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CREATIVITY, 3D PRINTING AND DESIGN EDUCATION

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ABSTRACT
The core of this paper outlines and reflects on a project set as a challenge to final year Product Design Students. The project is used as one approach to explore the possibilities of new manufacturing technologies within an under-graduate curriculum. The paper explores how these technologies can be introduced creatively as well as formally. Within this the current purpose of product design is touched upon. Its starting point is observations of how the landscape for manufacture is changing due to scale and cost of new technologies to the point that citizen designers can manufacture at home. The question of 'What is the mandate and role of the modern professional designer?' is explored. Universities are training the next generation and it is important that they address these issues both from an understanding of the technology but also the new creative possibilities through practical projects. The introduction places design in the context of manufacture from a traditional perspective allowing new technologies to be considered as both evolving and divergent to this knowledge. The project, 'designing a three dimensional business card utilising new 3D Printing technologies' allows students to explore the possibilities of these machines with a physical outcome while also considering how business cards can be used to attract attention and therefore promote themselves as creative designers.

Keywords: Creativity, Additive Manufacture, design education.

1 INTRODUCTION

This research paper considers the integration of the relatively new technologies of 3D Printing and Additive Manufacturing within a Product Design under-graduate curriculum. More particularly it outlines how the author and colleagues have progressively introduced these technologies both from a knowledge base and through practical project challenges. Initially, and in line with their capabilities, these new technologies were understood from a modelling or prototyping perspective whereby complex 'one-off' objects could be more quickly and cheaper when compared with traditional model making procedures [1]. As the capabilities of the technology improved, however, there followed a realisation that complex forms could be manufactured directly which otherwise would be impossible to produce. As these technology platforms have descended in price to the point, currently, whereby basic machines are available for less than £1,000, there has been a notable shift from 3D printing being available as a specialist service only, to more general and widespread availability. This facilitates manufacture at home and could potentially change the landscape of production and consumption. All of these possibilities impact on the education of future product designers. With manufacturing capability being shared with the consumer, the role of 'professional' designer is being re-evaluated to include facilitator, catalyst and co-designer.

Central to this paper is the superimposition of new possibilities on existing knowledge sets and methodologies within under-graduate design education. This superimposition is crucial if the next generation of designers are to understand and contribute effectively to paradigms of consumption and production. Through a focussed design project students are challenged to demonstrate creativity utilising 3D Printing. The project builds on the formal knowledge of manufacture and a theoretical understanding of the new possibilities facilitated by these new technologies.

2 NEW TECHNOLOGIES AND MANUFACTURE

Manufacturing technologies have always involved scale from the hand made one off object to the mass manufactured components and products. Since the end of the nineteenth century Product Design has been associated with the later. Indeed much of the possibilities of Western Culture has been made possible by our increasing capacity to manufacture repetitive objects in increasing quantities. This loosely parallels the evolution of scientific reason known as Enlightenment or Modernity [2]. In line with all scientific discovery manufacturing has evolved becoming more complex as greater understanding of materials and refinement of processes has allowed for a wider range of possibilities and also higher volumes of manufacture.

Where the new technologies of 3D Printing or Additive Manufacture differ from this evolution is twofold. Firstly we can now make objects which before were impossible by either machine or hand, and secondly scale. That is with traditional manufacturing technologies there is normally a pre-manufacturing stage of tooling including testing. This involves dedicated design, expense and time. As a consequence components were only financially feasible at given scales for differing manufacturing processes, from low tooling cost batch production to high tooling cost mass manufacture. However as 3D Printing now allows objects to be made without tooling there is little set up time or expense apart from defining an object by Computer Aided Design (CAD) allowing complex objects to be made as one offs.. This facilitates manufacture to become detached from large production companies to be available in different economic paradigms from companies such as Digits to Widgets who offer 3D Printing similar to 2D print or copy shops, many available on the high street to all citizens. Here anyone can bring or e-mail a computer CAD file and get a 3D object manufactured in hours rather than the months associated with traditional processes.

3D Printing is a relatively new technology and clear information about what the technology can currently achieve and how to achieve it is quite scarce……

……..At D2W we want our customers no matter what their level of experience, to get the very best from our Industrial 3D Printers [3].

There are also a growing number of collectives or maker spaces pooling both knowledge and access to machines to produce artefacts. This may or may not include professional designers within the knowledge pool.

Digital fabrication technologies such as laser cutters, milling machines and three-dimensional (3D) printers are increasingly available to citizens, especially in devoted spaces known as fab labs, hackerspaces and makerspaces. They are the low-cost equivalent of industrial prototyping equipment and enable 'making' and 'fabbing' activities where hobbyists, professionals, inventors and the curious can experiment with and realise their own ideas. [4].

In conjunction with this the cost of 3D Printing machines has dropped with entry point prices being below £1,000. This has brought the possibility of production directly into the home of consumers. If a future possibility is that anyone with a capacity for CAD, the resources to buy computers and a 3D Printer, can design and manufacture artefacts making a direct link between design, manufacture and consumer what is the role of a 'professional' designer?

3 THE CHALLENGE

3.1 The Brief

During the final semester students undertook a self-selected Final Major Project (FMP). On submission they had to demonstrate the ability to practice as Product Designers. This project required a rigour in all areas of the design process discover, define, develop and deliver based in the UK Design Council's Double Diamond Design Process [5] at a competency for entry level into the design profession. Against this backdrop final year students were set a very simple challenge:

'Design a three-dimensional business card for yourselves using new technologies.'

This project ran concurrently with the FMP and balances the commercial constraints of professional development with an abstract challenge, the success of which was dependent on the students creativity realised through new technologies, the computer and additive manufacturing. The 3D Business Card challenge had two distinct benefits: Firstly, it allowed students to express their creativity in form generation or other response in ways which were previously impossible and, secondly, the resulting 'card' could be used as self-promotion in an original way, again an expression of creativity. These two

approaches to creativity align themselves with the notion creativity being expressed in reframing the design problem and the concept of originality in proposed responses to defined issues [6] [7]. Within this challenge students were encouraged to think differently and use the new technologies to challenge the brief, what is the purpose of a business card? A subtext to the project was that it allowed students to demonstrate abilities in the understanding and realisation of form. The latter point is important as these new technologies allow forms to be produced which previously were impossible or beyond time and budgetary constraints. To achieve an output students also needed to be conversant with CAD skills. Thus the project also allows the students to tacitly demonstrate prowess within this environment. These creative aspects of the project were very important as technology is not only facilitating new possibilities but, particularly in digital and data driven fields, reducing human input in traditional economic sectors raising questions on what are we training students for? An example is technology replacing human input with driverless cars, which are being tested on public highways.

Ideation in its many forms currently remains an area where humans have a comparative advantage over machines. Scientists come up with new hypothesis .... journalists sniff out a good story .... chefs add a new dish to the menu .....

.... Many of these activities are supported and accelerated by computers, but none are driven by them. [8]

This highlights the need for creativity to resolve issues in different ways. Although by necessity Product Design needs a rigour of process which students need to learn, they also need opportunities to explore creatively and a core part of product design is an understanding of form. This project offers one of these opportunities. The responses to date can be loosely summarised as follows:

3.2 Response 1: Literal Translation

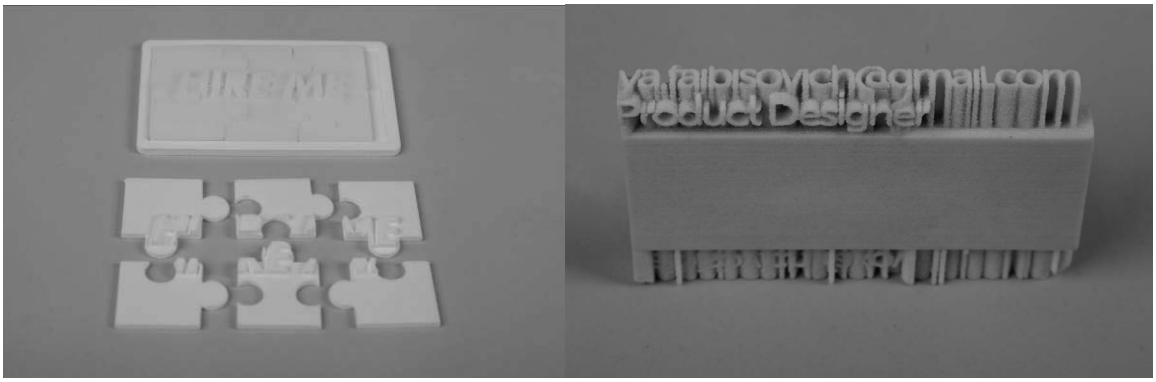

Figure 1. Examples of literal Translations

Many students took a literal response extending a conventional business card into 3 dimensions with embossed lettering or simple extrusion techniques.

3.3 Response 2: Exploration of Form

Figure 2. Examples of Form Explorations

The next level of response were students who explored the physicality offered by 3D Printing. In this instance they were also demonstrating an ability to explore and define complex forms within CAD.

3.4 Response 3: Complementing FMP

Figure 3. Designs related to FMP

Another approach taken was to make a card which was driven by and represented the FMP. In the example given in Fig. 3 where the project was focused on agricultural machinery the business card acted as a stamp with the wheel rolling out the students details onto card or cloth.

3.5 Response 4: Re-interpreting the Brief

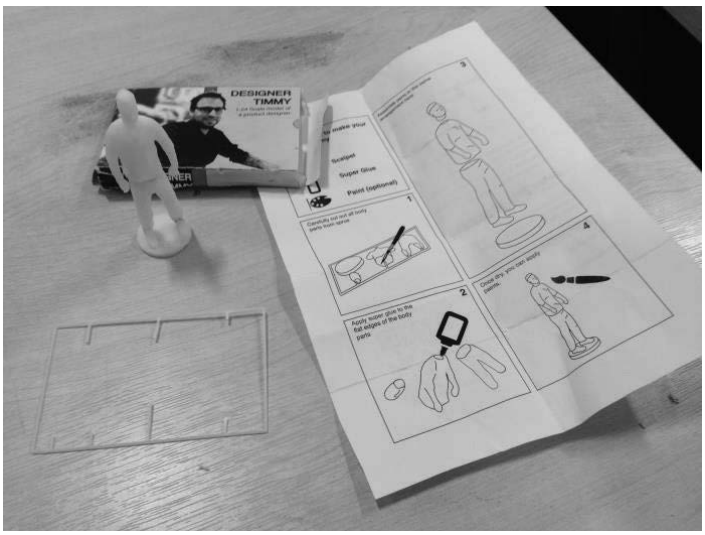

Figure 4. Example of Re-interpreting the brief

A final interpretation was where students pushed the possibilities of the brief designing imaginative ways to promote themselves while also utilising 3D printing as part of the deliverables. In this instance students are demonstrating creative thinking in solving problems by seeing them differently. The business card example in Fig. 4 comes as an assembly kit adding interaction and fun into receiving a card.

4 DESIGN EDUCATION

Traditionally the growth of the product design profession and its associated training, mirrors the growth in (mass) manufacture and consumption. It has been a combination of understanding the possibilities of manufacture from material forming, scale and economies while seeking to provide the consumer with a product appropriate to their need. In conjunction with an understanding of how products are made designers consider usability, ergonomics, aesthetics and cost.

Industrial and product design; the conception and planning of product for multiple reproduction…….. ……..is a creative and inventive process concerned with the synthesis of such instrumental factors as engineering technology, materials and aesthetics into machine producible solutions that balance all user needs and desires within technical and social constraints. [9]

With the introduction of these new technologies this traditional understanding needs to be reassessed against new paradigms of production and consumption afforded by new technologies.

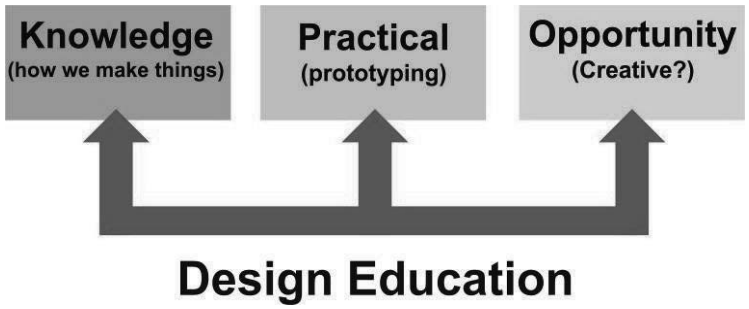

Figure 5. New Technologies and Design Education

At the University of Hertfordshire new technologies have been introduced to the under-graduate curriculum in Product Design in three interlinking ways (see Fig 5): Firstly as knowledge that is an integral part of the programme which explores and explains how we manufacture objects, secondly the University has invested in 3D Printing machines (notably an EOS Formiga P110 Selective Laser Sintering System [10]) allowing students to manufacture components either as one off objects or for prototyping purposes. This is in line with current educational practice whereby additive manufacturing has been seen as an extension of Rapid Prototyping [1] [11]. An extension of this is to consider additive manufacture as a method of producing complex 'one offs' as solutions to individual problems or needs. This has been highlighted by Jennifer Loy in a student project at Griffin University.

the student was interested in the use of biomaterials to create a scaffolding for a damaged heart that was 3D printed to allow the patient's own cells to grow around it. [12]

The last aspect of this teaching is about opportunities provided by these new technologies. Here the topic has two distinct approaches. On a philosophical level the impact of new possibilities due to cost, scale and ability to produce complex objects were discussed with students on a cultural level in the context of manufacture and consumption. Central to this work was the superimposition of new possibilities on existing knowledge sets and methodologies within under-graduate design education. Lastly, in the work described above students explored practically the creative possibilities that these new technologies afforded, in an abstract making challenge. It was important to introduce this in a practical 'making' project to balance the contextual discussions which place the work in a social-economic-design framework. It is up to you to judge, through the examples presented, whether this was successful.

5 CONCLUSION

Universities should be facilitators and thus encourage creativity within their students. Although there is a new space for product designers to operate; that is identifying opportunities, to question existing paradigms and act as a catalyst for change in which futures can be realised, there is also the need to be creative visually and deliver realisable artefacts. In essence we are training adaptable Creative Thinkers. The project outlined above builds on knowledge; the production possibilities of new technologies, by challenging students to use this in new ways. Two strands of creativity were evident in the way students responded. Firstly with the re-interpretation of the brief connecting the problem

(brief) to solution (artefact), the notion of self-promotion. Secondly with the originality of objects produced. Prowess was shown in the ability to understand new possibilities of manufacture and the technical skill of generating complex shapes in CAD. In one instance (fig. 4) this was extended to creating a 3D scanner with a mobile phone and swivelling desk chair. Skill, adaptability and originality all feed into creativity [6] [7], and are important attributes of a graduate designer.

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