ourselves to provide the design service that industry needs. We should perhaps remind ourselves:

"Imagination without knowledge is wings without feet."
Joseph Joubert

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[4] "Engineering Our Future" (Finniston Report) London: HMSO, 1980.
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[8] See www.cdio.org for more information.