

INDUSTRIAL DESIGN 2.0: A RENAISSANCE

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ABSTRACT

New product development has traditionally been aligned with the manufacturing sector and established global supply chains. However new production technologies and global connectivity are transforming the product design industry, and industrial designers are now empowered to be entrepreneurial and independent. Emerging technologies, especially additive manufacturing (also known as 3D printing), have the potential to dramatically redefine product manufacturing and create new design possibilities. This 'new industrial revolution' is enhanced by social media platforms, allowing designers to design, produce and distribute products whilst operating autonomously from the established manufacturing, sales and supply networks.

The profession of Industrial Design is on the verge of a 'renaissance' as designers and consumers are empowered by these new technologies; which enhance creativity and innovation, facilitate new product development practices and enable design entrepreneurship and encourage a participatory culture. Educators must respond to this paradigm shift and ensure that industrial design graduates are appropriately prepared to exploit the potential of these emerging technologies and respond to new product design practices. This paper examines technological and cultural impacts on industrial design practice and describes a teaching initiative that explores the combined potential of social media and additive manufacturing and encourages new product design and implementation strategies.

Keywords: Industrial design, additive manufacture, social media, participatory culture

1 INTRODUCTION

New interactions and technologies are transforming the product design industry and empowering industrial designers to be entrepreneurial and independent of traditional manufacturing and business models. Emerging technologies, materials and processes, in particular additive manufacturing (described as Manufacturing 2.0) are redefining product manufacturing and facilitating innovation by freeing designers from the established 'design for manufacture' constraints. In addition, social media (Web 2.0) is a major enabler of design entrepreneurship, allowing designers to gauge market potential, explore design possibilities, connect with potential markets, and raise seed capital while remaining independent of the corporate product manufacturing and supply networks.

The combination of Manufacturing 2.0 + Web 2.0 is democratising production and facilitating a new consumerism, encouraging the rise of the user-maker, and enabling customers to engage in adaptive customisation, co-development and even home production of products. As has been evident in ICT with open-source software development, the creative opportunities afforded by global connectivity and emerging technologies are facilitating a participatory culture, where consumers are empowered to become active participants in product development, rather than passive users. This will necessitate a new approach for industrial designers, who may be less engaged in the realisation of a single manufactured product outcome [1], instead delivering a flexible product platform where (within designer-set parameters), the user can adapt, personalize and produce the product.

Accordingly, Industrial Design as a profession is on the verge of a 'renaissance' as designers are both empowered and challenged by these new technologies and emerging practices. The ability to implement product strategies through social media, combined with the design potential of additive manufacturing, especially the liberation of product geometries and the reduction of production and financial constraints, enhances creativity and innovation and facilitates design entrepreneurship.

Educators must ensure that industrial design graduates are appropriately prepared to respond to this 'brave new world' of product design where the designer's role may be more of facilitation than resolution.

2 A NEW CONSUMERISM

Social media enabled by Web 2.0 has led the imminent promise of user participation and collective generation and sharing of content. The product design industry can now expect explicate consumer participation through conscious and active engagement across all stages of the product development and production cycle. This ‘participatory culture’ as described by Benkler [2] and Jenkins [3] describes an active, rather than passive, role for the consumer, where the individual is not directed by the end product, but instead contributes to its development, or is engaged in its production. Typically participatory culture has been used to define the behaviour of those engaged in the creation of published media and open-source software development; however the potential for adaptive customisation and home production of products enabled by additive manufacture should lessen consumer passivity and create demand for new product meanings and more direct designer-user relationships.

2.1 Prosumers and produsers

Toffler [4] identified the proactive consumer or ‘prosumer’ as those who are active in improving or designing products and services, thus transforming their role as consumers. Whilst the design or production of goods for personal consumption was common prior to the industrial revolution, the advent of standardised manufacturing led to the factory becoming the dominant institution [5], disempowering the user-maker and resulting in passive consumerism. Bruns [6] has more recently coined the term ‘produsage’ referring to user-led content creation or commons-based peer production [2] (e.g. Wikipedia) where the boundaries between passive consumption and active production are blurred. Accordingly, the term ‘produser’ refers to consumers who actively contribute to product production, an activity which, in a product design environment, is enabled by additive manufacturing.

2.2 Product produsers

Additive manufacture facilitates product produsage. The potential for customised geometries, hierarchical scaling and product personalization, in a low-cost home production environment, affords the opportunity for an unprecedented level of customer engagement in both design and manufacturing processes. For the first time since the industrial revolution, consumers are empowered to determine product outcomes through personal production, in a competitive and highly technical manner, rather than through craft-based activities. It is not difficult to imagine user-led design enclaves, collaborating through social media to develop independent products, in the way that software platforms (such as Mozilla and Linux), have evolved through the collective community will of programming produsers.

3 ADDITIVE MANUFACTURE

Additive manufacture (AM) is changing the way in which traditional industrial design activities take place. These Layer Manufacturing Techniques free designers from the manufacturing constraints imposed by ‘line-of-draw’ processes (e.g. injection molding and die-casting), and enable commercially viable products to be produced without upfront tooling investment.

3.1 Impact and potential

Additive manufacturing is a prospective second industrial revolution, a radical and disruptive technology with potential to transform global economies manufacturing and supply systems [7, 8], and consumer behaviour. The prospect of home manufacture will facilitate new consumer behaviour, encouraging the evolution from passive to proactive consumer (who expects customisation), towards the ‘produser’ who engages in personal product production. The potential for independent low-volume manufacture of products with minimal initial financial outlay empowers designers to assume an entrepreneurial approach to the development and production of innovative products. In addition, the absence of design-determining tooling results in product flexibility that allows mass customisation and multiple product iterations, and facilitates consumer-driven ‘adaptive customisation’ [9]. The ability for consumers to generate unique and personalised products helps to establish an emotional attachment with the product, that is often absent from mass-produced items. This production flexibility, especially when combined with social networks (e.g. crowd-sourcing, crowd-casting, peer-to-peer), permits user-driven innovation and the creation of an unlimited model range, which aligns with Anderson’s theory of ‘The Long Tail’ [10], where endless choice is creating unlimited demand and all market niches can

addressed through the internet. Anderson notes that as the cost of reaching consumers decreases, markets are shifting from a unique model of mass appeal, to one of unlimited variety for unique tastes. Additive manufacture also allows designers to be more sustainable by reducing a product's embodied energy through localised production and reduced transportation impact, more efficient use of materials with minimal wastage, and by enabling up-cycling and repair, increasing product longevity [11]. Although it threatens existing manufacturing and supply protocols, for product designers AM is an empowering technology, which offers new avenues of opportunity and is driving a renaissance in industrial design. However designers must adapt to this changing environment and provide adaptable product frameworks rather than supplying turn-key product resolution. In this situation, the designer's role will be that of a creative and technical *product facilitator*, enabling adaptive customisation and personalization whilst ensuring performance, safety, aesthetics and product integrity are not compromised within the multiple iterations enabled by the product framework.

3.2 Advantages and limitations

3D printing has some significant advantages over traditional manufacturing processes.

From a design perspective, this technology facilitates the design of unprecedented part geometries and enables bio-mimicry of complex forms previously impossible to manufacture. Additive manufacturing can print in many materials, even within the same part. It is now possible to have single parts with multiple material properties (e.g. flexible to rigid) introducing new design and innovation possibilities. Components can be designed with intricate internal channels, and the potential for rapid design changes and product updates affords the designer greater freedom in design and development.

From a production perspective, additive manufacture can achieve faster product to market timeframes, reduce labour-intensive assembly processes if components are printed with internal moving parts, and eliminate spare parts inventories with 'just in time' parts.

However as a relatively new manufacturing process, additive manufacture does have some downsides, although many of these are being overcome through rapid technological advancement. Unlike high volume production technologies, additive manufacturing has slow build times and build size limitations, and consequently higher part costs. Quality is not yet optimized with instances of rough and ribbed surface finishes due to layer thicknesses, build issues, material instability and part inaccuracy. Whilst the palette of materials for 3D printing was originally limited and more suited to prototyping, advancements in both material and print technologies within the last decade have significantly improved part quality and performance. Consequently additive manufacturing is now a genuine low volume production option in many fields, including bio-medical and aerospace.

3.3 Personal Manufacture

The introduction of affordable small scale desktop 3D printers opens the possibility of home manufacture, placing production of complex parts in the hands of the user-maker and produser. This opens up new opportunities for product designer who can sell digital design files directly to users who will undertake adaptive customization, and part personalisation before printing the product. These non-commercial 3D printers are typically fused filament fabrication (FFF) devices, as used in the RepRap and Makerbot Replicator, which feed from a reel of polymer filament and produce average part quality. However, the recent development of small scale stereolithography units (e.g. FormLabs, B9Creator and MiiCraft) will greatly improve the quality and viability of home production.

4 THE ROLE OF SOCIAL MEDIA IN DESIGN ENTREPRENEURSHIP

Up until 2011, strategy consultancy Deloitte Digital was being asked by clients 'Do we really need to use social media?' but the question they now ask is "How do we use it effectively?" [12]. Social media has had a major impact not only on individual social interaction, but is increasingly impacting on the operational processes of designers and business. Social media platforms are a major enabler of design entrepreneurship, allowing designers to engage in user-centred research using crowd sourcing and open-source collaborative design through open innovation platforms. Venture capital can be generated through crowd funding, markets developed and sales generated through forums and blogs, and social networks used for personal career development and self promotion. This unprecedented access to global communities creates new opportunities for new product development and will greatly influence the careers and working methodology of the next generation of product designers. When product implementation strategies combine social media with low up-front investment technologies

such as additive manufacturing, a new participatory culture is enabled. Entrepreneurial designers benefit from autonomy and freedom from the customary manufacturing and financial constraints, whilst customers are empowered to engage in adaptive customisation and individual production. These are many new pathways for entrepreneurial product designers.

4.1 User-centred research through crowd sourcing

Social media enabled crowd sourcing, allows interaction with global communities for user-centred research. Designers can directly engage with the end user to test ideas and design solutions, initiate co-design or participatory design activities, access broadly dispersed groups or targeted demographics; encouraging participants to become stakeholders in the final outcome. FrogDesign uses social media to conduct wide-ranging design research, through 'frogMOB', an experimental method of guerrilla research based on the idea that "anyone can channel their inner design researcher by looking for inspiration from everyday life" [13]. frogMOB encourages a world-wide audience to submit product-user experiences and supporting images, which then informs the subsequent design process.

4.2 Data mining and social diffusion research

Social diffusion (or diffusion of innovations) theory [14] describes how, why, and at what rate new ideas and technologies spread through social structures, and reveals the evolution of trend spreading dynamics. Data mining, a process of searching and analysing data, and then extracting its meaning, can utilise social media to analyse consumer behaviour, find hidden patterns and predict emerging trends. In a product design instance, data mining allows design researchers to understand changing consumer patterns and to make proactive, knowledge-driven product strategy decisions.

4.3 Open-source design and open innovation platforms

Open innovation platforms are global collaboration communities that draw on participant's inspiration, ideas and opinions to solve problems together, often for the collective social good. Whilst many crowd sourcing sites (such as Jovoto, Innocentive, Ahhha) use social ideation or crowdstorming to drive commercial innovation, other open-innovation platforms such as Design21, DESIS and OpenIDEO focus on social activism through design, challenging people to collaborate to develop solutions for critical societal or environmental issues. In the competitive, yet collaborative OpenIDEO environment, participants earn points (known as their Design Quotient), for their contributions. IDEO promotes the Design Quotient as a means to publicly identify and promote design expertise to potential employers.

4.4 Crowd funding websites provide a service that enables creative initiatives to be promoted, financed and realised through collaborative support. This occurs through pledge-based fundraising via an online portal, (such as Kickstarter, Indiegogo, Pozible, Sponsume and Quirky). Crowd funding enables designers to 'pitch' a product without any financial commitment or inherent risk. This allows product ideas to be tested for marketability, sales generated, and production financed whilst the design is still at a pre-production or even conceptual stage. This allows the designer greater freedom for experimentation and risk taking, as the project will not proceed without sufficient financial support.

4.5 Design for download

In 2011 Dutch conceptual design company, Studio Droog, launched its 'design for download' platform which provides open-source designs for download and private production, specifically 3D printed and CNC routed parts for furniture. At the Milan launch they declared that "everything is makeable, anytime, anywhere, by anyone" [15]. Within this platform, a broad market can be accessed without needing production and distribution facilities, as customers download the design, customize it to their requirements, and then independently produce the furniture.

4.6 Global connectivity and creative communities are enabled by social media. Curated design-specific websites and weblogs such as Inhabit, Behance, Treehugger, DesignSpotter, Design:Related, and ProductDesignHub, provide an informed communiqué and track design and technological innovation. Blogs (e.g. Wordpress, Blogger, Twitter, Tumblr), and social networks (e.g. LinkedIn, Facebook, Biznik, Xing) enable peer connectivity whilst media sharing sites (e.g. Vimeo, YouTube, MySpace, Google+) enable content sharing and are invaluable for product and self-promotion. Portfolio hosting sites such as Coroflot and Behance enable designers to promote their

capabilities, whilst professional ‘meetups’ (e.g. Industrial Design Meetup Group), enable those who are in close proximity to connect through virtual networks, then meet up in the physical world.

5 NEW CURRICULA

At Swinburne University of Technology, a new subject in the Master of Industrial Design course, entitled Innovative Practice in Product Development, examines additive manufacture and social media as facilitators of new product design. This subject explores the potential of these new and emerging technologies to impact on, and enhance, existing Industrial Design practice. The unit consists of two initial research projects, followed by a design and product strategy project where research findings direct the product outcome.

Research project 1 investigates new and emerging Additive Manufacture technologies and materials, focussing on processes that empower new directions in industrial design. Students are required to research the capabilities and limitations of AM processes and materials, and communicate how these new technologies could influence new product development.

Research project 2 requires students to investigate the potential of Social Media for entrepreneurial product development. The research examines the influence of social media on industrial design practice and product realization, identifies product development opportunities enabled by social media, and develops strategies for user-centred and social research, crowd funding, product sales and distribution, and social innovation.

In the **Entrepreneurial Design project**, students must demonstrate how new technologies and strategies can direct new product development. They apply research findings to design a consumer-enabled product, and develop an associated product implementation strategy. Design outcomes must incorporate features that exploit the technological potential of additive manufacturing, for example unique part geometry that cannot be produced using conventional manufacturing, varying material properties, and the reduction of assembly complexity through the integration of internal moving parts. The entrepreneurial product implementation strategy must utilise the opportunities afforded by social media, including initial user-centred research, market research, adaptive product customisation, and strategies for seed funding, product marketing and sales.

5.1 Project outcomes

The initial iterations of the subject were well received by students and generated successful outcomes. A number of creative designs and innovative product strategies were developed that afforded a high level of consumer engagement, through adaptive customisation, crowd sourcing and crowd funding and social awareness strategies. Amongst these was an open-source design for a pair of spectacles that could be resized, reshaped and restyled within the designer-imposed constraints of the parametric product framework. The final design could then be downloaded for personal production (i.e. home printing), or ordered as a complete unit. Social media was used to generate a product awareness ‘buzz’ through an on-line film festival (on Vimeo), to raise crowd funding (through Kickstarter) and to engage the market through a product development blog and connection with specific social media communities. In addition, the website interaction allowed potential consumers to adapt the design then upload images of them wearing the virtual eyewear to Facebook friends for feedback. Another student developed a lamp shade based on the Torus Knot. This design allowed limitless customisation as the parameters of the mathematical model could be manipulated to generate a range of forms from simple to complex. Variations could also be achieved through manipulation of the width, twist and the eccentricity of the component bands. This product had an implementation strategy that involved marketing through on-line pinboards such as Tumblr and Pinterest. An innovative design for a bicycle helmet exploits the multiple material potential of the Objet Connex printer with the outer shell and impact absorbing inner layer, printed as a single part with variation in material density and flexibility. The ability to fine-tune individual compression struts within the structure enabled variations in impact absorption rates and helmet thickness across differing surface zones, allowing for design and performance optimisation. Social engagement features heavily in student product implementation strategies. One student’s jewellery allows personalisation through an interactive program that creates three-dimensional shapes (e.g. bracelets) from customer uploaded experience mapping. It enables the user to create sculptural representations of tourist experiences (such as a walking tour of the laneways of an old city) or bicycle rides (e.g. a Tour de France stage) mapped using smartphone apps (such as ‘Map my Ride’ or Strava). In another project, the potential influence of ‘crowdcasting’ was evident in

the development of jewellery to raise awareness of violence against women in India. This student collaborated with communities to design an immediately recognisable ring, a product integrated into a social media campaign that encouraged others to ‘wear’ their support for this humanitarian cause.

5.2 Student engagement has been enthusiastic as evidenced through student satisfaction surveys. The notion of independence and collaborative interaction with peers has high appeal for this next generation of product designers. Students were inspired by the potential of these emerging technologies to not only shape their personal lifestyles, but to drive a renaissance in their chosen profession. The subject intended to provoke new approaches to the design, manufacture and distribution of consumer products. The students were able to develop realistic and economically viable proposal for product implementation that were independent of established financing, manufacturing or retail systems. This realisation has triggered significant post-study entrepreneurial activity and points towards different design practice for graduates.

6 CONCLUSION

Additive manufacturing + social media = new opportunities for product designers. Whilst some of these technologies are disruptive and will have wider ramifications for global manufacturing and supply industries, for product designers they are liberating technologies that offer creative autonomy and a greater potential for entrepreneurship, product innovation and consumer engagement. Designers and consumers are empowered by these new technologies and practices. The ability to collaborate, co-design, research and market through social media, combined with additive manufacturing processes, frees designers from corporate and manufacturing constraints, enabling entrepreneurship, and enhancing creativity and innovation. This empowering technology is driving significant social change for which an educational response is needed. This paper has described early efforts to develop an awareness of the potential of these technologies and to encourage new design entrepreneurship.

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