INTERNATIONAL CONFERENCE ON ENGINEERING AND PRODUCT DESIGN EDUCATION
8 & 9 SEPTEMBER 2016, AALBORG UNIVERSITY, DENMARK

TACTILE DIGITAL: AN EXPLORATION OF MERGING CERAMIC ART AND INDUSTRIAL DESIGN

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ABSTRACT
This paper presents a pilot study that highlights collaboration between ceramic art and industrial design. The study is focused on developing a ceramic lamp that can be mass-produced and marketed as a design artefact. There are two ultimate goals of the study: first, to establish an iterative process of collaboration between ceramic art and industrial design through an example of manufactured design artefact and second to expand transdisciplinary and collaborative knowledge.

Keywords: Trans-disciplinary collaboration, emerging design technology, ceramic art, industrial design.

1 INTRODUCTION
The proposed project emphasizes collaboration between disciplines of ceramic art and industrial design to create a ceramic lamp that can be mass-produced and marketed as a design artefact. It addresses issues related to disciplinary challenges involved in the process and use of prototyping techniques that make this project unique. There are two ultimate goals of the project. First is to establish an iterative process of collaboration between ceramic art and industrial design through an example of manufactured 3D ceramic lamp. The second goal is to develop a transdisciplinary ceramic design course for Arizona State University students. The eventual intent is also to share generated knowledge with scholars from academia and industry through various conferences, academic, and technical platforms.
In the following, we will first discuss theoretical perspectives about collaboration between ceramic art and industrial design to highlight positives and negatives of disciplinary associations. Secondly, we will explain the detailed process of design and development of the ceramic lamp and how we resolved challenges involved in developing the final product. Thirdly, we will identify gaps between the phases of design, development, and manufacturing and open up novel opportunities to address those challenges through further transdisciplinary collaborations. Finally, we discuss how a transdisciplinary course can be designed to guide students for future successful collaborations.

2 BACKGROUND
The presented study is designed to stimulate trans-disciplinary dialogue between the fields of Ceramics and Industrial Design. Transdisciplinarity highlights multi-level co-ordination of disciplines and interdisciplines. The focus is usually a mutual systematic purpose. Boix Mansilla (2005) defined the goal of interdisciplinary understanding as,

> The capacity to integrate knowledge and modes of thinking in two or more disciplines to produce a cognitive advancement – e.g. explaining a phenomenon, solving a problem, creating a product, raising a new question – in ways that would have been unlikely through single disciplinary means. (2005, p.14)

In other words, interdisciplinary research approaches can provide an opportunity to combine advanced technological, pedagogical, and empirical knowledge from two or more disciplines to produce interdisciplinary tools for each of those fields, thus pushing the disciplinary boundaries.

The discipline of ceramic art and industrial design can significantly benefit from the cross-pollination of processes and ideas between two disciplines (Faste, n.d.). Faste argued that there are areas of benefit which can be divided into seven sections covering following categories: shared fundamentals, thinking by doing, adding value, drawing as thinking, 3D visualization of things, rapid prototyping = rapid sculpting, and historical context and relevance beyond functional. Those seven categories can be elaborated as follows.

Disciplines of art and design come from the same place and thus share fundamentals that focus on hands-on training. Exploring and experimenting with a wide variety of materials during the process of conceptualization is another common approach between the two disciplines, which emphasizes thinking by doing category. Design firms often point out that good design adds value to a product (Brown et al. 2009). Similarly, beauty, art, and consumerism are closely associated. Drawing and observing are important skills in both art and design. The discipline of art emphasizes on building hand-eye coordination and accurate sense of proportion through observation. In design focus is on accurately representing forms that have not yet been created and cannot be seen until drawn. These are two different styles of "drawing as thinking" category. What is important here is, for both art and design, drawing is a valuable tool, which is used for thinking and to shape ideas outside of the mind. Visualized ideas can encourage new thoughts to emerge to achieve iterative conceptual development of thoughts (McKim, 1972). Use of virtual visualization tools is more prevalent in design than art, but rapid prototyping and rapid sculpting are shared practices in both the fields. Cultural context and relationship with longstanding history are emphasized more in the discipline of art but direct reference to a larger dialogue related to history is often lost in designers' work (Faste, n.d.). But in a recent practice, it appears to be changing. For example, clean and minimalistic designs of Apple products can be traced back to the work of Deter Rams.

The above arguments are valuable from both benefit and improvement perspectives. They highlight disciplinary gaps that need to be considered while collaborating and we intend to address those through our work. The example of 3D ceramic lamp exhibits an increased overlap between art and design practice that focuses on technological advancements.

3 CONCEPT

During several discussions, we deliberated designing a ceramic object that incorporated both hand-making skills and digital fabrication. We decided to explore a ceramic mountain form that would function as a light made out of translucent porcelain. The lamp design was inspired from contours of Antelope Canyon of northern Arizona in U.S. Here striking shafts of glorious light accentuate smooth sandstone walls to produce astonishingly photogenic sights. Therefore, the metaphor of the Antelope Canyon was the perfect inspiration to design a lamp.

Figure 1. Form inspiration by Antelope Canyon of northern Arizona

We started with an exploration of form through small-scale models and produced a prototype of the mountain by hand using techniques of hand forming and cutting from a solid mass of clay. The model was 3D scanned, converted into a 3D mesh file, and then digitally manipulated for shape and scale in Rhino program. Once we established a 3D digital model of the form, we wanted to explore methods to develop further a model in the ceramic form using the CNC (Computer Numerical Control) machine that could mill the negative of the object into plaster that could then be used as a mould to cast the object directly into porcelain. The other method was to print a 3D model of the form using Z-printer and the model to make a mould out of plaster, which could then be used to cast the object out of porcelain.

4 PROCESS

We began with some small clay prototypes that were cut into their final form using a wire-cutting tool. The goal at this stage was to acquire a mountain-like object with very raw, hand-cut edges. We decided upon two final models of different shapes. The mountain shapes would be bisected to create one unique half with a flat wall on one side so it could be used with another mountain shape back to back. Figure 2 and figure 3 explain those stages.

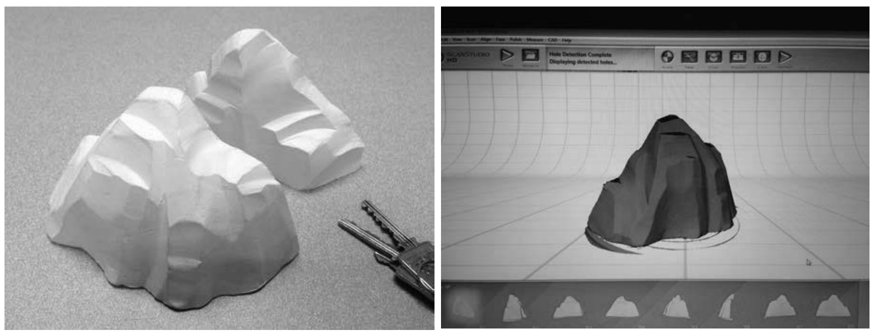

Figure 2. Form exploration by hand and 3D scan

The final two models were captured using 3D scanning technology and the scanned data was imported into a surface-modelling program (Rhino). Once this was completed, the 3D models were manipulated to enlarge its scale and elongated with the same proportions of the object. The CAD models were rendered using KeyShot program to visualize the product appearance with the ceramic surface finish. The 3D models were completed and ready for the next steps of prototyping.

4.1 CNC milling plaster mould

Our first test was to create the mould directly from the 3D digital model and have the form milled into the plaster. The 3D scanned data was used to create a CAD model for CNC using Rhino program. The plaster consisted of three individual slabs, two of which would be milled flat for the bottom and back surfaces, and one that would mill out the face of the mountain. In other words, the CNC would remove the mass of the digital model within the plaster, and the plaster would then be used directly for slip-casting. Based on the limitations of our routing bit, we were only able to achieve a surface that exposed a pronounced tool path of the bit powered by the CNC machine. While this was somewhat disappointing, it did provide a unique surface that was only possible by using this type of technology. The resulting tool marks resembled elevation ridges along the surface of the mountain. One set of moulds was made, and one of the mountains was cast in porcelain using this method. Figure 3 visually elaborates those steps.

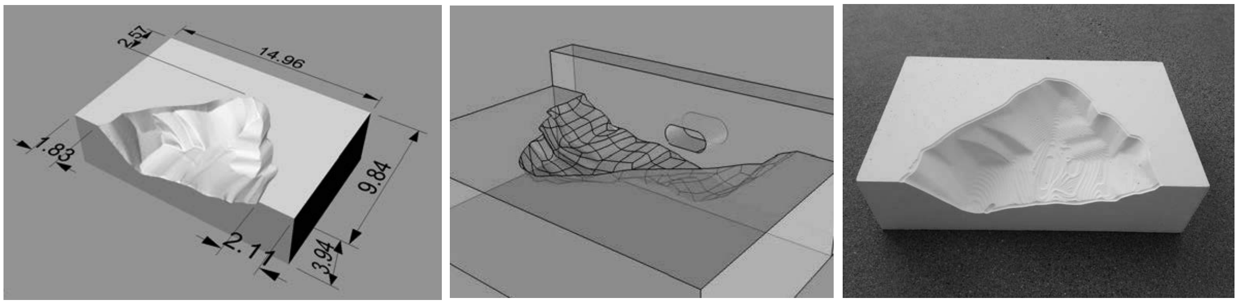

Figure 3. CAD Model for CNC in Rhino and plaster mould cut by CNC

4.2 Prototyping and mould making

Our second test was to create the plaster mould of the object using a 3D printer. The objects were printed using Z-printer and would then be used to make a plaster mould. The two objects were printed, and a mould was made from each and cast in translucent porcelain. While this proved to deliver a much more accurate physical rendering of our model, the prototyped objects broke as they were being removed from the plaster during the mould-making process. It was due to the somewhat fragile nature of the prototyping material. However, one of the authors, professor in Ceramics was able to conduct numerous tests casting the forms in different thicknesses and firing the objects with various porcelains at high temperature (2,350 F) and mid-range temperature (2,232 F). The final results showed that the mid-range temperature produced a better result regarding colour (warmer) and form (less warping).

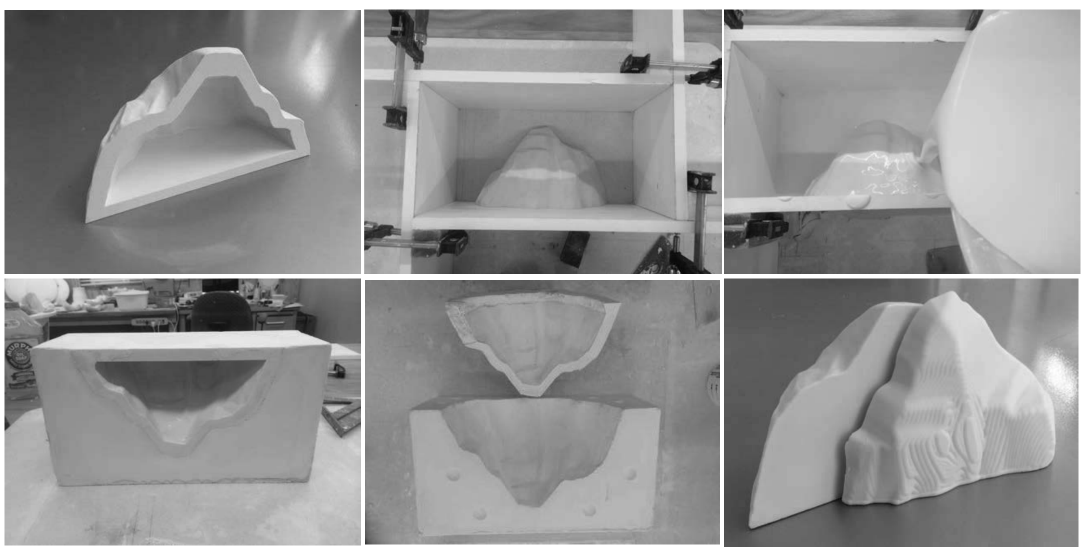

Figure 4. Images of 3D printing prototyping, mould making and porcelain mountain

4.3 China - production

One of the authors travelled to Jingdezhen in China, the birthplace of porcelain. It is still a thriving industry with thousands of artisans practicing some traditional ceramic processes. The purpose of the trip was to make moulds from 3D printed models and have them slip-casted in Chinese porcelain. The results were mixed. The good thing was excellent quality fine porcelain casts could be produced with the help of the local artisans. But final porcelain slip-casted forms warped too much to have them marketable. It wasn't a problem that could be resolved in that trip because it was a technical issue related to the actual model itself. Approximately 20 mountain forms were cast, out of which 10 survived despite some wrapping. Following images capture the process.

Figure 5. Work done in Jingdezhen, China

4.4 Technical solutions

It was now time to figure out how to add light source into the ceramic mountain forms. An opening was created at the bottom of the objects to insert a small light fixture with a cap to cover. We encountered the problem of finding the right bulb sizes and discovered that the light bulbs available on the market were somewhat large and difficult to fit inside the form. The frosted bulb provided more consistent lighting with the form than the one with clear glass. The bulb socket was designed and printed using an FDM 3D printer.

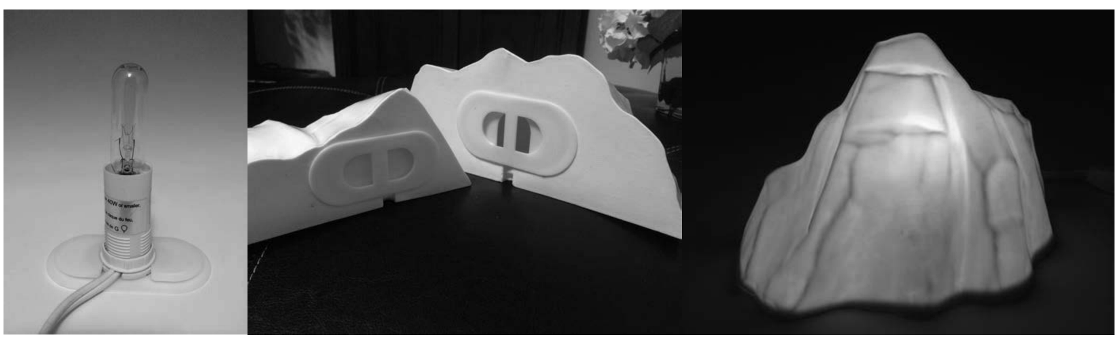

Figure 6. Inserting light source into the ceramic mountain form

4.5 Final outcome and challenges

We could create a lamp that was almost ready for marketing. However, there were a few unresolved issues such as the modest amount of warping in the ceramic forms, light bulbs that were difficult to find on a smaller scale, and determining the means of marketing once the design issues would be resolved. With regard to the difficulty in finding a small enough sized bulb, this could easily be resolved by increasing the scale of our prototype to allow for a larger bulb and cap.

5 DISCUSSION

The ceramic lamp example provides an interesting perspective on the transdisciplinary collaboration between the fields of design and arts. Our determination to transform an organic form, which is typical of art discipline into an industrial marketable object, was a challenging process because it encouraged us to discover new tactics. We hope to resolve technological issues in near future and introduce the lamp into the market. We would particularly like to point out that the entire process taught us invaluable skills that are iterative and can be actually implemented in future projects.

6 FUTURE WORK

One of the major objectives of this project is to develop a collaborative course in ceramic design. It would be an invaluable experience for design and art students who intend to work in applied industry. We are obliged to expand the project further in the near future to create versions like night lamps, wall-mounted lighting fixtures, or outdoor lighting. We would like to explore a different process of 3D scanning using digital photos rather than capturing surfaces with 3D scanners, and this will provide high-quality surfaces of 3D objects. Instead of 3D printing with the Z-printer, we would like to invest our time exploring the CNC technology to create a higher resolution mould directly from a block of plaster, as the work conditions and the nature of plaster material are somewhat limited and can change. We look forward to another grant opportunity to develop our process, explore different digital techniques and commercialize our ceramic products into the market.

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