Conference Paper

Whose Job is it? 3D Scanning Design for Innovation

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Abstract

There are often references in design education to the idea that design graduates of the future will be working in jobs that do not yet exist. There are therefore opportunities emerging that are not currently recognised as within the designers' purview. One such area of growth is emerging out around the potentials created by technological developments relating to 3D scanning. This technology is proving to be a catalyst for not only new product outcomes but also innovations in thinking and practice. This is particularly in relation to new workflows that are permeating traditional discipline boundaries. The wide range of advances in digital scanning over the last twenty years have resulted in a myriad of complex capabilities, and the potential of these technologies to support innovation in practice, outcome and thinking are only beginning to be explored. Examples of these explorations are considered in this paper, demonstrating how they can provide a basis for redirecting design for a future of digital immersion. This paper questions the rigour in current approaches to teaching 3D scanning technologies in design education. It provides an argument that 3D scanning is part of a rapidly evolving suite of digital enablers that are challenging conventional design practice and suggests that educators need to more effectively research and understand the innovations that 3D scanning technologies can inspire.

Keywords: Research, digital, technologies, megatrends, heritage, education

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Academic Editor: Paul K. Collins

Received: 28 November 2016
Accepted: 4 December 2016
Published: 9 February 2017

Publishing services provided by Knowledge E

Selection and Peer-review under the responsibility of the DesTech Conference Committee.

1 Introduction: Digital immersion

Stepping back from the coalface of designing for current production practices, and considering the global megatrends predicted by researchers (e.g. Hajkowicz 2015, Singh, 2012), allows for a re-evaluation of where design might be heading. According to Hajkowicz (2015), the emerging global megatrends are: More from less, Planetary pushback, Silk highway, Forever young, Digital immersion, Porous boundaries and Great expectations. Each of the megatrends will impact the role of the industrial designer on their own, but in combination the innovation required for a designer to maintain relevance is increased exponentially. For the design educator, developing an agile curriculum that consciously responds to the relevance imperative is paramount as design, by definition, addresses the new.

Amongst the myriad of directions for design educators to consider that current global megatrends inspires, a move from mass production to mass customisation provides an example of drawing across the trends to rethink practice for the designers of the future. Hajkowicz's 'great expectations' explains a consumer demand for bespoke products that are experience and identity based. Viewing this through the lens of 'digital immersion', industrial designers are creating products that respond directly to the individual and empower their relationship with their particular environment. In order to effectively achieve this, traditional disciplines boundaries, particularly between industrial design, interaction design and electrical engineering have become porous and innovations are occurring where trans-disciplinary collaborations have occurred. Trans-disciplinary, as opposed to cross-disciplinary solutions, elevate practice beyond the traditional 'bouncing ball' methods of sequential project collaboration management, to creating innovative solutions based on new ways of thinking not bound by discipline conventions. Yet, identifying and exploring practices that perforate the discipline silos sufficiently for porosity requires taking risks. Educational risks involve creating collaborations where the outcomes are not predetermined, and growing learning activities that are at the fuzzy edges of practice prior to resolution and definition. It also requires rethinking of the social and cultural impact of changes as the relationships between people and products are affected by emerging approaches to design.

One such area of growth emerging out around the potentials created by technological developments, relating to digital immersion and the changing expectations of experience and customisation, is 3D scanning. Just as additive manufacturing covers a wide range of digital technologies with very different attributes and applications, so does 3D scanning. From micro-scanning for accurate forensic analysis, using articulated arm mechanisms, to long range scanning of large sites for geological and topographic surveys using free standing, continuous scanning solutions. For industrial designers, the use of contact, non-contact, active and passive scanners as part of industrial design practice has long been established for reverse engineering applications to inform product additions and modifications. However, the integration of 3D scanning into new ways of thinking about the relationships of users and the objects that populate their lives, changes the importance of the technology. The move from mass production to mass customisation requires improving mechanisms, such as 3D scanners, for collecting data in relation to bespoke products. More importantly, rethinking the way that 3D scanners are utilised as part of the industrial design workflow will provide a catalyst for the evolution of the human object interface that instigates a changed relationship between people and products. 3D scanners up until now, have been at the periphery of industrial design practice, but this shift in thinking will bring them into the heart of design practice and therefore design education.

2 Innovations in practice

Whilst it is difficult to identify industrial design practitioners who provide exemplars of working practice utilising 3D scanning as integral to their workflow based on expertise learned specifically in relation to industrial design, there are examples that can provide indicators of how this could be emerging. The difficulty in considering these examples at the fuzzy edges of practice are that they are not refined for a design workflow approach, and therefore the examples are predominantly based on sequential, cross-disciplinary collaborations, rather than demonstrating transdisciplinary ways of working where 3D scanning is integral to industrial design practice. However, whilst not constituting a paradigm shift in themselves for industrial design, they do provide starting points for describing what that paradigm shift might look like in the near future.

High quality 3D scanning is currently viewed as a technical capability, and is generally bought in for a specific project challenge. Rarely do designers currently engage with the actual collection of data for a high-end project, or the subsequent translation of cloud point data into usable, accurate models as the basis for design applications. Nor does design education focus on the social, cultural and psychological implications of 3D scanning as a technology becoming more prevalent. Yet, as associated technologies, such as additive manufacturing (3D printing), advance capabilities in distributed production, then the possibilities for the design and manufacture of viable, end-use products for individual needs is expanding the engagement of designers in bespoke products and therefore also with 3D scanning. The implications of this are yet to be thoroughly thought through.

In practical terms, the key shift in thinking is around the move from a one-off static product, to a system of data collection, translation and iterative design development. Outcomes based on 3D computer models built from 3D scan data are moving from dimensioned-based modeling to relational modeling. The discipline heritage of establishing resolved product for a projected customer is being replaced by the development of iterative, relational product. Without the designers themselves fully understanding the technology required to create these products – and the social and psychological impacts of changes to products based on these - the outcomes could fail to maximise their potential.

First we shape our tools, and then the tools shape us (Lipson & Kurman, 2013)

For this paper, it is important to consider the broader relationship of people, products, systems and environments, and how rethinking 3D scanning based on an informed, considered understanding of the technologies involved can provide sign posts for the evolution of workflow and values for designing for the future.

3 Key indicators and examples of practice

3D scanning technology is proving to be a catalyst for not only new outcomes but also innovations in practice, and in particular in relation to workflows, that call into question the future role of the industrial designer. A wide range of advances in digital scanning over the last ten years have resulted in a myriad of capabilities not previously possible, and the potential of these technologies to support innovation in practice and outcome are only now being understood. Examples of innovations in practice demonstrate how the range of 3D scanning technologies are challenging what was previously possible. The first 3D scanning technologies were developed relatively recently, during the 1960s, when surveyors and engineers used lights, cameras and projectors to create a measuring tool. After about twenty years, this approach was replaced by a combination of white light and lasers. Cyra Technologies (now known as Leica Geosystems) was founded in 1993 and produced one of the first commercial scanning systems. Since then 3D scanning technologies have expanded to include a wide range of technologies, from passive to active that are becoming increasingly important in the light of the global megatrends discussed. When researchers explore new approaches to digital immersion, there will be a transition period where the understandings that underpin change can be identified as key indicators prior to the full significance of the ideas being clarified and explained. An example is studying the evolution of thinking on heritage scanning. Just as preservation architecture over the last thirty years has moved from mimicking existing buildings, to differentiating between restoration and building evolution, so the use of scanning and the 3D printed replication of culturally significant public art is causing discussion on what that means for a society. The documentation of historical buildings and archaeological sites, combining laser scanning and photogrammetry, has evolved over the last ten years to a level of sophistication. Software in the field is becoming more accessible, and the shift in thinking is around the applications. Where the thinking becomes complex is in relation to evolving fields of practice, and who is responsible for developing the body of knowledge and the responsibilities of considering the implications of emerging practice, when there is no academic heritage to draw on, and researchers are working cross-disciplinary approach rather than taking the time to elevate the study to a transdisciplinary level.

An example is in the increasing digitisation of assets. For industry practice, the ability to digitise as much as possible of a spare parts inventory makes commercial sense. From a sustainability point of view, printing on demand and distributed manufacturing reduces the environmental impact of transport miles and so the embodied energy of a product, and the amount of pre-consumer waste from spare parts never commissioned. Yet this practice has significant implications for organisations working within the supply chain that need to be considered. Similarly, the digitising of unique items, particularly those that are too delicate or considered too precious to be accessible to the public, is not merely a straightforward activity that can be considered in isolation. Industrial

Figure 1: QUEENSLAND MUSEUM DINOSAUR BONES 3D SCANNED PLUS CONCEPT FOR SPECIMEN HOLDER.

Design projects based on this activity need to be considered as part of a discourse on the use of digitalisation and its impact on the social and cultural values placed on objects.

A practical project example is a collaboration between Queensland Museum (Dr Scott Hocknull) and Industrial Design students and researchers at Griffith University, Australia where unique artifacts were digitized, 3D scans of a 120,000 year old Diprotodon pelvis (the world's largest marsupial) and develop a method of producing a light weight cradle to protect the specimen allowing for improved packaging, stack ability, transportation and storage of multiple specimens.

This work was undertaken as part of a project to rethink the accessibility of rare artifacts for the general public. Industrial design and 3D students and researchers were involved both in the construction of a digital database and the re-imagining of cultural heritage engagement. There is little research yet on the in-depth implications of this approach, and of fostering the ability of students for working in this way, yet it will be needed if students are to engage with the cultural and natural artifacts as the basis for new thinking and innovation in design.

There is more to cultural heritage than the science behind the physical artifacts, monuments, architecture and locations. There is an intangible social network of cultural activity that intrigues but may not or cannot be fully understood. (Silberman 2005)

One body of knowledge that could inform thinking comes from architecture. The work preserving the cultural heritage of architecturally significant buildings is illustrated in a project in Bucharest (Erghelegiu et al, 2014). Major buildings in this city are in a state of advanced decay and 3D scanning is being used to capture this eroding cultural heritage. However, whilst this application is indicative of the advances in the field, it is a straightforward progression of the technology and its applications. The work of Arias et al (2005) provides a focus on the use of digital technologies to prevent erosion itself, rather than capture the data:

Computers methods and close-range photogrammetry are proposed as a preventive method which allows us to detect, measure and track the temporal evolution of some structural problems detected, and also to assess the degree of conservation of the materials employed (Aries et al 2005)

Where this field of investigation is interesting in the context of this paper, is where it moves to intersect with rethinking the human relationship with objects, and in particular objects invested with social and cultural meaning. There has been some controversy about the scanning, computer modeling, and 3D printing of existing monuments for example, because of concerns over authenticity and devaluing existing sculpture.

We may be able to measure precisely the dimensions of the excavated rooms of an ancient structure, count and map the artifacts found within it. We can accurately chart settlement patterns on the landscape, and perhaps even approximate the outward physical appearance of ancient communities. But we can only guess at the human dimension of past civilisations by piecing their surviving fragments together with the glue of our own ideas of logic and cause-and-effect. (Silberman 2005)

The checkered architectural history of Leuven as a result of decisions made following the repeated destruction of medieval sections of the city illustrate that the ability to replicate is not in itself a neutral activity but must be considered within the context of values and aspirations for a society at a particular point in time. However, the pre-emptive scanning and modeling of public artworks and memorials in the face of cultural destruction during warfare is changing thinking again.

Digital recording, documentation and preservation are demanded as our heritages (natural, cultural or mixed) suffer from on-going attritions and wars, natural disasters, climate changes and human negligence. (Remondino 2011)

Context, such as political events, will always impact attitudes, and should always impact design education. The growth of digital technologies and the move towards digital immersion in societies needs to be thoroughly researched and considered, and 3D scanning not merely incrementally introduced into learning activities as a skill, but embedded with a cultural, sociological and philosophical understanding for more rigorous and complex understandings.

3D scanning for heritage preservation should not only be about processes and file sizes, comparing new technologies, developing methods and workflows. While these are important to the end product of preservation and vaulting, there is also opportunity to communicate so much more of the social and cultural legacy to future generations. To better understand customs, practices, artistic expressions and values of the past through digital reconstruction as an interpretive tool, combined with digital creativity to reconstruct, illustrate and share the underlying untold stories of the past through multimedia visualisation (Silberman, 2005)

3D scanning for mandraulic anthropometric studies of armoured crewmen for fatigue and ergonomics is potentially a cost effective method of data capture with improved accuracy. Griffith University Design students recently scanned troops from the Australian Forces 2nd/14th Light Horse Regiment (Figure 2) in order to understand and develop these 3D scanning workflows to meet specific requirements.

The New Zealand Defense Force is carrying out similar studies relating to 3D scanning to measure and better equip troops. According to Group Director Richardson, re-

Figure 2: STUDENTS EXPLORING WORKFLOW—3D SCAN, POST -PROCESS 3D PRINT.

sponsible for human systems at New Zealand Defense Force, the data collected over time will provide a basis for understanding "how the size and shape of our Defense Force personnel is changing over time, and will enable us to make better-informed capability management decisions regarding future acquisitions" (Benedict, 2016).

As 3D scanning becomes more accessible to designers, and the range of technologies becomes better understood by the discipline, the opportunities for collaboration on projects responding to the global megatrend of digital immersion increase. 3D scanning is one of the digital enablers that will work with associated digital enablers, such as additive manufacturing, ubiquitous computing and big data, to fundamentally change what design is and does. Higher education needs to consider more effectively the connections made by collective digital technologies and digital immersion through its scholarship and research, to inform the development of graduates capable of navigating the new world, post the digital revolution.

4 Conclusion

For designers to graduate into the 'jobs of the future', ones that do not yet exist, then design educators need to embrace the uncertainty of practices that extend the conventional boundaries of the discipline, and intersect with other disciplines in new and interesting ways. This is not an easy approach to take, as it requires relinquishing the certainty of established practice, and the authority that provides, and it allows other disciplines to encroach on discipline territory. Yet for all professions to evolve, then these risks need to be taken. With digital immersion, porosity and customised experience identified as drivers for change, design academics need to actively up skill in digital technologies that may not be conventionally ascribed to their practice. However, more fundamentally, design researchers need to engage with academics across disciplines in understanding and directing future practice. If the aim is to elevate design in an informed, yet creative response to global megatrends, rather than incrementally evolve within discipline boundaries, then a deeper understanding of the implications and potentials of 3D scanning as a major tools for mass customisation is essential.

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