In Search of the Impossible Ceramic Object

David Huson, The Centre for Fine Print Research, Faculty of Art, Media and Design, University of the West of England, Bristol, UK

Abstract

Developments in the area of Digital Fabrication, and particularly 3D printing bring the intriguing prospect of being able to form ceramic objects by a completely new process. David Huson and colleagues at the Centre for Fine Print Research in the Faculty of Art, Media and Design at the University of the West of England are conducting a research project into the use of Digital Fabrication techniques in the area of bespoke ceramics. One of the aims of the project is to research the possibilities, and then to develop the methodology of forming a ceramic object directly by the use of 3D printing technologies. The unique characteristics of this process mean that it is feasible to build a ceramic object that would be impossible to make by any of the conventional forming processes. This new process will allow artists and crafts persons to investigate, develop and implement ideas and concepts that were previously unattainable. Two examples of the possibilities are the production of a series of ceramic objects nested within each other and the forming of ceramic articles with complex relief and perforated surfaces.

Introduction

The Centre for Fine Print Research at the University of the West of England in Bristol has recently been awarded a substantial grant from the United Kingdom Arts and Humanities Research Council to fund a three year project "The fabrication of 3Dimensional art and craft artefacts through virtual digital construction and output" to investigate the use of 3D rapid prototyping and digital fabrication techniques in the areas of Art/Craft and Designer /Maker Ceramics.

The CFPR has had much experience in working with industry to incorporate unique and useful fine art based paradigms into industrial research partnerships and commercially successful developments. This integration of industrial needs and academic research has formed the basis of a number of the Centre's previous AHRC grants and Knowledge Transfer awards.

The CFPR has ongoing experience in the application of digital fabrication techniques in an artistic context and has recently completed a project using digital technology to convert photographic images into a ceramic relief surface by using 3D design software and a desktop CNC milling machine. The application of a specially tinted glaze to this surface allows a permanent fully continuous tone image to be produced on a ceramic tile.

Further funding has been obtained to investigate the commercial possibilities of this process and it is expected that current collaborations with the ceramic industry will allow this process to come to market.

The Centre has an ongoing collaboration with Hewlett Packard in other areas of research.

Within the Centre, the company sponsors a broad range of activities from pure research, philanthropic projects with schools and the community through to the post of professorial chair. Also as a result of this link, unique knowledge and technical insights have recently led to the formulation of routes for addressing issues surrounding the application of 3D digital fabrication technologies as a tool for the actual fabrication of permanent, artist quality artefacts.

Digital Fabrication Techniques in an Art/Craft Context

3D computer aided design is a visualisation tool, assisting in many aspects of contemporary industry. It has also become increasingly evident that it holds enormous potential as an exciting tool for the creation of artefacts by artists and crafts people. However as observed by Aitkin in 1999 "a minority of makers have had the opportunity to investigate the benefits of new digital media..." This situation is on the cusp of change due to the rapid advance of technology.

The development of rapid prototyping technology has already seen several phases; the first being purely a virtual visualization tool for assisting conventional fabrication, the second a means of visualizing and outputting 3D objects using both stereo lithography and subtractive, numerically controlled modeling techniques. The most recent however, enables 3D computer rendered objects to be created using a far more user friendly digitally driven output, especially through the additive 3D printing process.

While the subtractive and now the additive processes have fed both general and specialist industrial needs, high equipment and access costs have impeded the development of their potential for art and craft use. The new generation of relatively low cost rapid prototyping systems have now become available. This allows more than ever before the full scope of the process to be accessed and explored by the creative practitioner. Not only can its potential for art and craft use be speculated and tested, a hands on skill base for this particular sector can also be finally developed.

As suggested by the title "Rapid Prototyping", the technique in industrial terms has become a means of creating prototypes for the visualization of an actual product, or in many cases a source for creating moulds to fabricate production line products. While previously subtractive and additive processes have needed a certain amount of extra manual finishing to prepare smooth surfaces and colored finishes. In 1998 Rees predicted "Full photo - resolution color models would be able to contain color and pattern with as much variety as a 2D printer, and could have notes photographs, patterns and solid colors printed directly on the model". Developing color may yield other important results. As materials are selectively applied in areas of the model to make different colors, the same mindset could imagine materials applied selectively towards greater strength characteristics and variations of material characteristics."

This era has now begun to dawn with the resolution of systems such as the new ZCorp 3D printers allowing the production of a relatively finished surface without the need for external intervention. Significantly in addition to this the

technology is now moving towards the production of printed objects with photo quality colour.

This new more finished output, when viewed from the perspective of art and craft practise - (especially in relation to the traditional 'one off' and 'limited edition' paradigm) marks the emergence of a unique possibility. As observed by Dr Ian Gibson in 1998 'As RP (rapid prototyping) processes become more refined, so the prospect of functional prototyping extends into mainstream fabrication. Already in some cases we don't just use these machines to make prototypes but to make real products. CAD systems also have greater capability for realism which we want to transfer into physical forms with relative ease."

However, in considering the objectives behind the manufacture of this technology and the formulation of its output, the transient properties calibrated specifically for facilitating a range of industrially derived purposes hold little in common with traditional art and craft materials. In assessing possibilities in art and craft terms, these existing modes may prove to hold new value for creating certain types of artefacts, however, by comparison with traditional analogue fabrication methods, their colour and longevity at this point of development may be seen to be lacking.

The Aims of the Project

In light of the current level of quality achievable through the new generation of 3D printers and the enormous potential of this technology for art/craft production this research aims to theoretically define and practically consolidate routes which can assist in incorporating the creative flexibility of digital 3D rendering with the material and tactile qualities intrinsically associated with art and craft practice. The research will focus on the direct output of finished objects produced through the additive 3D printing process and the use of CNC subtractive processes to directly mill both moulds and ceramic material to produce of ceramic artefacts.

In order to fulfill the aims and objectives of the project a number of strands of research will be employed. These include:

- Data searches and surveys to build an overall picture of the emerging field.
- Practical research to assess the value of existing technology for addressing the research question
- Experimental research to modify and refine existing technology to reflect needs identified within the art and craft sector.
- Evaluation of methods identified and developed through the research by the production of artifacts from a diverse selection of arts & craft practitioners.
- The ongoing dissemination of findings to facilitate a loop of dialogue between art & craft practitioners, industry and the findings of the research.

Although the overall research aim is broad, it is envisaged that the pursuit of the problem principally from a ceramic building perspective will provide a model, which will have and imply possibilities for other areas of art and craft related needs. Also through linking virtual 3D digital modeling directly with the output of objects embodying art and craft values, it is envisaged that a new knowledge base for the sector will be developed. This ultimately has the potential to feed back into industry as well as enrich contemporary art and craft practice.

The Objectives and Project Plan

The following plan indicates how the objectives and methods employed for their fulfillment will be undertaken for the proposed project throughout a three-year time scale.

Year 1

- Full literature review, fieldwork visiting industrial establishments where various degrees of digital 3D design and Rapid Prototyping are employed. These will include…
- Instances of where this technology has assisted artists and crafts persons will also be surveyed
- A review of 3D software and its application for rapid prototype output.
- The purchase and installation of a 3D printer and accompanying software
- Further developing existing CFPR skills and knowledge base in CNC milling for the creation of full 3D models from 3D software in order to assess (in practical craft studio parameters and aspirations) the value of other 3D prototyping related technologies. CNC milling will be used as a baseline for the production of ‘one offs’, ‘limited editions’ and sources for moulding and fabricating objects.
- Running a symposium focusing on the use of 3D digital technologies from an arts and craft perspective, drawing on practical and speculative insights into the technology from industrial and arts practitioners.
- . Throughout months 1 to 12 ongoing consultation will be maintained with industry and suppliers in order to promote links and support for the research.

Year 2

- The development of additive 3D design and printing skills, assessing the range and colour possibilities of output in art and craft terms. Benchmarks from CNC milling and analogue craft practice will be used.
- Integration of art &craft parameters into additive 3D printing technology. Initial emphasis will be on permanence using ceramic production values as a baseline. This section of the research will therefore focus on the production of objects that through the addition of clay bodies in the printing process can be rendered and (without the use of any further casting techniques) fired to produce ceramic objects.
- The ongoing assessment of results, consultation with industry, to assist and assess results. One to one workshops with a specially selected group of practitioners from the arts and crafts in order to confirm test and expand findings from a range of perspectives.

Year 3

- Assessment of 3D colour printing possibilities followed by a practical investigation of the possibilities for the application of permanent colour for ceramic decoration.
- Working with artists the creation of artworks to test, refine and expand the findings of the research.

- Exhibition of work with catalogue publication. Seminar based around the broad issue of digital 3D fabrication for artists and craftspeople

Progress to Date

3D Printed Artwork

To investigate the design parameters and software the opportunity was taken to use the recent commissioning of the ZCorp 510 Spectrum colour printer to produce Digitally Fabricated artwork for an exhibition.

Anticipating future requirements the forms chosen would be difficult if not impossible to produce by any other method.

A series of freeform shapes designed by colleagues Dr Peter Walters RCUK 3D design research fellow at the University of the West of England and Paul Sandammeer a ceramist based at the University of the West of England were modeled using Rhino and SolidWorks software and printed on a ZCorp 510 Spectrum colour 3d printer.

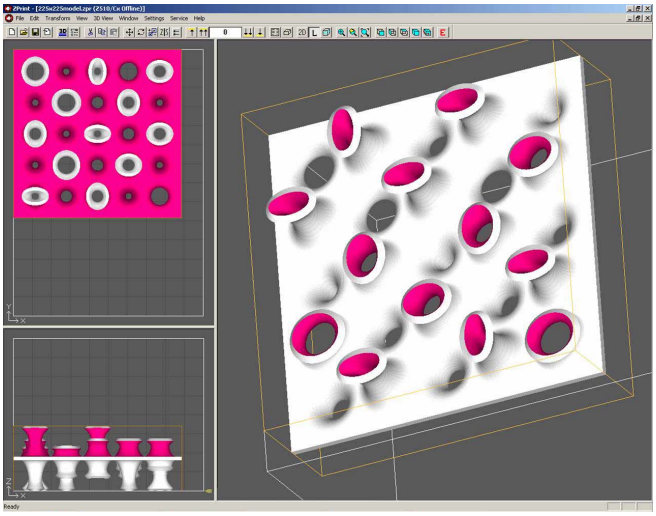

Figure 1. *CAD model of artwork*

The Walters 3D prints have utilised the unique properties of the ZCorp 3D printer to produce self-supporting objects with integral coloured surfaces.

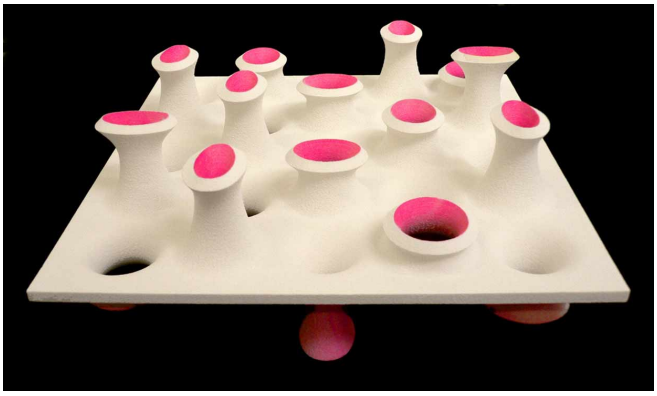

Figure 2. *3D printed artefact*

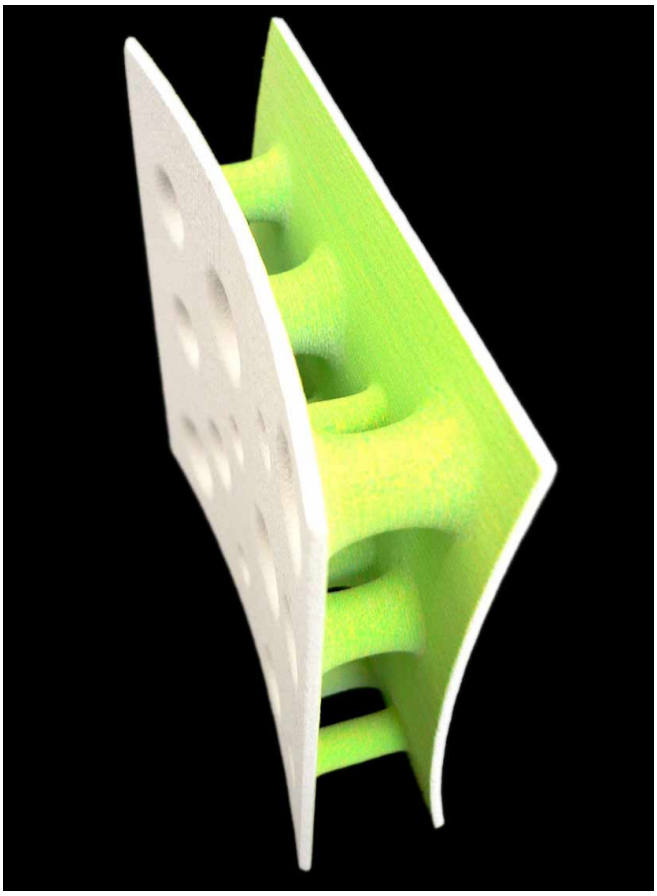

Figure 3. *3D printed artefact*

Figure 4. *Removing 3D print from machine*

Figure 5. *3D printed artefact*

The Sandammeer artwork has utilised the property of the ZCorp 3D colour printing process to produce an artefact with selected photographic images printed into the surface of the piece. The smaller form nests perfectly into the cavities of the larger forms, which can be closed to make a single object.

The artworks produced as part of the project were exhibited at the Royal West of England Academy in Bristol UK in an exhibition showcasing the recent work and output of the Centre for Fine Print Research at the University of the West of England.

3D Printed Ceramics

A series of test samples produced using ZCorp equipment to test the viability of using these materials as casting moulds or shells for the casting of ceramic suspensions porosity tests have indicated that the material along with a suitably controlled ceramic suspension can be utilised to for the production of a fired ceramic object.

Preliminary tests have been conducted using a ZCorp 310 3D printer and materials to investigate the viability of using this technology to bind clay materials to produce a finished ceramic object; a basic ceramic test piece has been produced and fired successfully.

Discussions are underway with UK ceramic material suppliers to produce graded ceramic materials to advance the process. These will be dry blended to produce a powder containing pottery body components of a specific particle size range in the correct ratio to form a fired biscuit ceramic body. The dry clay body mix will be printed on a ZCorp 310 printer to form an unfired ceramic object. This will be dried, fired and glazed. It is anticipated that a 3D printed ceramic artefact will be produced in the near future.

Summary

At this stage the project is progressing well in the aim of making the “impossible ceramic object”. The next task is to refine the printing of 3D computer generated ceramic objects using the ZCorp printing process and to use this method to produce direct 3D printed ceramic artefacts.

References

1. Bunnell, K, 'Re-Presenting Making, The Integration of New Technology into Ceramic Designer-Maker Practice', Centre for Research in Art and Design, Gray's School of Art, The Robert Gordon University, 1998. ISBN: 1-901085-28-7)
2. AHRB Aylieff F. Exploring 3D Modeling Software in the production of ceramic artworks) (Gernand B. Exploring sculptural practice and design strategies through the media of ceramics and 3D Computer Modeling
3. Rees M. Rapid Prototyping and Art, paper given at the Rapid Prototyping Conference May 1998. Facets and Fingerprints: Contemplating the Computer in Art. Paper at the International Sculpture Conference 1998 Rapid Prototyping: Realizing Convoluted Form and Nesting in Sculpture. Prototipazione e Produzione Rapida 1998.
4. Marshall J. Computers and Creativity-Is CAD a useful tool for studio potters. Ceramic Review Mar/Apr 2002
5. TACTICS Aitken, P, Bunnell, K, Pirie, I, 'The Integration of New Media Technology In Craft Practice', CADE (Computers in Art and Design Education) 99 Conference Proceedings, University of Teeside, 1999 Page 192 - 200

Author Biography

David Huson is a Research Associate at the University of the West of England. Previously he has worked in the ceramic industry, holding positions of Research and Development Manager, Technical Manager and Works Manager. He also ran his own business for five years producing commercial ceramics. He is currently researching photo ceramics and the use of digital fabrication techniques for Art/Crafts and Designer/Maker ceramics.