# Lithobox: Creative Practice at the Intersection of Craft and Technology

**Jennifer Weiler**
Arizona State University
Tempe, AZ, USA
jjweiler@asu.edu

**Todd Ingalls**
Arizona State University
Tempe, AZ, USA
todd.ingalls@asu.edu

**Piyum Fernando**
Arizona State University
Tempe, AZ, USA
piyum.fernando@asu.edu

**Stacey Kuznetsov**
Arizona State University
Tempe, AZ, USA
kstace@asu.edu



TEI '19, March 17–20, 2019, Tempe, AZ, USA

ACM ISBN 978-1-4503-6196-5/19/03.
https://doi.org/10.1145/3294109.3301258

## Abstract

The integration of new digital and physical fabrication tools with fine arts has the potential to provide new outlets for artistic expression, while at the same time raising questions about the role of material and process in artistic practice. In this work, we present Lithobox, a system that translates the traditional ceramic and lighting technique of lithophanes into a means of creating illuminated 3D models through a creative approach that utilizes both digital and tangible construction. Through work sessions with nine artists, we explored how the Lithobox fabrication process impacted the way artists manifest design ideas and engage in creative exploration in crafting. At the TEI arts track, we plan to show our system and the physical lithophanes from our work with artists. The attendees will likely discuss the design, material, and artistic aspects of our exhibit. From these discussions, our goal is to gain insight into beneficial directions for integrating digital technology into traditional fine arts practices.

## Author Keywords

Lithophanes; 3D printing; fine arts; digitally-mediated art; light art.

Figure 1: Examples of lithophanes created using Lithobox.

## Introduction

As digital fabrication methods become more accessible, they are increasingly being explored in collaboration with traditional crafting practices and the fine arts. In recent years, TEI has had a growing focus on integrating digital fabrication with traditional craft activities [5, 12, 16, 17]. In particular, recent research has explored how the incorporation of technology may alter creative practices in addition to changing the medium or materials of the fabricated objects [3, 7, 14, 21].

In our work, we have focused on how the combination of a traditional craft approach with new fabrication tools and methods based in digital technology can be used to support fine arts practices. We present Lithobox, a software system and physical kit inspired by the ceramic technique of lithophanes and recent tangible interaction design explorations into light as a creative medium for design research [1, 11, 13, 15, 16, 18, 19]. Lithophanes are a type of bas-relief, in which a sculptural image is depicted with little overall depth. However, when back-lit, the thinner parts of the lithophane allow light to shine through while the thicker parts of it do not, creating a luminescent image. Traditionally, lithophanes are made by carving an image into clay and then firing it in a kiln [11, 19]. Because the clay needs to be evenly backlit during the carving process, ceramic lithophanes were generally created as flat tablets, though there were some rare cases of lithophanes molded into three dimensional shapes, such as orbs [11].

The concept of lithophanes has recently been explored through additive fabrication, with several online programs and tutorials allowing users to turn their images into 3D printable lithophanes on flat plaques or cylinders [1, 4, 6, 20]. However, considering the

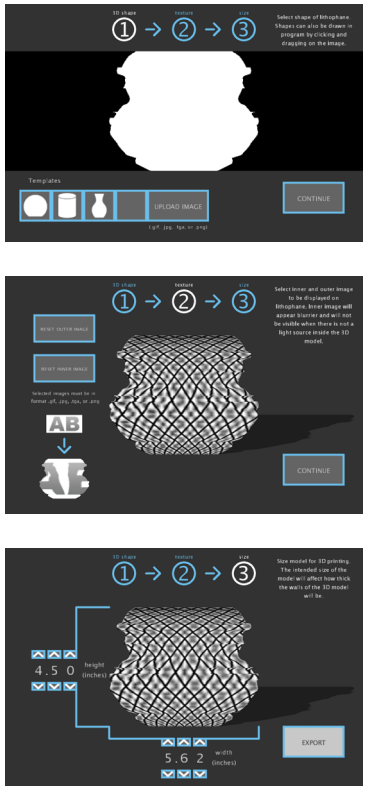


Figure 2. Lithobox workflow, from top to bottom: user draws outer shape of lithophane; user chooses images to be displayed on the surface of the lithophane; user selects print size of lithophane.

potential complexity of 3D printed forms and the various ways in which 3D models can be shaped [8, 9, 10, 12], we sought to expand the types of designs available so as to take full advantage of the unique attributes of 3D printing technology. With this goal in mind, Lithobox was designed to encourage greater variety and complexity in the overall shape of the lithophane. Through this, we wanted to allow individuals to have more creative range in their designs and enable the creation of lithophanes that would be extremely difficult to produce with traditional materials.

As part of our development of Lithobox, we gained feedback from nine artists from a variety of traditional and/or digital arts domains, all of whom created their own lithophane using our system. Based on their experiences with Lithobox, we obtained insights into ways in which the incorporation of digital fabrication techniques affects the creative practices of artists. We propose to present our system and six to nine physical lithophanes from our work with local artists at the TEI arts track, through which we hope to encourage audience members to experiment with our system and engage in a discussion about the broader implications of incorporating digital approaches into established fine arts traditions.

## System: Lithobox

To generate our 3D printed lithophanes, we created an intuitive software interface in Processing. For the display of the lithophanes, we also designed a physical kit that could be 3D printed or laser cut, and that, along with the addition of some electronic components, could be used to rotate and illuminate the lithophane.

*Software Interface*

The 3D model lithophanes are generated within Lithobox, a downloadable application created with Processing that outputs the finished models as OBJ files. When using Lithobox (fig. 2), the user will create the outer shape of the lithophane, chose the images to be displayed on the surface of the lithophane, and can adjust the print size of the lithophane. When designing their lithophanes, users are able to save and iterate on multiple designs during their making process.

When using Lithobox, the user begins by drawing the outer shape of the lithophane. The system is designed so that the user can create any radially symmetrical form. We made this choice because it allows for a wide variety of forms which are extremely difficult to create by hand in traditional mediums such as ceramics. When designing their shape, users can iteratively draw their desired form, use several pre-existing options, or upload images on their computer.

In the second step, users select the 2D images that will be extruded from the outer and inner sides of the lithophane. Uploaded images are mapped along the 3D shape horizontally and then extruded from the surface of the model based on the darkness of the color in each pixel (based on several early trials, we chose to use a maximum additional depth of 3mm). Once 3D printed, the image extruded on the outer surface of the lithophane is visible even when there is no light inside

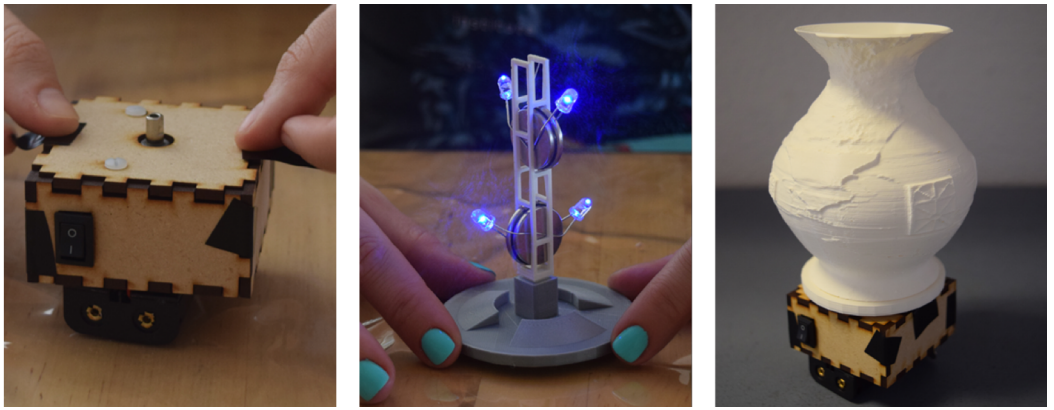

Figure 3. Lithobox physical assembly kit for rotating and illuminating the 3D printed lithophanes

the lithophane, while inner images can only be seen when the lithophane is illuminated from the inside.

In the final step, the user scales the 3D model to their desired print size, and our software ensures that minimum thickness of the lithophane is maintained. Additionally, the base of the model is proportionately resized to maintain a diameter of 1.25in (31.75mm) so that the lithophane will correctly attach to other parts of our kit. The finished model is exported as an OBJ file which can be printed on most commercially available 3D printers.

*Physical Assembly*

As part of the Lithobox setup, we created a step-by-step physical assembly process that allows the finished 3D printed lithophane to be evenly lit from the inside and displayed on a rotating platform. By allowing the lithophane to rotate, the image it presents changes over time, adding an interesting perspective for observing the illuminated images. In addition to the 3D printed lithophane, the materials required for the finished assembly include additional 3D printed or laser cut parts consisting of a base, a light support tower, and sides of a makercase box (fig. 3). The electronic components include a 6 RPM servo, switch, battery pack, batteries, and LEDs.

To illuminate the lithophane, strings of lights or individual LEDS can be inserted in slots along a vertical tower at the center of the rotating platform (fig. 3). After the lights are situated, the 3D printed lithophane is placed over the light tower and latched into notches on the base. The rotator is constructed by attaching the wires of the servo to the battery pack and switch, and then putting all the materials inside of the assembled makercase box. The spinning end of the servo, which sticks out through a hole in the box, can be fitted to the

bottom of the 3D printed base, allowing the illuminated lithophane to rotate.

## Exploration with Artists

As part of our development of Lithobox, we wanted to understand how the integration of digital fabrication might affect artistic practice. To do so, we recruited nine local artists to create lithophanes using our system. We conducted work sessions wherein we observed the artsts' creative processes while using Lithobox and discussed their design and physical fabrication experiences.

Before using Lithobox, participants were sent an email explaining what traditional lithophanes are and were asked to bring several digital images that they would like to see displayed on a lithophane. Participants attended individual work sessions, whereby they discussed their artistic background and engaged in a brainstorming activity in which they generated ideas for lithophanes through either sketching on paper or molding playdough. Afterwards, they used Lithobox to design a 3D lithophane and experimented with their own images and the images researchers had on hand as the lithophane's outer and inner bas-reliefs. If participants wanted to continue to iterate after the session, they had the option to download the Lithobox program to their personal computer and email their design to the researcher. After each participant decided on their final design, it was 3D printed using an Ultimaker. Each participant was then invited back for a second session during which they physically assembled the lighting and rotating platform for the finished lithophane setup. At the end of the session, participants kept their lithophanes and were offered a copy of the Lithobox software for future projects. Participants were compensated for their time ($10 for attending the first session and $15 for attending the second).

Our nine participants are active art practitioners with between five and twenty years of experience in traditional and/or digital arts domains (only two participants had any previous experience with 3D printing).

## Summary of Findings

Using Lithobox, all of our participants were all able to create their own 3D printed lithophane. From the discussions we had with them during their time using the Lithobox software and physically assembling their lithophane, we were able to gain insights into how the fabrication process in Lithobox affected their creative practice.

*Manifesting Design Ideas with the Aid of Technology*

When using Lithobox, participants who had no digital 3D design experience and participants who had previously given up on learning modeling software were able to design a complex 3D printable model with relative ease. They discussed the potentially freeing aspects of technology when compared to using traditional tools or methods. In recounting their own creative practices, participants described being limited by the medium they are using and/or their own skills. In contrast, new technologies were perceived as a means to enable different kinds of fabrication within craft traditions, provided that the technology was accessible, easy to learn, and allowed for creative engagement through experimentation and iteration.

*Valuing Material Manipulation within Creative Practice*
While they were happy with the design process and the objects they created, some participants expressed a desire for more physical manipulation and crafting in the creation process. Several participants mentioned that the design activity in which they drew on paper or molded forms using playdough was more intuitive and tactile than the mouse/keyboard setup for using Lithobox. In addition, participants suggested that printing in alternative materials (such as clay or dirt) would allow them to continue iterating on the design in ways that they felt unable to with the 3D printed plastic. Overall, while the artists who participated in our study appreciated the ease of use offered by the digital interface and simple physical assembly, the lack of tactile engagement in the digital interactions and the perceived unalterable characteristics of the 3D print limited their ability to engage with and iterate on the design. Future work could focus on alternative physical-digital interfaces and 3D printing with alternative materials to help reintegrate physical fabrication into the creative process.

## Presentation

Because of our work's focus on combining traditional craft activities with digital fabrication, we propose that it would be well situated as part of TEI, which has displayed a growing interest in the intersection of HCI practices and the fine arts [5, 17]. For attendees of the TEI arts track, our work will function both as an art viewing experience, in which they will be able to view instances of a traditional fine arts technique being presented through a novel fabrication method, and as a creative fabrication experience, in which individuals will have the chance to use our software to design and create their own lithophanes.

The art exhibit will consist of six to nine lithophanes created and assembled using Lithobox. The designs for the lithophanes will be a mix of those created by our study participants and those created by the researchers. We will also have a computer setup and offer attendees the opportunity to design their own lithophanes using the Lithobox software. We hope that our work will provoke discussion about the integration of digital technology into traditional arts practices and the effects that the resulting hybrid practices have on the fabrication processes of creators. From these discussions, our goal is to gain insights into potential directions for our future work as well as broader implications for the benefits and drawbacks of hybrid crafting within fine arts practices.

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