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INNOVATION SHOULD BE TAUGHT TO ALL 14 TO 16 YEAR OLDS IN SCHOOLS

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ABSTRACT
This paper is a discussion regarding the teaching of creativity and innovation and the supply of professionals to the product/industrial design business. It argues that the scope of design in the business has changed over recent decades to include a broader breadth of activities and that an understanding of innovation and creativity in schools should be a part of much broader subject curricula to provide the right future innovators for the product/industrial design profession as well as broader applications. This would also offer more students the chance to experience iterative creative practice before making directional choices.
The UK Government is strongly advocating the need for innovation as essential to future economic growth [1], supported by publications at national level including those by the UK Design Council [2] and 'Restarting Britain: design education and growth: a report by the design commission 2011[3].
Industrial Design has become a more intellectual subject over the last 20 years. Globalisation of the sector and sophistication of product market-places has caused the Industrial Design industry itself to expand its offer, particularly in the pre-design areas of strategy, service design, customer insights, perceived quality and sustainability. The creative industries sector overall is increasingly operating on a convergence basis and regarding designers as creative practitioners without identification by individual discipline.
Creativity and innovation are increasingly advocated as essential to broader application in leadership and management in industry as advocated by 'The Cox Report on Creativity in Business [4].

Keywords: Innovation, leadership, iteration, convergence, education.

1 INTRODUCTION

The UK's leading reputation for producing highly effective professionals for the product/industrial design industry has been enhanced over the last twenty-seven years by the requirement in secondary schools for all children to take a Design and Technology or Art subject. This situation has now changed and the numbers of students taking these subjects has plummeted, particularly in terms of high-achieving students studying science and engineering along with a creative subject for their profile to lead to tertiary level product/industrial design study and subsequently enter the industry [5].
This paper suggests that now is a suitable juncture to reassess the place of creative and innovation studies in secondary school education. Secondly how learning underpinning the subject should be included in a much broader breadth of curricula and subject areas so that it is experienced in a meaningful way by a much greater number of students to give more people the knowledge to make balanced decisions for their futures that includes the option of creative careers. This will also support universities in supplying the best and most appropriately prepared graduates for the industry.

2 INDUSTRY APPLICATION

2.1 Changes in Industrial Design

'Industrial design is not what it was 20 years ago, it's far more intellectually rigorous'
The comment above is made by Les Wynn, Head of Experience Design Europe for the international technology company HCL Technologies and Design Manager of Xerox for over 20 years. It suggests that the practical nature of the professional area in solving problems and designing products on a functional, production and operational level now only represents one part of the professional

discipline. It also reflects the globalisation of the profession, with much of the practical and production aspects of the practice being carried out away from Europe. This has given rise to the expansion of practices relating to the intellectual aspects of the subject particularly those involving research and strategy.
This suggestion is reinforced by the profiles of services offered by leading product/industrial design companies. DCA Design, the leading Industrial design company in the UK according to the Design Week Creative 100, offers as its services: research and strategy, mechanical engineering, industrial design, interaction, human factors, electronics, software and prototyping [6]. Other major Industrial/Product design companies offer a similar range of services including an increasing emphasis on Service Design indicating a wider and more diverse range of services than were evident 15 years ago.
Jaguar Land Rover now employs product designers, fine artists, and other creative practitioners from different disciplines alongside automotive designers in its automotive design programmes.
Imagination, the leading UK design company, a global company with offices in over 10 major capital cities, the number 1 creative company in the Design Week creative 100 for over 10 years, calls all its designers 'Imaginers'. This is to deliberately avoid the delineation of title to any one discipline area, which may be misleading as to what they do in the present environment, and also because it considers that creatives must be ready to develop and change to meet changing requirements [7].
Changes have also occurred in the content of practice. Product areas for which the main design input was once mechanical and electrical are now dominantly a digitally driven design exercise with focus of user interface design, user experience design, human factors and brand experience. These are the areas by which the products compete in the market place, the electro/mechanical performance being assumed, and in many cases delivered by application of hardware produced by third party suppliers.

2.2 Developments in the industry

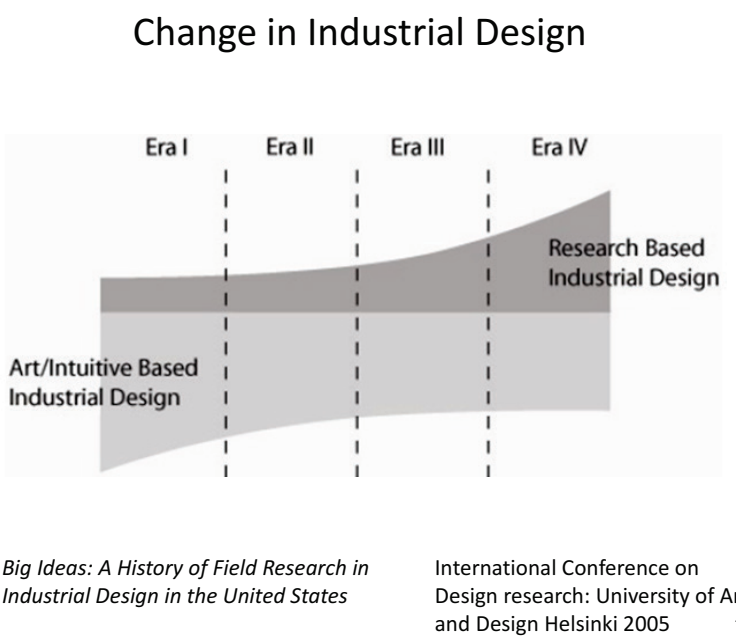

Figure 1. Industrial design changes in the United States.

Figure 1 above, taken from Goatman and Moody. Design and Technology an International Journal 2014 shows the change in the practice of industrial design in the United States, demonstrating the increase in activity in researched base activities over traditional creative design activities.
A paper by Goatman and Moody 2014 involved a request to a number of product design leaders in companies ranging from small consultancy to multi-national organization to write a short narrative entitled 'What is Industrial Design'. The research then identified the main keywords in each narrative into one of five categories and are recorded in the table below.

Table 1. Keywords by product design business leaders (Goatman & Moody 2014).

Designers Employed	Business	People	Operation	Function	Cognitive
Contemporary 1-5	3	3	13	6	8
Established 1-5	11	1	6	2	10
15-20	9	12	2	4	23
35-50	8	1	8	1	19
200 plus	3	1	7	1	30
TOTALS	34	18	36	14	90

It can be observed from the table that words in the category 'cognitive', which refers to thought based activities, occur significantly more in the design leaders' narratives than words in each of the other categories referring to the practical and functional areas of activity traditionally associated with Industrial Design. This is generally more evident as the number of designers employed by the company increases in the chart. Words in the 'cognitive' category include 'vision, possibilities, meaning, purpose' as well as those referring to 'brand, perception, process, exploration and dreams.'

3 GOVERNMENT COMMENT

The Government's intention to put innovation at the forefront of its strategy for growth is well stated [1]. The case for design as a major contributor to the economy is a compelling one, made strongly by the Design Council [2], the Design Business Association, and The Design and Technology Association and The Innovation and Research Strategy: Growth Review BIS 2011 below:

'*The future prosperity of the UK will depend upon our ability to innovate successfully, and to adopt and embed new innovations across business and the public sector. Innovation is the main pathway to sustainable economic growth, higher real incomes and greater wellbeing over the long term. Raising our innovative capability, and increasing the level of private sector investment in innovation are the only ways in which the UK can prosper in the global economy.' [4]*

4 DEVELOPMENTS IN EDUCATION

4.1 The relationship of design and engineering

'Engineering used to be an art, now it's a science'

Professor Rajkumar Roy: Head of School of Manufacturing Cranfield University 2009

The above statement made by an eminent professor of engineering at Cranfield University suggests a change that has taken place in the nature of engineering as practiced in industry and learnt at degree levels of Bachelors and Masters. It referrers to the much greater complexity in engineering that has developed in recent decades and the development of specialisms. These have created a need for retention of more complex and comprehensive knowledge for each area and the adoption of complex dedicated algorithms.

Traditionally design and engineering involves the integrated application of innovation, technical knowledge and creativity represented by universally known figures such as Isambard Kingdom Brunel and Ettore Bugatti. This mode of operation has been regarded as foundational to the practice of product design and engineering and therefore its educational content. The above statement by Professor Roy suggests that the depth of specialism now involved in the learning and practice of each area of engineering has left this generalist viewpoint outmoded as a direct foundation of professional practice. The general learning of creative and innovation techniques in science and engineering subjects has therefore diminished due to the specialist focus of these subjects and the additional software knowledge necessary in any area.

4.2 Teaching and Learning in education

The increase of specialism in science and engineering curricula in schools and tertiary courses reflects the change referred to by Professor Roy above. Teaching and learning to experience and understand

creativity and innovation do not figure strongly in these curricula. If a student is to choose design for their tertiary course they need to study a creative subject at the higher level alongside science and other subjects in order to understand and be attracted to creativity and innovation as a career focus. Reduction in accessibility to these subjects is a serious threat to supply of practitioners into the creative product design and engineering industries.
The increased breadth of expertise demonstrated by the profiles of services offered by industrial design companies suggests that science and engineering in addition to design subjects in schools no longer solely represents the natural pathway into product/industrial design. The increased significance of research, with particular interest in the human based areas of ethnography, brand experience, service design, customer insights and perceived quality suggest that social science subjects such as sociology and psychology are also appropriate subject areas to lead into the profession. The importance of full life cycle planning in product/industrial design and consideration of sustainable solutions suggests that study in subjects such as biological sciences also present subject areas appropriate to this area of career. Students studying a broader range of subjects potentially have an exciting and rewarding career in the design industry where their more diverse expertise is needed in the future. At present students taking these subject areas without one of the art or design specialisms, which are now much less accessible in the UK, are unlikely to have experienced creativity and innovation in their studies at secondary education and will not be cognisant to consider design in their choices for tertiary level, nor will these courses be drawn to their attention.

4.3 Left and right brain thinking

A distinction can be made in the nature of cognitive activity relevant to creative subject areas in contrast to subjects that rest more strongly on mental retention and prescriptive application. The latter approach has traditionally formed the core of learning at secondary school level. Karl Jung makes the distinction of right and left brain thinking [9]. The right brain broadly addressing the creative and emotional approaches involving nuance and the left brain the calculated and deductive approaches characterised in mathematics. Inclusion of learning in creativity and innovation in broader subject areas will require modifications to curricula to address both areas of mental engagement, which will involve the addition of right brain techniques.
Innovation techniques are generally taught in a studio situation, with a strong emphasis on experiential learning in teams pursuing challenges for which there are not set answers, an essential quality necessary for innovation. Terms commonly used include ‘workshops’, ‘brainstorming’, ‘co-design’ and ‘deep-dive’. These techniques provide the students with important skills including the ability to work in teams, participate in open exchange of ideas, to think laterally, communicate and present verbally, digitally and using kinaesthetic techniques, and significantly the ability to deal confidently with ambiguities for which no fixed answers exist. Students who have progressed from secondary school to university and into the creative professions have usually taken a mixture of subjects at A level that include Art and/or Design and Technology with science and/or humanities subjects and straddle both right and left brain thinking. This is the basis of the methods applied professionally for creativity and innovation in industry. This paper advocates that these forms of learning should be integrated into a much wider breadth of subject areas so that their experience and understanding is appreciated by many more students who are then equipped to make balanced comparisons at the points they are required to make directional choices.

5 CREATIVITY AND INNOVATION IN BROADER APPLICATION

The application of creativity and innovation in the core roles of industry is the theme of recommendation made by ‘The Cox Review of Creativity in Business: building on the UK’s Strengths 2005 [4]. This has been a highly influential document commissioned by the Government in 2005 of Sir George Cox, then Head of the UK Design Council, to examine the situation of how the UK’s known prowess in creative education was being effectively applied for the benefit of the UK economy. The report concluded that the creative industries, the main employers of graduates from this area of study, were operating largely independently of core business in the UK, selling their services globally on a consultancy basis, with the benefits being applied largely outside of the UK. The report strongly recommended that this creativity is applied more broadly and made a set of recommendations to integrate creativity into the core activities of industry, noting:

'...the review will have a particular focus on the role of creativity in modern manufacturing. Secondly, the review will look at strengthening the links across university departments and with industry. This will include new forms of courses, services and alliances involving, amongst others, art, design and creative courses, business schools and engineering and technology courses.'

A number of university collaborations at post graduate level were subsequently funded by the UK Government including Design London, a collaboration between The Royal College of Art and Imperial College London.

6 CONCLUSIONS

Product Design and Engineering as a professional discipline no longer operates only as a stand-alone area identified by its problem solving, development and product creation practices and being identified by its own business sector. The education pathway that introduces all students at secondary school level to relevant knowledge and skills that could lead them towards the profession is trailing in its relevance. In the UK, a disruption has occurred in this process through changes in curriculums at national level and this represents an opportunity to update the learning of knowledge and skills relevant to the current profession and improve the industry supply of graduates with the people it needs for the future as well as giving a much broader range of students the opportunity of careers with a creative base.

Globalisation has distributed professional practice of industrial/product design developing the profile of the profession particularly as practiced in Europe. Significant aspects of this involve the integration of knowledge and practice with removal of traditional discipline delineations referred to as convergence, addition of new areas of practice, and an emphasis on the creation and application of tools and methods, particularly those relating to human response as the basis for creative design.

Content and structure of education in secondary schools has strong relevance to the future supply of people into creative industrial/product design and related development- based engineering professions because it is at this intermediate stage of education that directional decisions are made defining personal pathways towards tertiary education and leading to careers in this subject area.

In order to ensure a supply of the right professionals for the future, learning of creativity and innovation need to be recognised as foundational to much broader subject area application than is currently the case where it is treated as a specialist study for students choosing pathways towards specific design disciplines, often seen as vocational careers. This position no longer represents either the relevant areas of the design profession, nor the needs of careers generally. The iterative and collaborative processes of creativity and innovation need to be a meaningful part of study in a broader range of subjects in schools, and be recognised as an important constituent of science, engineering and social science subjects in order to address productively the needs of future industry.

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