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Industrial design digital technology

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Abstract

This paper is a reflective opinion piece suggesting that the Industrial Design discipline has an opportunity to react proactively to disruptive practices made possible by innovations in digital technology, by developing a field of practice in 'Industrial Design Digital Technology' that challenges the boundaries of the current Industrial Design discipline and potentially stimulates new directions for the profession and for graduates. This would also provide an opportunity for new research collaborations that are in line with the demand for more interdisciplinary work in higher education, creating genuinely transdisciplinary practice that will attract funding and attract students.

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1. Introduction

It is difficult to predict where technological innovation will take designers, how it will impact users' lives and the way businesses will operate. In his 2005 book *Fab – The coming revolution on your desktop – from personal computers to personal fabrication* [1], Neil Gershenfeld, the director of the MIT Centre for Bits and Atoms, draws a parallel between current attitudes towards digital fabrication technologies and the lack of understanding, at the time, of the impact of Claude Shannon's circuits work in the 1930s which provided a foundation for developing the capabilities of computers. He argues that digital fabrication is being regarded purely in terms of conventional thinking as an additional production process by many engineers and designers, when it needs to be considered in a much

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broader sense as a transformational technology in order to glimpse its potential: "To even call digital fabrication a manufacturing technology risks trivialising it, just as the original dry descriptions of thresholds in circuits for communication and computation hid their eventual implications in the creation of Web sites and portable music players and video games." [2]

Gershenfeld discusses the underlying principles informing digital fabrication as being similar to those driving the molecular assembly functions of ribosome in biological cell construction. He suggests that the challenges in effectively exploiting the recent developments in digital fabrication are a result of our limitations in design thinking: "One of the intellectual frontiers associated with the development of digital fabrication is the development of an associated design theory."[3]

However, breaking with conventional design thinking about digital fabrication to the extent argued by Gershenfeld requires a paradigm shift in the way Industrial Designers fundamentally view digital technologies, as it is misleading to consider digital fabrication in isolation. Rather, advances in digital fabrication over the last ten years, moving it from a prototyping technology to an end use technology are part of a wider set of digital developments that are impacting design practice and industrial design in higher education – and have the potential to not only impact, but disrupt the incremental evolution of the discipline that has occurred since the industrial revolution.

2. Digital Revolution

" [Referring to TV as 'Video'] Video won't be able to hold on to any market it captures after the first six months. People will soon get tired of staring at a plywood box every night." Zanuck, Exec. 20th Century Fox, 1946 [4].

When email became widespread in the mid nineties, the impact on working practices twenty years later would have been hard to predict. The changes in communication that have been brought about by the development of the internet over the last twenty years that have resulted in skyped interviews, you tube blogs superseding television for the younger generations, Facebook as a facilitator of social activism, and a myriad of other instances have challenged underlying assumptions about business as usual. For designers, the ability to interact with users through the internet has enabled not only an increase in participatory design in relation to embedded and ongoing consultation throughout a 'design thinking' branded approach to design, but in concert with additive manufacturing technologies and demonstrated through the work of companies such as Digital Forming and Nervous System, changed the very scope and nature of the role of the designer in designing products: "The designer of the future has to become a meta-designer, shaping environments in which unskilled users can design their own objects." [5]

Just as, for example, graphic design consultancies and the music industry have both had to face the unexpected impacts on their market brought about by online digital technologies and re-evaluate conventions in business practice, so all industries, even those considering themselves currently on the fringe in terms of being impacted by the tools of the digital revolution, would be wise to acknowledge the scope of advances in digital technologies and take a deliberate step back to consider the implications. However, as Zanuck's prediction – and the experience of the music industry or book sellers – suggest, it takes a considerable break with tradition to be able to conceive of what might be a radical change of direction needed by an industry or discipline in order for it to remain relevant in a digital age: "It would likewise be a mistake to assume the use of twentieth-century technologies in analysing and addressing a twenty-first-century threat." [6]

2.1. Taking a step back: The digital revolution and Industrial Design

Over the last ten years there have been major digital advances in technology that have the potential to significantly change practice in Industrial Design. These include, but are not limited to:

- Improvements in access to the internet worldwide – the expansion of the network, increased band width, improved communication tools supporting sophisticated interactions between designers, production companies and consumers.
- Advances in scanning technologies and the software to manipulate point cloud data.
- Developments in the use of RFID chips and the creation of digital tools to support an internet of things approach.
- Advances in additive manufacturing to include the use of metals, functional polymers and ceramics.

- Increasingly accessible electronics and digital design tools, such as for App development.

According to Gershenfeld: "The biggest impediment to personal fabrication is not technical; it's already possible to effectively do it. And it's not training; the just-in-time peer-to-peer project-based model works as well in the field as at MIT. Rather the biggest limitation is simply the lack of knowledge that this is even possible." [7] Industrial Designers need to be able to step back from conventional practice and see if there are new directions that could be explored that will help maintain the relevance of the discipline in an increasingly digital age. This will help it to continue to make significant and worthwhile contributions to problem solving, economic development and social and environmental activism in the twenty-first century. One of the challenges to maximising the opportunities of digital technologies is in providing professionals with the knowledge and understanding of an emerging technology sufficient for them to be able to see the possibilities the technologies offer to the discipline – and to trust it will be worthwhile to develop those skills and that understanding, in an area that is not conventionally part of the discipline core knowledge and practice, to a point where they can draw those conclusions. For practitioners and lecturers in Industrial Design, expanding their knowledge base to include a level of expertise sufficient to be able to innovate through a sophisticated application of advances in digital technologies requires an investment of time and money. This disincentive combined with a 'lack of knowledge' of what is even possible, may contribute to a reticence in practitioners to expand the discipline profile to include more digital technology and to review it fundamentally for its potential to support a paradigm shift that could be positive for the discipline at this time.

However, just as the music industry has been driven to change by a generation enthusiastic for digital technologies, so are digital natives (born after the spread of the internet in the mid nineties) already driving change in commercial product design. An example of where the discipline should be looking for clues to the future is in the experiences of Hasbro in 2014 [8]. Hasbro is a toy manufacturer. One of their leading products is My Little Pony, marketed to preteens and early teens. Hasbro started with an uncomfortable introduction to commercial 3D Printing as their target audience began uploading versions of My Little Pony to an online 3D Printing provider, Shapeways. Initially, they fought for the copyright of their product, but then Shapeways suggested a competition to allow children to design their own version of My Little Pony and have Hasbro select it for manufacture. The application numbers were so overwhelming and the standard of designs so high, that Hasbro made the radical business decision to allow any youngster to redesign the product, submit it for approval to Hasbro and then sell it themselves through Shapeways, paying a royalty to Hasbro. This proved so commercially successful for Hasbro it then extended the range of products allowed to be redesigned to six, including the leading Transformers range.

3. New directions for a more digital take on Industrial Design

It is evident that digital technologies are influencing the way that design project work and practical studio work are taught [9]. As an example, 3D computer modeling, which began as a documentation tool for designers, used traditionally at end of design processes once a concept had been developed and resolved, is now coming out of darkened labs and into practical studios to be used in conjunction with other studio tools, allowing designs to be developed iteratively between screen and reality [10]. However, if this specific practice is considered in relation to the propositions made in this paper, it is a divergence to current practice to adapt to digital technologies, albeit a significant change of practice, rather than an example of a radical redirection based on opportunities identified through a study of advances in digital technologies. To prompt new thinking for Industrial Design in relation to opportunities that might be provided by advances in digital technologies requires a disciplined initial research approach [11] to exploring a specific field that could have relevance for a discipline prior to having a problem to solve.

3.1. Example of disciplined initial research into advances in digital technologies: Scanning

In the last ten years, scanning has matured from 2D technology into a spectrum of equipment and software to capture real-world data in 3D that encompasses nano to geotechnical engineering applications with combined technologies allowing for the capture of larger data sets, including colour data, and also the ability to process that data more quickly. The type of data that scanning involves is very similar to the 3D data that has been used in CAD systems by industrial designers for over 20 years, yet it has not been traditionally recognised as an integral part of Industrial Design. The field of 3D scanning and the integration of this data into the workflow of Industrial Designers present widespread opportunities for new generations of products suited to individual needs. Scan data is frequently used in industrial design projects, but there is little evidence to suggest that advances in this field are being fully exploited as a driver for inspiring innovative design directions and generating cross-disciplinary collaborations.

In order to explore any potential for Industrial Design in the skilled area of knowledge and practice that encompasses advanced scanning technologies, designers need to study digital / laser scanning and the manipulation of point cloud data for:

1. Knowledge and understanding required to do it properly
2. Knowledge and understanding required to use the software

3.2 Why Scanning?

Developments in additive manufacturing have had an interesting side effect in relation to Industrial Design. Industry conferences on additive manufacturing over the last five years have operated in two distinct streams – industrial and medical (evidence). This difference in approach has manifested itself with a body of knowledge and understanding that addresses additive manufacturing from very different points of view, with the industrial stream focussed on hardware and materials, whilst the medical stream has focussed on software and the generation and manipulation of data. The two streams have come together through additive manufacturing, although again, their focus has been different, with the medical researchers concerned with bioplotters, surgical planning and bespoke medical applications whilst the industrial concerns have been around the consolidation of assemblies into single parts and topological optimisation for light weighting. However, the shared forum of additive manufacturing research has opened up a potential for transdisciplinary research and product development that transcends current practice, shifts the industrial design paradigm more inclusively around digital media and opens up the possibility for graduates to move into new areas of design and production, particularly in the medical field, in the creation of bespoke products, and meta design of products modelled using relations with constrained parameters that can be adapted to be patient specific by clinicians, providing links and collaborations not possible before. This is an area that is currently unpopulated, unclaimed by a specific discipline capable of producing the professionals with the skills and understanding to truly make the most of the opportunities and contribute to problem solving in new ways.

The other driver for the inclusion of this field in design comes from the students themselves. Students entering Industrial Design in 2014 at Griffith University brought with them a digital technologies ease that included experience of basic scanning technologies through gaming applications, and the students themselves, who see possibilities in scanning and have no fear or preconceived ideas of boundaries, are proving a driver for change in this field.

3.3 Examples of student projects showing how scan data is being used as a basis for the design of bespoke products

3.3.1 Basic exterior scan data

Scanning of a foot with a hand-held scanner presents designers with the opportunity to design shoes of unparalleled levels of fit. The foot shown in fig. 1 (a) was scanned to provide information for the design of a shoe to be 3D Printed with extra support for a person with one leg longer than the other. The basic cloud data shown in fig. 1 (a) was rationalized to provide a level of definition suitable as a modelling form in fig. 1 (b). Students used exterior scan data for a variety of projects, such as for a fitted dog chariot for a dog with no hind legs fig 1 (c).

Fig. 1 (a) initial scan data (b) refined point cloud data (c) dog scan

3.3.2 Combining digital technologies

An initial surface scan of a back provides basic information for the development of the surface profile for research student Chris Miller's design project exploring the ability to create structures with different flex capabilities within the product to allow for bespoke patterns of movement designed for individual needs. This project demonstrates how the combined digital technologies could support the development of new products that rely on their particular capabilities. Combining a surface scan with a 3D model built on information from CT scans would take this further, as would including information from a virtual reality system tracking the flex of the spine during movement.

Fig. 2 (a) refined scan data of torso (b) 3D Printed back brace (C.Miller 2014)

3.3.3 Combining complex digital data for design

The digital scanning of an individual's face presents opportunities for bespoke glasses, headgear including safety equipment, respirators, helmets etc. However, combining surface scanning, with information on structure based on CT data, plus video tracking using virtual reality technologies can then be enhanced with information provided by sensors during a specific activity. For example, in addressing the complex issues relating to the development of individual sleep apnoea masks, including compliance, the provision of data from multiple sources of digital technologies could suggest new ways of responding to the task.

Fig. 3. (a) Facial scan vertical (sitting); (b) horizontal (sleeping); (c) comparison overlay for design of sleep apnoea face mask

4. Challenges to Industrial Digital design synergy

Even with a willingness, an ability and the investment of time and money to extend conventional Industrial Design practices more into the digital realm to maximize the emerging markets created by changing needs, changing attitudes, changing technologies and changing communication and production, there are major hurdles to overcome. Not least are the practical issues that arise when attempting to perform design alchemy across platforms. For example, one of the major barriers to the adoption of additive manufacturing by Industrial Designers has been a lag in relation to improving 3D computer modelling software to meet the needs of the new fabrication technology and then, further, to be able to fully exploit it. Organic modelling capabilities using solid modelling parametric software have been slow to mature. Computer aided design software was originally developed to replace an existing practice of documentation that serviced a long established system of manufacture. According to Chen, of the University of California, constraints of manufacture drove the development of CAD tools, rather than the other way around, so software developers had a specific list of requirements/capabilities their products had to match in order to meet industry approval and thus adoption [12].

The current situation is far more complex than the situation that existed twenty years ago where a single digital solution dominated in fulfilling the requirements of a specific discipline, such as Architecture or Automotive design. A study by Kunwoo Lee, based in Seoul National University in Korea [13] suggests that investing in the development of a tailored 3D CAD computer aided manufacturing software solution to additive manufacturing needs for a specific discipline would require a leap of faith in an emerging market. This forces the hand of practitioners currently focusing on 3D Printing to look for tools outside of their disciplines in order to achieve the needs of their designs. The strengths and limitations of 3D Printing are still largely untested and technical advances are happening on a daily basis. Materials, machine capabilities and machine costs are changing at a pace difficult for any software developer to be able to effectively match [14]. Bringing in other digital technologies, such as laser scanning where the captured 3D data of an object is often converted to triangulated mesh and used as a guide to allow the designer an accurate visual representation of design limitations and restraints imported into a 3D CAD software that allows for a integrated design process, working iteratively between the digital and the physical, creates whole new ways of working that can build a wall of challenges that can seem impenetrable. It is not surprising that there has been some hesitation in the profession and academia to move the discipline from its established scope.

5. Conclusions

“The wise old men were indignant. Their smiles faded. "If you had any education yourself," they said severely, "you would know that the essence of true education is timelessness. It is something that endures through changing conditions like a solid rock standing squarely and firmly in the middle of a raging torrent. You must know that there are some eternal verities, and the saber-tooth curriculum is one of them!"” [15] After two centuries of a fairly consistent approach in the development of the profession and having finally found academically acceptable areas of research in social activism and design for the environment, academics in the discipline of Industrial Design could be forgiven for hoping that its relatively recent inclusion in redbrick Universities could be overlooked by a focus on established practices but this is an outdated argument for a sabre-toothed curriculum that is rapidly losing its relevance in a digital world. The reality is that design education is in transition as content becomes disrupted by innovations in digital technology and change driven by the students themselves. The opportunities created by digital technologies, such as scanning, app development, additive manufacturing etc, challenge traditional ideas of what constitutes disciplinary practice and start conversations on what should be taught going forward.

The lines between Industrial Design and digital design are blurring, just as is happening in other disciplines such as Graphic Design, Architecture, Forensics and a myriad of others. Digital technologies are disrupting the boundaries and academics and designers can respond positively or work against it. Just as John Lassiter challenged traditional animation in Disney with his first computer animated film proposal and was fired for it, only to be brought back into the fold later once Toy Story proved the validity of the new art form [16], so there are new designers working at the digital boundaries of Industrial Design, such as Joris Laarman, Moritz Waldemeyer, Auger-Loizeau [17], Assa Ashuach [18] and Fung Kwok Pan [19]. Industrial Design can either barricade its discipline doors, shore up its defences, reconfirm the extent of conventional practice and deny the bleeding edges of what designers in the discipline do, like Disney did, until digital technology innovators prove themselves and the discipline tries to claim them back, or instead, use this time of flux to explore the emerging possibilities, even if not within the scope of currently acknowledged practices and see what happens.

Embracing change means giving up a hard fought for stability for the discipline in higher education, a growing sense of gravitas, and it may be that just as design thinking is undermining the credibility of the profession by opened the door for business practice and the social sciences to grab at the core of the discipline, so opening the door to digital media could cause similar culture shock, but it is that very relative youth that allows the discipline to provide an agile response to learning that aligns with the definition of design that encompasses looking at the world as it really is, and of forward planning. Industrial Designers, and in particular academics, owe it to the discipline, the profession and future graduates to respond to the challenges made by Gershenfeld and develop design theory that encompasses opportunities provided by developments in digital technologies as the basis for future practice

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