ISEA2015
Proceedings of the 21st International Symposium on Electronic Art
ISSN: 2451-8611
ISBN: 978-1-910172-00-1

Frozen: Exploring creativity and the process of making using photogrammetry.

Neil Glen MA RCA

Bath School of Art & Design, Bath Spa University

Bath, UK

n.glen@bathspa.ac.uk

Abstract

The ability to capture, remake, reinterpret, is fundamental to the process of making. The physical act of drawing repositions ideas thus enabling us to re-imagine them and move forward with new concepts. Translating what we see into a new medium gives us a fresh insight.

Another way of taking a fresh look is through sampling. This has existed for some time in 2D image making, and more recently digitisation of audio has created a new genre of music making.

The physicality of 3D objects presents a different challenge. 3D printing is becoming commonplace; yet there is little discussion about where data for these objects comes from. Technologies for capturing 3D data are primarily expensive, slow and require detailed calibration, but one emergent technology which could change this is photogrammetry, which has roots as old as photography itself. Also known as remote sensing, photogrammetry allows objects to be measured without being touched. Cloud based technology has removed the limitations of desktop computing, simultaneously increasing the scope of objects which can be captured, and democratising the process.

Using open software and capture mechanisms I explore the nature of ownership and the role of the maker when 3D capture becomes commonplace.

Keywords

3D printing, sampling, craft, making, photogrammetry, CNC machining, prototyping, design, copyright, authorship

Introduction

The history of making is invariably bound with the notion of craft. The combination both of human motor skills, whether mediated through mark making or the tactile manipulation of materials, and imagination has shaped our comprehension of value in finished artefacts. Traditionally this is an iterative process, mediated by practical research and visualisation in the mind of the maker, but when augmented by technology a new form of practice emerges through sampling. The notion of sampling is not new, nor is the technology used to mediate the work. From the knives and scissors used in collage and decoupage, to the many new genres of music that have emerged with the advent of digital audio sampling, there is evidence to suggest that capturing and refashioning existing material stimulates creativity.

The emergence of the maker movement has seen many technologies appropriated through physical exploration and experimentation. FabLabs and hackerspaces have brought together makers and provided a platform to raise the public profile of tools such 3D printers and drones, and microprocessors such as Arduino and Raspberry Pi. The rise in popularity of 3D printing can largely be attributed to MakerBot Industries, who launched Thing-O-Matic at the Maker Faire in New York 2010 [1]. Their first machine, Cupcake released in 2009, used electronics from an open source project at Bath University called RepRap. The RepRap project led by Dr Adrian Bowyer (Bowyer et al 2006) demonstrated how a suitably designed 3D printer could be capable of printing the parts required to create a copy of itself [2]. This early democratisation of the 3D printing process enabled exploration by anyone with sufficient workshop knowledge, and access to the 3D printer, to replicate it from open source data.

The potential of 3D printing has been explored by many craft makers and designers. Ron Arad's work Bouncing Vase (Arad 2000), utilised the properties of the process to create forms difficult to create through other media [3]. This focus on the act of manufacture as the key benefit of the digitisation of craft was demonstrated clearly in the Power of Making exhibition at Victoria & Albert Museum, London in 2011 created in collaboration with the Crafts Council (UK), and in the accompanying publication (Charny 2011), which highlighted a growing use of digital manufacturing technologies [4]. These works however still remain focused on production, and require 3D data for the printers to work with. Unless you are proficient with, and have access to, Computer Aided Design (CAD) software where does this information come from?

Sampling in the creative process

Drawing or working with raw materials is often perceived as the essence of creativity, suggesting that somehow the craft of the practitioner conjuring up an inner force to make something anew. The process of sketching or making is reflective, observations made during the process create new interpretations and reinterpretation is the basis of sampling. In the visual arts Richard Hamilton's collage for an exhibition catalogue, "Just what is it that makes today's homes so different, so appealing?" (Hamilton 1956), is filled with reused images of desirable objects representative of contemporary living. The piece is now recognised as a formative work in the genre of Pop Art in which the use of found imagery to create new works is acceptable [5].

Yet the borderline between derivative and transformative can sometimes be unclear. When a photograph of Barack Obama by Mannie Garcia in 2006 was used by artist Shepard Fairey as the basis for the HOPE poster (Fairey 2008), the resultant legal action took five years to resolve [6]. When Paula Scher used Herbert Matter's original poster for the Swiss Tourism industry to promote Swatch she did so with clear intent, and agreement to reinterpret the original (Scher 1984) [7].

This discourse about originality and ownership has often been driven by technologies that enable sampling to couple with those that enable reproduction and distribution. The combination of digital audio sampling and software to allow remixing, together with the internet as a distribution channel, has forced change in the music industry.

The commercial and intellectual boundaries developed to enable the distribution of physical artefacts are being similarly challenged as data files permit wide distribution and 3D printing develops as a process to realise the objects in physical materials. The absence of mass market understanding of facilities to digitise physical objects has so far limited the opportunity for sampling to impact the market for consumer goods.

Inspiration from observation

> "*To me, photography is an art of observation. It's about finding something interesting in an ordinary place. I've found it has little to do with the things you see and everything to do with the way you see them.*" Elliott Erwitt (Erwitt 2011) [8].

Photography can reveal new ways of seeing. An example of this, from a series titled Long Exposure by artist Geoffrey Mann, captured the motion of a moth around a light bulb. The resultant trails were translated into digitally sculpted work "Nocturne" (Mann 2009) [9]. Surprisingly, although captured through photography, the artwork is not a direct result of an image from a camera but was created using CAD software.

Photogrammetry is a process of deriving information about a surface from photographs of that surface. A series of images, taken from known positions, can be analysed to reveal information about the relative heights of points on the surface.

Using photogrammetry, the process at the heart of the software 123D Catch from AutoDesk Inc., I realised that I could easily and quickly construct physical objects directly from images. Using digital cameras to sample objects and create detailed 3D data files became a new starting point for the development of new forms, permitting shapes to be captured and readily converted into new objects through familiar processes such as casting, forming and machining.

Starting with small pieces such as sculptures, I quickly realised the photographic nature of photogrammetry permits the capture of soft objects, objects at a distance, objects in motion and transient moments. Experiments with constructing contoured surfaces from tangible and intangible surfaces; such as flowing fabrics, and a series of images of clouds taken in a flight from London to Florida, yielded unexpected abstract results over which I had little control other than selecting the subject (fig 1).

Figure 1. Clouds, 5 frame series © Neil Glen

Traditionally craft makers respond to tactile materials, and exploit the properties of those materials. If I could consider a cloud as a material could I exert control over this in some way? I began to question if a material could be considered independently of working methods; for example could a potter use throwing skills to form molten metal or other material, and how would this change their approach?

Methodology

To explore this concept I worked with an ice cream maker, who creates custom ice cream for festivals and corporate events, and a potter with many years of experience, to develop an experiment. We combined traditional clay throwing with hand made ice-cream, which had been frozen with liquid nitrogen, to allow a pot to be thrown in an unfamiliar material but ultimately realised in ceramic.

Manufacturing the ice cream in the studio and transferring it directly to the potters wheel allowed us to determine a suitable working consistency to permit the potter to transfer his skills in working with clay to ice cream, and to throw a pot (fig 2).

Figure 2. Throwing the pot in ice-cream © Neil Glen

Although there are similarities between clay and ice cream the structure of the changes more rapidly as the ice cream melts, requiring the potter to respond to this, and altering the forms which could be achieved. Refreezing the ice cream with liquid nitrogen whilst on the wheel allowed the material to be reworked and thus emerged a new language for a thrown pot.

The resultant object could not be handled without destroying it, indeed it was difficult to make detailed observations since the form and detail changed as a consequence of the ice-cream softening and melting. Photogrammetry offered a means to capture the form of the ice cream pot without touching it. Setting out an array of cameras around the pot permitted the images required to construct the 3D data to be simultaneously taken from multiple points of view.

The 3D data file generated from these images was of sufficient integrity to allow a master object to be machined and used to cast mould for a slip cast porcelain object to be made.

Method

To ensure the images used to construct the 3D model were consistent 20 identical cameras were used; Nikon D90 DX format DSLR with CMOS sensor 23.6 x 15.8 mm fitted with 18-70mm f3.5-4.5 zoom set to 50mm and exposure set to ISO200 1/15th sec f16 capturing at 4288 x 2848 pixels. A Nikon ML-L3 remote was used to trigger the cameras, previous testing determined that four remotes, triggered by two people, were sufficient to actuate all of the cameras simultaneously.

20 cameras were spaced at 18 degree intervals to photograph the ice cream pot simultaneously from 20 positions (fig 3) and careful note was taken of the frame counter after each set of images to account for any camera that may not have taken a shot.

Figure 3. Camera rig, © Neil Glen

To ensure the software could more effectively determine the relationship between the images the top of the plinth was included in the photographs (fig 4).

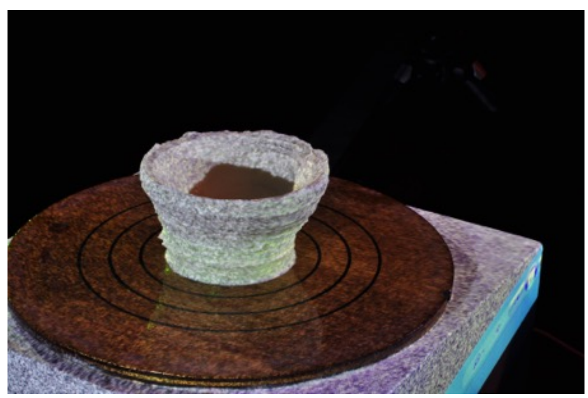

Figure 4. Ice Cream Bowl, frame 19 of 20 © Neil Glen

Previous work had revealed that the software was unable to determine surface variations on surfaces without patterns. To capture of the surface detail of the ice cream pot it was illuminated using three data projectors, positioned equally around the object at a spacing of 120 degrees, each projecting a white noise pattern.

The images were imported into and published to a 123 Catch account for download as an a STL file. This was opened in Roland SRP Player software connected to a Roland MDX-40a desktop CNC machine equipped with a ZCL-40A rotary axis unit. The master was machined in polyurethane model board with a density of $580kg/m^3$ without alteration to the files. This master was durable enough to enable plaster moulds to be cast and used to slip cast porcelain to create the final outcome; a porcelain bowl (fig 5).

Figure 5. Ice Cream Bowl, slip cast porcelain © Neil Glen

Conclusion

The machined master of a single object in 360 degrees revealed that the external surface had a wealth of detail, both the fine marks made by the potters fingers and the softness of dripping ice-cream.

Thus we have an object which is a synthesis of two materials, a direct tactile response to working the ice-cream as if it were clay translated back into a ceramic. Also the natural evolution of the melting ice-cream adding it's own signature, frozen in time.

The continued development of 3D printing will ultimately offer the means to reproduce practical and useful objects. Just as analogue home taping evolved into digital CD burning, which became MP3 file sharing, 3D printing will mature to allow physical objects to be shared and repurposed. The ability to capture forms and surfaces, rescale and remake them in a range of materials will enable designers and makers to face the challenges this presents to our established ideas of authorship and authenticity.

With this will come new types of creativity, new ways of working across materials and new forms of collaboration. As a designer with a passion for photography I have found new medium for expressing creativity; a new freedom, to observe capture and remake from the world around me in the tradition of the designer makers.

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Author Biography

Neil Glen MA (RCA) Royal College of Art, London.

Neil is a Design Practitioner and Learning Technologist for Bath School of Art and Design at Bath Spa University.

Neil is interested in the relationship between ubiquitous technologies and the process of design and learning; questioning and re-defining how such technologies can be used to explore and develop our sense of place. Working with academics and technical staff on the use of technology to enhance the learning experience, with researchers and industry developing new facilities and with industry in the development of new products and services.

Collaborators

David Jones: Ceramic Artist, Corsham.
Charlie Harry Francis: Ice Cream Artist, lickmeimdelicious.com