Slip Casting as a Machine for Making Textured Ceramic Interfaces

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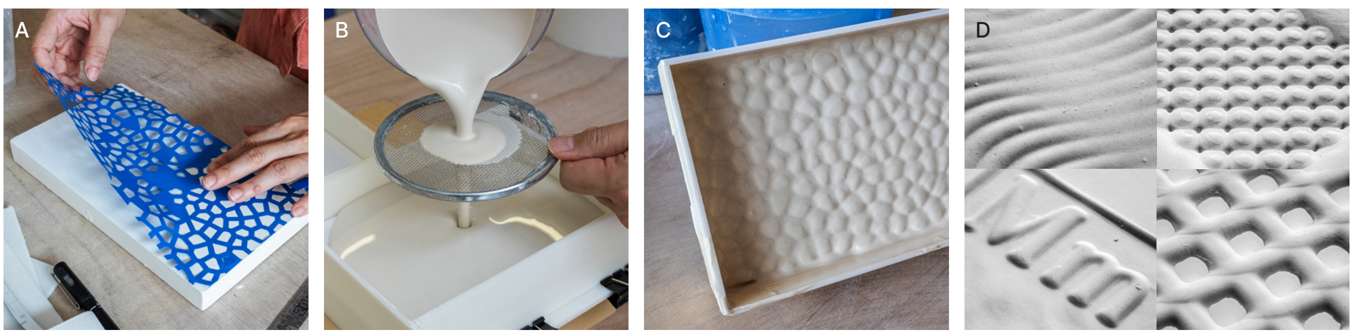

Figure 1: The *resist slip-casting* process. A: Masking a plaster mold with vinyl. B: Filling the mold with slip. C: Removing excess slip to reveal the cast texture. D: Textures from *resist slip-casting* with same plaster mold.

Abstract

Ceramics provide a rich domain for exploring craft, fabrication, and diverse material textures that enhance tangible interaction. In this work, we explored slip-casting, a traditional ceramic technique where liquid clay is poured into a porous plaster mold that absorbs water from the slip to form a clay body. We adapted this process into an approach we called *Resist Slip-Casting*. By selectively masking the mold's surface with stickers to vary its water absorption rate, our approach enables makers to create ceramic objects with intricate textured surfaces, while also allowing the customization of a single mold for different outcomes. In this paper, we detail the resist slip-casting process and demonstrate its application by crafting a range of tangible interfaces with customizable visual symbols, tactile features, and decorative elements. We further discuss our approach within the broader conversation in HCI on fabrication machines that promote creative collaboration between humans, materials, and tools.

CCS Concepts

• **Human-centered computing → Human computer interaction (HCI)**.

Keywords

Slip-Casting, Textures, Ceramic, Masking

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1 Introduction

Ceramics is a time-honored material deeply embedded in our everyday lives. It holds cultural significance and is widely used for artistic, decorative, and functional objects. Ceramics is also a growing site for HCI research in the areas of fabrication, interactivity, and materiality. We are particularly drawn to the tactile qualities of ceramic ware. Whether it's the warmth of a smooth coffee mug in hand, the coolness of rough bathroom tiles underfoot, or the intricate and colorful mosaics adorning public and religious spaces, ceramics provide haptic and visual textures that influence how people experience their objects and environments.

In this research, we explored how textured ceramic ware can be designed and fabricated through slip-casting, a ceramic forming technique where liquid clay (slip) is poured into a mold to create hollow or solid shapes as the clay sets against the mold walls. From our investigations, we developed the *resist slip-casting* approach, which we introduce and detail in this paper. This approach uses adhesive stickers to alter the water absorption rate across the surface of a plaster mold, producing a textured surface on the clay body during the casting process (Figure 1). By varying the masking material and pattern, different textures—from simple geometries to intricate patterns, symbols, or text—can be customized and produced from the same mold (Figure 1D).

This paper details our investigations into the traditional slip-casting process and our development of the resist slip-casting approach on top of it. We also detail the growing library of ceramic textures it enables, and demonstrate how resist slip-casting can be applied in various design contexts through applications across tangible user interfaces, tactile graphics, and home products. Throughout the paper, we reflect on what we learned from this research, including a deeper appreciation of the agency that materials and tools bring to a making process, as well as a our shifting perspective of making and machines in the context of fabrication.

2 Related Work

Our material-driven inquiry into slip-casting builds upon many theoretical concepts and related work investigating craft and materiality within HCI. In this section, we discuss the key research that informed our investigation into making textured ceramic interfaces through the craft of slip-casting.

2.1 Crafts-machine-ship in HCI

HCI researchers have argued for the changing relationship of human-machine collaboration, particularly in the areas of making and materiality. In this context, the term "machine" has evolved beyond its traditional mechanical definition, to include social, emotional, physical, and digital systems [2]. This broader interpretation of what a machine is provokes a deeper exploration into the composition and configuration of machines between human and non-human actors—supporting, enhancing, and critically questioning creative collaboration between maker, materials, and tools [3].

Within making and HCI, this shift from *using* machines to automate production—to a more dynamic partnership between humans and non-human systems—led us to consider how we collaborate with materials, tools, and making situations as makers. Notably in the area of digital fabrication, HCI researchers have investigated shifting the autonomy and agency between the designer-maker, materials, and fabrication tools in different ways to expand digital fabrication processes beyond a black box that materializes design intent. Zoran & Paradiso's *FreeD* system [44] offers a manual-digital handheld carving tool that provides makers with a physical margin of expression within the boundaries of a virtual 3D model. Devendorf & Ryokai's explorations in "Being the Machine" [11] expands and inverts the conventional boundaries of 3D printing systems to encompass the maker and their everyday spaces and materials. In this work, the maker is given agency to interpret and act on 3D printing instructions in their own way; supporting individually meaningful making experiences. Bourgault & Jacob's *Millipath* [4] translate actions and values from the manual practices of various artists to digital fabrication machine paths that learn from the expressiveness of handcrafting.

In this work, we explore slip-casting and the materials that contribute to its operation, in particular the nuances of how these materials affect the absorption of water from slip to form clay textures in non-direct ways. Our development of resist slip-casting was initially motivated by leveraging it as a fabrication machine capable of automating the challenging task of creating intricate textures on ceramic objects. However, through our material and making explorations, we experienced a shifting relationship between our role as designers and and the materials of slip-casting. More than a craft process for producing tangible interfaces and artifacts, we began to see resist slip-casting as a machine like Andersen et al. [3] describes—a machine that entangles us along with the materials and temporality of the situation. We revisit and expand on this reflection in the discussion section (Section 8).

2.2 Ceramics in HCI

Ceramics is a growing site of research in HCI. As a familiar material with deep crafting traditions, ceramics are used across many cultures for everyday objects and spaces. HCI researchers have drawn on the materiality of ceramics in various ways, exploring its potential to contribute to both digital fabrication and interaction design.

In the realm of fabrication, HCI researchers have investigated 3D printing ceramic objects and have developed software and hardware systems to support these digital processes. Notably, work in this area often draws inspiration from traditional ceramic craft, adapting existing techniques and equipment into new digital fabrication systems. For example, *Digital Pottery Wheel* [32] integrates a traditional throwing wheel with a clay extruder-based 3D printer, enabling a combination of manual throwing and 3D printing in object fabrication. Similarly, *SketchPath* [15] allows artists to directly sketch the toolpaths for a clay 3D printer, bridging the gap between manual and digital creation. Other works, such as *CoilCam* [5] and *WeaveSlicer* [14], incorporate the material properties of clay into the design process, accounting for texture and structural integrity in their software systems for 3D printing.

In terms of interactivity, ceramics has served as a canvas for tangible interactions. For instance, *Listening Cups* [8] and *The Inner Ear* [9] translate sound data from the home through 3D printed ceramic tactile textures, bringing an auditory experience into a physical form. *The Tilting Bowl* [27] and *Morse Things* [42] present ceramic research products that probe the experience of living with smart and connected objects. To further support the crafting of interactive ceramics, Zheng et al. [43] developed a method for incorporating electronic circuits onto glazed ceramics through sandblasting, expanding the possibilities for creating interactive ceramic artifacts.

Beyond artifact production, researchers have also studied the craft of ceramics and explored its value for HCI. Moradi et al. [30] examined ceramic glazing materials and processes, offering guidelines for integrating such materials into interaction design. Similarly, Rosner et al. [37] discussed the implications of engaging with an "imperfect" material like clay, highlighting its tensions and potential for digital craft and embodied interaction.

In this work, we dive into slip-casting, contributing another approach to engage with ceramic craft for creating textured artifacts relevant to HCI and design. We reflect on our evolving relationship with slip-casting materials, aiming to inspire others exploring physical materials and craft within the context of HCI and interaction design.

2.3 Textures in HCI

Textures play a crucial role in HCI by enhancing sensory experiences across functional, experiential, and aesthetic dimensions [24]. Functionally, textures provide tactile feedback, guiding user interaction. Experientially, they evoke emotions and create immersive and memorable interactions. Aesthetically, textures enhance visual appeal, adding depth and dimension to interfaces.

Our research is broadly interested in exploring how textures are fabricated on physical objects. Digital fabrication, particularly 3D printing, is a common approach employed by HCI researchers to create new textures. For instance, researchers have fabricated dense hair-like structures with plastic materials as surface textures using additive manufacturing, demonstrating their use as aesthetic treatments or for passively actuating objects [25, 35]. Additionally, 3D printed metamaterials [23] and actuated structures [17] have been developed to toggle between smooth and textured states, providing haptic feedback or conveying information under different conditions. Sun et al. [39] further demonstrated how 3D printed textures on flat surfaces can be programmed to morph into 3D textured objects.

Materials play a significant role in determining the texture of an object. Harrison and Hudson [18] explored different sheet materials such as textiles, sandpaper, and rubber to create passive textures that support interactions and convey information. Albaugh et al. [1] investigated machine knitting of spacer fabrics with tunable stiffness and surface textures. Cheng et al. [6] used swell paper and conductive ink to create textured paper interfaces capable of detecting touch. Hu and Hoffman [20] employed inflatable structures to create dynamic textures for expressive robots.

Ceramics offers a distinct set of textures within HCI. As mentioned earlier, researchers have used 3D printed ceramic textures for data physicalization [8]. The unique texture of 3D printed ceramics arises from the layered bands formed during production, which can be further accentuated with glazing. Researchers have built on these base textures, manipulating fabrication paths to emphasize the strings and coils formed during 3D printing [5, 31]. Beyond 3D printing, ceramic textures have also been explored through other processes, such as slab forging [4, 19], surface ornamentation, and glazing [40].

In this work, we explore using water-resistant masks and slip-casting to create textured ceramic surfaces. Like 3D printed ceramics, slip-cast ceramic textures have a unique structure shaped by the interactions of different materials involved in the casting process. We characterize these textures in the subsequent chapters and provide a sample library of possible textures for future reference.

3 Collaboration model

Our research team comprises six full-time researchers and a practicing ceramicist—Genevieve Ang. Genevieve is an independent ceramic artist and designer with more than 10 years of experience in the craft. She adopts a material-driven approach in her practice, such as adopting glass waste as a raw material for formulating glaze that is applied to her ceramic pieces. The rest of the authors are industrial design-trained researchers with interests in tangible interaction design and ceramics-making.

In line with previous HCI work, we worked with Genevieve as a *technical collaborator* [10] that contributed deep knowledge on material and processes, as well as value assessment that helped steer the overall research exploration. In consideration of her schedule as a full-time practitioner, we opted to collaborate with her as a paid consultant, with group meetings approximately every two weeks. During the initial meetings, the research team shared updates on project process including new fabrication approaches, insights, and physical samples, while also seeking advice from Genevieve on the craft-specific challenges encountered. As the project progressed, these meetings included hands-on making sessions at Genevieve's studio where she tried resist slip-casting as part of her broader ceramics-making process. Towards the end of the project, we also discussed the significance and value of resist slip-casting for both HCI and ceramics practice; envisioning possible future work in these two areas that resist slip-casting might contribute to. Apart from these in-person meetings, we had an active online message group with Genevieve that served as a more casual and convenient platform to share immediate updates and any relevant information.

For this research, we bought a kiln and all our slip-casting materials from Sam Mui Kuang Pottery, a local ceramics craft supply store that is also owned and run by professional ceramicists. As part of this business relationship, the store owners, Chua Soo Khim and Chua Soo Kim provided training concerning programming and operating the kiln. They also offered valuable advice around slip-casting, such as strategies for mixing and diluting slip, as well as mitigating warping during the drying and firing process.

In this paper, we explicitly attribute work done and insights contributed by Genevieve and other stakeholders. Otherwise, we use the term "we" to refer to the researcher team responsible for most of the making and documentation.

4 Engaging with Slip-Casting

Slip-casting is a process where liquid clay, known as slip, is poured into a plaster mold. Water is absorbed by the slip through the plaster surface and the remaining clay adheres to the mold's surface, forming a solid layer. A hollow ceramic form is left after draining the excess slip away [16].

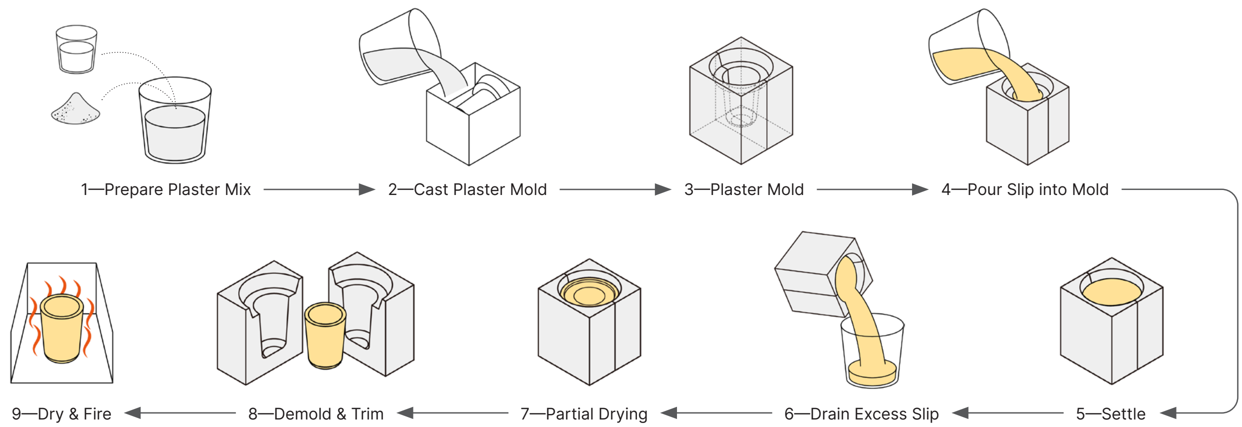

Figure 2: Flowchart of the traditional slip-casting process.

4.1 Investigating Traditional Slip-Casting

From our exploration, we identified several key steps of slip-casting:

(1) *Preparing the Plaster Mold:* To produce a traditional mold for slip-casting, makers first create a master form of the cast geometry, and then cast plaster around this form. The master form can be made with a variety of approaches, including hand-sculpting in clay, or 3D printing in plastic. Depending on the size of the mold and the complexity of the cast geometry, the time required to fabricate this plaster mold, as well as for it to completely cure can range from hours to several days.

(2) *Pouring Slip into the Mold:* The slip is first mixed well to reach a consistent density. The slip is then poured into the plaster mold.

(3) *Formation of the cast:* Slip is left in the mold for about 10 to 30 minutes. The plaster mold absorbs water from the slip, causing clay to concentrate and solidify on the mold's surface.

(4) *Draining:* When the clay skin on the mold's surface is sufficiently thick, excess slip is drained from the mold.

(5) *Demolding:* After draining, the cast body is kept in the mold for approximately 30 to 60 minutes until it has dried and hardened sufficiently. The cast body can then be removed from the mold. The cast body shrinks as it loses water during this phase.

(6) *Drying and Firing:* After demolding, the cast body is left to dry until it becomes bone-dry. This process may take several days based on environmental conditions and the thickness of clay body. It can then be fired in the kiln. During this process, the cast body continues to shrink.

We conducted tests to measure the shrinkage ratio of the specific porcelain slip (Cool Ice Porcelain) that we used in this research (Figure 3). We observed a 5% shrinkage from the freshly cast state to bone dry, and a total shrinkage of 14.5% from the freshly cast state to after firing.

4.1.1 *Slip-casting parameters.*

Slip-casting works by water absorption due to capillary action. The porous plaster mold has the ability to draw water out of slip. This causes clay particles to deposit and solidify evenly along the mold's inner surface. There are several factors that collectively influence water absorption, and consequently, the results of slip-casting:

(1) *Casting time:* During slip-casting, water is gradually drawn from the slip into the plaster mold. The longer the casting time, the thicker the resulting cast body becomes (Figure 4A).

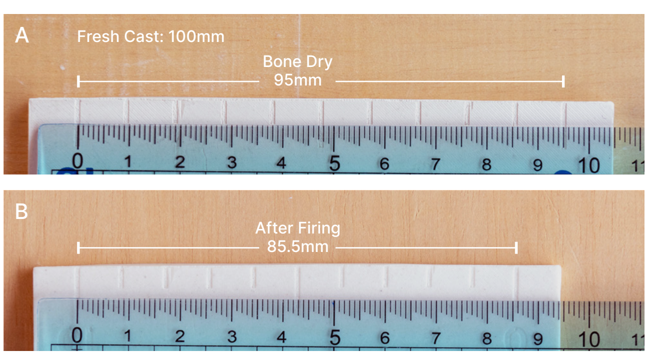

Figure 3: Measuring shrinkage ratio pre and post firing. A: Bone-dry size; B: Size after firing. The test sample was cast to an approximate wall thickness of 3.7mm.

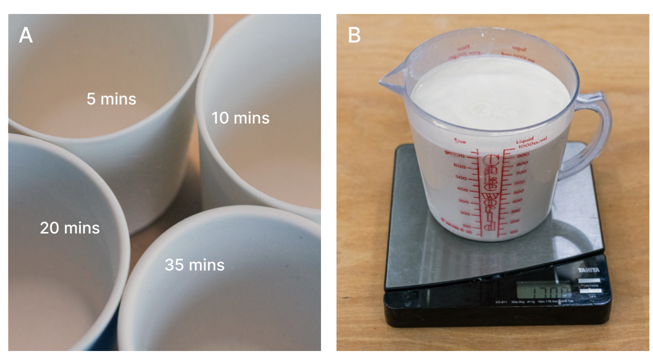

Figure 4: A: Longer casting times result in thicker cast bodies. B: Measuring weight and volume of slip to calculate specific gravity.

(2) *Specific Gravity of the Slip:* Specific gravity, or relative density, is the ratio of the mass of the slip to the mass of an equal volume of water. This indicates the clay particle-to-water ratio. A lower specific gravity indicates a more diluted slip, resulting in a thinner clay body given the same casting duration (Figure 4B).
(3) *Plaster Mold Porosity:* The porosity of the plaster mold affects the rate of water absorption, which is measured as percentage porosity. This is controlled by the ratio of plaster powder to water by weight used to make the mold. A lower plaster-water ratio results in higher porosity and water absorbency, but decreases the mold's strength. In this research, we used a plaster-water ratio of about 4:3 by weight for our molds.
(4) *Wetness of the Mold:* The wetness of the mold impacts water absorption. The wetter the mold, the less absorbent it is. In this research, we keep the mold in a dehumidifier for approximately 6 to 12 hours, depending on its wetness, to ensure it is fully dry before reuse.

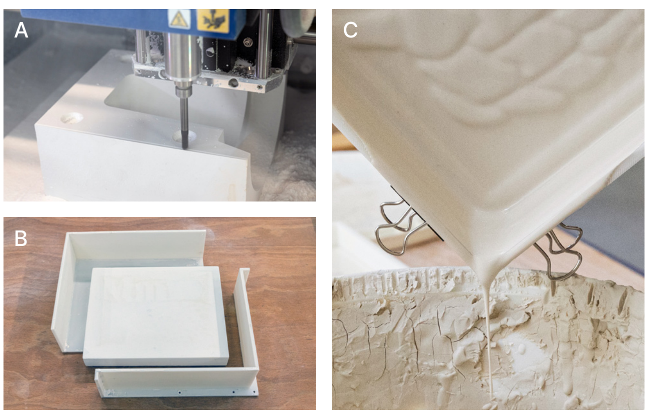

Figure 5: A: CNC milling of vessel mold from a plaster block. B: Tile mold with 3D printed walls. C: The slip drains away and does not solidify into clay on the 3D-printed wall.

4.1.2 Mold Making. In this research, we focused on two main forms of ceramic objects: vessels and flat tiles. The flat tiles offered a simple and consistent canvas to explore ceramic textures, while the vessels offered a three dimensional form to test textures in contrast to the flat tiles. We explored various approaches to creating plaster molds for these geometries.

Vessel Mold: HCI researchers have previously demonstrated using computer-aided design and 3D printing to facilitate the fabrication of a 3D slip-casting mold [28]. Inspired by this work, we explored using the CNC milling machine in the lab (Figure 5A) to directly carve the negative form of the vessel into a prefabricated block of plaster. We also used this digital fabrication process to incorporate features such as registration holes and flanges into the mold to facilitate slip-casting and demolding.

Tile Mold: Our tile mold comprises a flat block of plaster at the base, surrounded by walls 3D printed in PLA plastic (Figure 5B). The waterproof plastic walls ensure that water is only absorbed through the plaster base, preventing any build up of clay on the side walls. The plastic walls also help to prevent warping of the flat tiles when it dries in the mold as the edges of the wet clay slab adhere to the smooth walls (Figure 5C).

4.2 Reflecting on slip-casting

As novices to slip-casting, our explorations revealed many material and process considerations that are critical to a successful pour and cast. We reflect on these challenges here and how we navigated them with the help of Genevieve and our ceramics supplier, surfacing these otherwise tacit details for other makers who might want to adopt this process.

4.2.1 Balancing Specific Gravity & Skill. The consistency and specific gravity of the slip are critical parameters influencing the pouring, settling, and draining processes in slip-casting. A more diluted slip (lower specific gravity) is easier to pour and drain, but it requires more time for the clay to form within the mold. In contrast, a thicker slip (higher specific gravity) accelerates the casting process but introduces challenges such as inconsistent pouring and draining, which might lead to undesirable details such as visible pour marks on the cast object. Another notable challenge we faced was in assessing the thickness of the clay layer as the slip settles in the mold. This typically requires physically probing the clay skin, which risks damaging the cast. To address these issues, we discussed with our supplier and they proposed maintaining a consistent specific gravity for the slip and standardizing casting durations to ensure uniform wall thickness across multiple pours, and demonstrated how to dilute slip with water.

In this research, we determined that a specific gravity range of 1.66–1.7[1] for porcelain slip offers a comfortable balance between ease of pouring and draining while optimizing casting time. This range aligns well with our skill level and intended outcomes, enabling more controlled and predictable results for the purposes of this research.

4.2.2 Mold Design & Warping. Creating flat tiles through slip-casting proved more challenging than anticipated, despite the seemingly simple geometry of the object. Our initial mold design consisted of a single plaster block with a shallow cuboid recess to shape the slip into a clay tile. However, this design often resulted in cracking and warping of the clay body while in the mold. Through discussions with Genevieve, we discovered that mold design plays a significant role in these issues. Specifically, the differential exposure of the clay to plaster and air leads to uneven drying rates, which, in turn, create stresses that cause warping and cracking. To address this, Genevieve recommended two strategies: covering the mold with a plastic sheet to slow air drying and incorporating a "moat" feature into the mold design to help weigh down the clay and mitigate warping.

Inspired by this advice, we experimented with incorporating different features and materials into the mold. This exploration ultimately led to the use of 3D-printed walls in our tile molds (Figure 5B), a design adaptation that successfully addressed many of the challenges we initially faced, while facilitating other steps in the slip-casting process such as draining and trimming.

[1] We developed a specific gravity calculator in the form of a web application to facilitate calculating the amount of water required to dilute slip to achieve a certain specific gravity: https://specific-gravity.glitch.me/

4.2.3 Managing Material States and Risks. The process of slip-casting required us to pay careful attention to the transformation of slip into clay as it lost moisture over time. Each key step had to be carried out when the material reached specific conditions. For instance, the clay body needed to be released from the mold for drying at the right moment—too early, and the wetter body would deform; too late, and the drier clay would crack in the mold.

Ceramic craft, in general, uses subjective terms like "leather-hard" for trimming and "bone-dry" for firing to describe the different states of clay and what can be worked on. As novices, we found these terms challenging to interpret and manage, so we sought advice from Genevieve. Through our discussions, she gave us helpful tips, such as observing the glossiness of the clay surface to estimate its wetness and using excess clay trimmings from the same batch as sacrificial test pieces to determine when the clay was ready for the next steps.

Alongside these practical tips, our conversations with Genevieve encouraged us to acknowledge the inherent risks of craft processes [36] and to consider the temperament of both machines (like the kiln) and materials. For example, she shared personal experiences of failed kiln firings when experimenting with new clay types and glazes. She also highlighted how kilns distribute heat unevenly, and emphasized the need to discover the "sweet spot" in the kiln where the heat distribution is most even to minimize warping for thin-walled pieces. These insights helped us understand the delicate balance required in ceramics craft between control, and working with the agency of materials, environmental conditions, and machine processes.

5 Developing Resist Slip-Casting

During our first few encounters with slip-casting, we played with adding other materials to the surface of the plaster mold to affect the shape of the cast ceramics. For instance, we used plasticine to introduce holes into the clay body, and also applied different types of stickers to observe their impact on the surface texture of the cast ceramics (Figure 6). From these tryouts, we noticed that these additions to the plaster mold offered a rapid approach to customize the outcomes of slip-casting, while keeping the original plaster mold intact and reusable. We also noticed that different sticker materials vary the water absorption rate of the plaster at its specific location. Consequently, varying water absorption resulted in different thicknesses of the cast clay body, allowing for a range of surface textures and reliefs to be achieved. By selectively applying these stickers across the plaster mold's surface, we could create distinct and intricate surface features on the final ceramic product. This direct relationship between the applied mask and the resulting texture shaped our initial perspective of this technique—a system that accepts customizable mask patterns as input for different textures as output.

From these initial findings, we focused on investigating selective masking of a plaster mold with stickers and their effect on the resultant texture of the clay body after slip-casting. We call this adapted process resist slip-casting—as an analogous approach to resist dyeing or resist printing with wax in textile crafts.

We detail our exploration and characterization of resist slip-casting in this section, which includes several key aspects. First, we discuss traditional slip-casting and the techniques we used to make the molds. Next, we outline the end-to-end process of resist slip-casting, from initial material preparation to firing the ceramic ware. We also detail our investigations and characterizations of various sticker materials and patterns used for resist slip-casting. We end this section by reflecting on resist slip-casting and our insights from working with it and the challenges we faced.

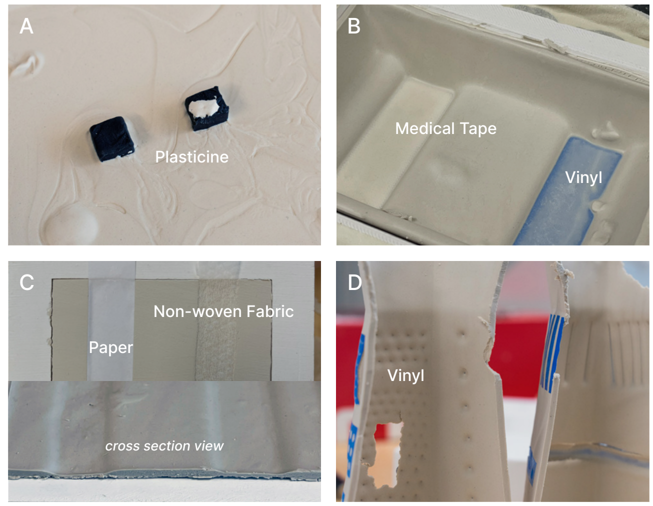

Figure 6: Early explorations using different masking materials during slip-casting. A: Plasticine. B: Water-permeable medical tape and vinyl. C: Paper and non-woven fabric. D: Vinyl.

5.1 Process: Resist Slip-Casting

Resist slip-casting builds on top of traditional slip-casting. We outline the end-to-end process from slip to clay to fired ceramic with resist slip-casting in the middle (Figure 7):

(1) ***Mold Preparation:*** We began by preparing a plaster mold as introduced in the previous section (Figure 4.1.2). We ensure that the mold is sufficiently dry before slip-casting.
(2) ***Masking:*** We prepare the masking pattern and transfer it onto the plaster mold. We make use of transfer tape to transfer large patterns onto flat surfaces (e.g. tiles), or, we manually transfer the masks individually on a complex mold surface (e.g. the inner surface of a vessel).
(3) ***Resist Slip-Casting:*** After the mold is masked, we pour slip into the mold through a sieve to prevent clay clumps from entering the mold (Figure 7D). We then wait for the slip to settle into a clay skin. The thickness of the cast depends on the duration that slip is left in the mold during this step, as well as its specific gravity (Figure 4A). The mold is covered with a plastic enclosure during this step to minimize air drying out exposed slip (Figure 7E). We then drain the excess slip by pouring it out and recycling it for future use (Figure 7F). The freshly cast clay is still wet and soft. It is left to dry in the mold till it is stiff enough to be removed (Figure 7G).
(4) ***Post-Processing:*** Once the cast body is firm enough to handle, we use a trimming tool to clean and shape the edges

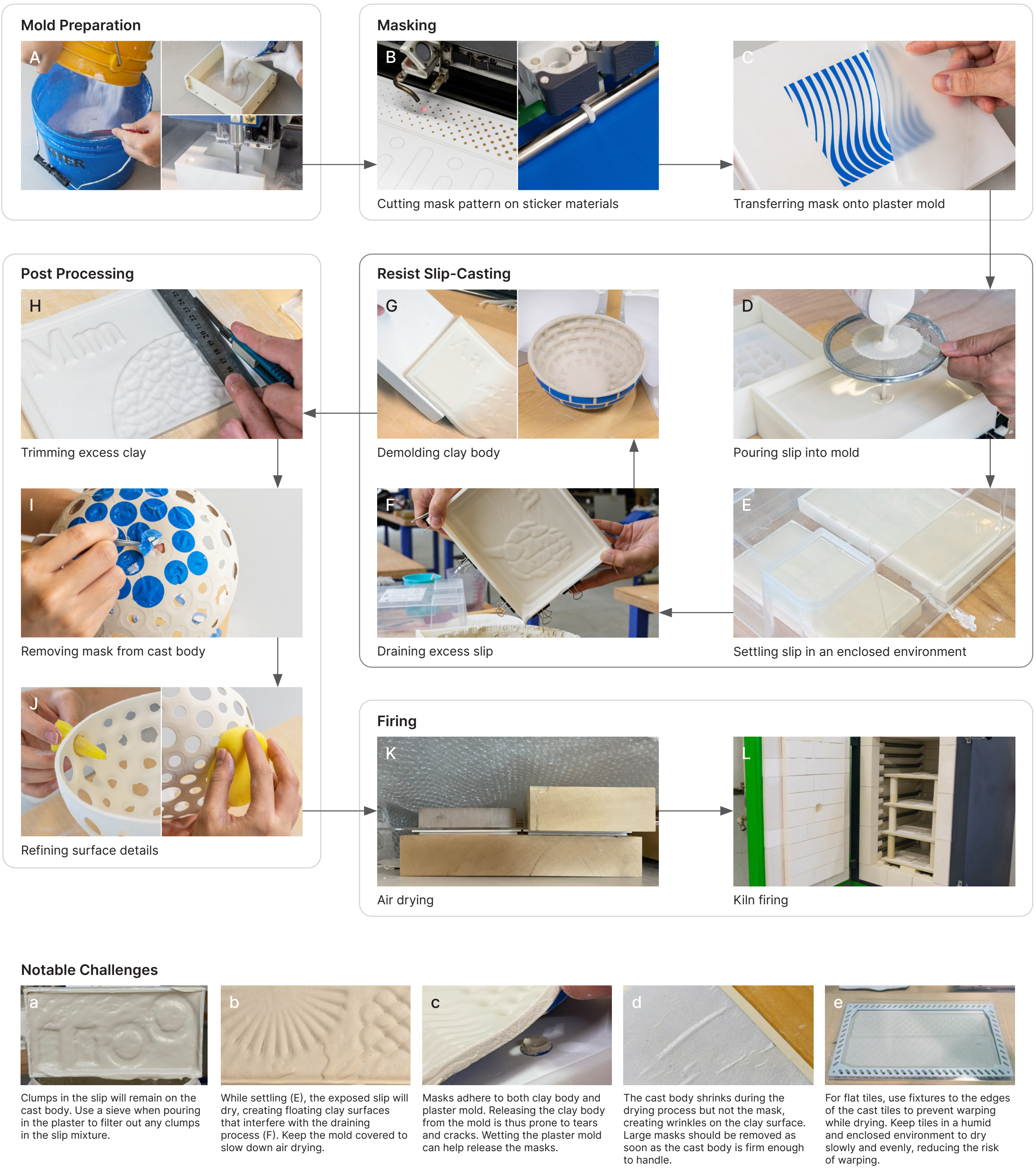

Figure 7: The process of making textured ceramics via resist slip-casting.

(Figure 7H). We also peel off (Figure 7I) all masks stuck to the surface of the cast body to prevent it from warping or cracking the part (Figure 8). We also refine details at this point, such as smoothing the jagged edges of holes created by the mask and smoothing out the imprints of the masks left on the cast body (Figure 7J).

(5) ***Firing:*** We store the drying clay pieces in a humid cabinet to prevent uneven drying which might cause distortion (Figure 7K). We fire the pieces in the kiln once the clay is fully dry (Figure 7L).

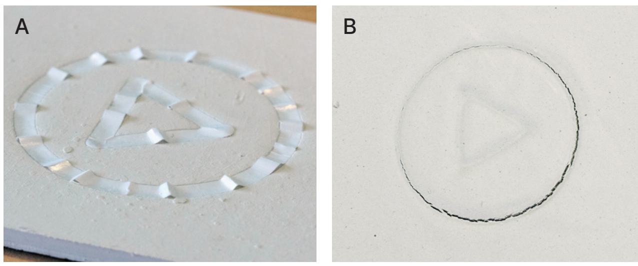

Figure 8: Deformation occurs when the mask is left on the drying clay body. A: Warping of mask as clay shrinks. B: Resulting cracks.

5.2 Characterizing Resist Slip-Casting

In resist slip-casting, we mask the surface of the plaster mold with waterproof and water resistant stickers to reduce the water absorption rate of the mold selectively. This results in a clay skin with variable thickness—the texture—that forms on the mold. We investigated the water absorption behavior of the plaster mold when it is mediated by masking, and the effect on the textures that form.

Plaster absorbs water in all directions, not just perpendicular to the surface (Figure 9). Using waterproof masks for slip-casting therefore exhibits a degree of complexity that diverges from one-to-one translation of the mask's shape to the surface profile of the clay body. Notably, clay will bleed over the edges of the masked areas. This bleeding effect can be further organized into two key directions:

(1) In the *perpendicular* direction from the mold's surface, masks vary the cross-sectional thickness of the clay body. Bleeding results in a gradient in the thickness of the clay body across the boundary of the mask.
(2) In the *tangential* direction of the mold's surface, masks vary the surface spreading of the clay body. Notably, sharp corners in the mask will soften into rounded corners.

Resist slip-casting involves the interaction between ceramic slip, mask materials, and plaster molds.

5.2.1 Materials: Slip. The slip material used in our study is Cool Ice Porcelain slip from Clayworks, a translucent white porcelain that fires between 1186 and 1222 degrees celsius. The slip comes with varying specific gravities, ranging from 1.8 to 1.9 in different batches. In our research, we diluted this slip to a specific gravity of approximately 1.66 to 1.7. This makes it more fluid and therefore easier to pour and drain during the slip-casting process.

While we focused is on porcelain slip in this research, we conducted a small test with terracotta slip (Figure 10) and verified that resist slip-casting works across different clay types.

5.2.2 Materials: Mask. We investigated a variety of commercially available waterproof and water resistant stickers for resist slip-casting.

Table 1 outlines the different characteristics of the masks we explored. Generally, masks made from plastics were waterproof and resist water absorption completely. Paper masks are slightly water absorbent and is able draw some water out of slip to form a clay surface at a slower rate than bare plaster.

The flexibility of the mask material also determined how well it conforms and adheres to a three dimensional mold surface, with vinyl being the most flexible and stretchable of all the masking materials explored. However, vinyl is also the most difficult to demold as it sticks firmly onto the cast clay body. We also considered how patterns might be fabricated onto the mask material to support more intricate textures. Besides PVC-based vinyl, patterns can be

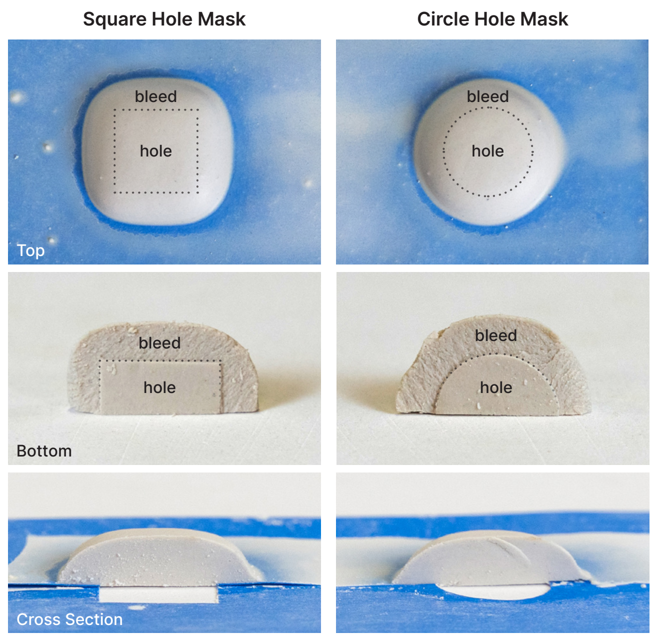

Figure 9: Bleeding effect of resist slip-casting demonstrated through square hole and circle hole masks.

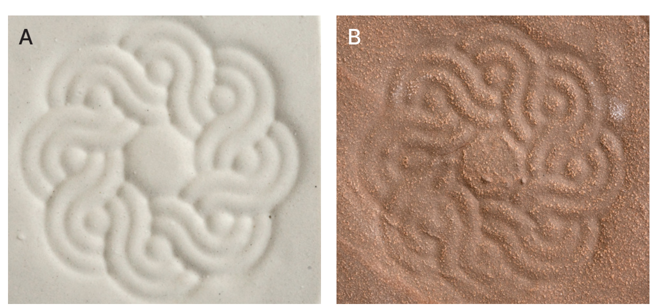

Figure 10: Resist slip-casting same texture with A: Cool Ice porcelain slip. B: Terracotta slip.

Table 1: Characteristics of mask materials.

Material	Water Absorption	Masking Characteristics	Cutting Method	Removal
Vinyl	waterproof	stretchable; thin	manual; plotter	sticky, hard to demold
PVC-free Vinyl	waterproof	non-stretchable; less flex	manual; plotter; laser cutter	sticky, hard to demold
PP Synthetic Paper	waterproof	non-stretchable; less flex	manual; plotter; laser cutter	easy to demold
Paper	slightly absorbent	non-stretchable	manual; plotter; laser cutter	easy to demold

laser cut onto the other mask materials. We also used a Cricut plotter machine extensively to fabricate our mask patterns.

5.2.3 Characterizing Resist Slip-Casting. We characterized the resist slip-casting ability of two masking materials—vinyl and paper—based on two parameters: 1) casting time, and 2) mask width.

Figure 11 shows the results of our tests. We clearly see the differences between using a waterproof material (vinyl) and a slightly water absorbent material (paper). Vinyl resists water absorption, leaving deeper traces as well as holes in the clay body with the mask's width exceeds the bleeding diameter. Paper, on the other hand, absorbs some water and leaves behind a thin layer of clay in contrast to the surrounding plaster. We also clearly see that the thickness of the cast and the amount of bleeding increases with increasing cast time.

We further characterized the compound effect of bleeding when masks are placed close to each other. Figure 12 shows the results of these tests. Notably, we observe that complex textures are formed when the gap between masks is smaller than the bleeding diameter—such as the pillowed grid in Figure 12B. We also tested perforating different waterproof mask materials to allow some water absorption to occur over the mask surface (Figure 12C) to create thin layers of clay. Bleeding also rounds off the sharp edges of a mask in the resultant texture (Figure 12D, E).

5.3 Reflecting on Resist Slip-Casting

Resist slip-casting builds upon the traditional slip-casting by introducing water-resistant masks as a mediating material to create textures during casting. This new mechanism enables us to create a variety of textures on top of an established process. But, it also introduces new materials to consider, which shifts the emphasis of labor and amplifying the time sensitivity of certain processes. In this reflection, we examine these considerations to highlight the nuances that others should be mindful of when adopting resist slip-casting.

5.3.1 Attending to inter-material actions. Resist slip-casting creates textured ceramic pieces through a system of materials acting upon each other. Slip itself can be naively seen as a mixture of water and clay. The porous plaster of the mold absorbs water from the slip mixture, leaving clay behind on the mold surface. Water-resistant stickers placed on the mold surface block the water absorption properties of plaster at specific locations, resisting the removal of water from the slip.

While we composed this system of materials to work during the pouring, settling, and draining processes of slip-casting (Figure 7D, E, F) for the purpose of creating ceramic textures, we also noticed how arriving at this composition implicates adjacent processes along the larger slip-casting journey. For example, we used transfer tape to apply intricate sticker patterns onto the plaster mold. Conventionally, transfer tape adheres less strongly to stickers than the application surface (e.g. window decals) and are therefore easy to peel off, leaving the stickers in place. However, plaster molds are typically rough and stickers often remain stuck onto the transfer tape during application. To address this, we had to pay careful attention to the removal of transfer tape, using a pair of tweezers to keep the edge of stickers on the plaster surface while slowly peeling back the transfer tape. Similarly, during the demolding process (Figure 7G), the wet stickers might pull against both the plaster mold and the clay body—tearing the soft clay if not careful. We addressed this by wetting the plaster mold before demolding, which makes the stickers adhere less strongly to the plaster, releasing along with the cast clay body.

The material system of plaster, stickers, and slip worked effectively to automate the creation of textures on ceramic objects through slip-casting. However, our experience also shows how adding new materials can create ripple effects across the process. In the case of resist slip-casting, while textures could now be automated, the process shifted labor and attention to other preparatory stages that required careful handling for a successful outcome.

5.3.2 Attending to time. Slip-casting is inherently a time-sensitive process, and resist slip-casting further amplifies this factor. While traditional slip-casting is used to create hollow ceramic objects with consistent wall thickness, resist slip-casting introduces the ability to form walls with variable thicknesses—resulting in textured surfaces. However, the bleeding effect adds another dimension to this process, altering the resolution of textures over time (Figure 11). A slightly longer casting duration not only produces thicker clay walls but also softens the edges of the mask boundaries, reducing the sharpness of the resulting textures. This makes casting duration a critical parameter that directly influences the resolution of the texture.

Beyond texture, the inclusion of water-resistant stickers in the slip-casting process also narrows the timing window for releasing the clay body from the mold. Stickers impact the shrinkage behavior of the clay body as it dries (Figure 8), increasing the risk of cracks and warping if the process is not carefully managed. To mitigate

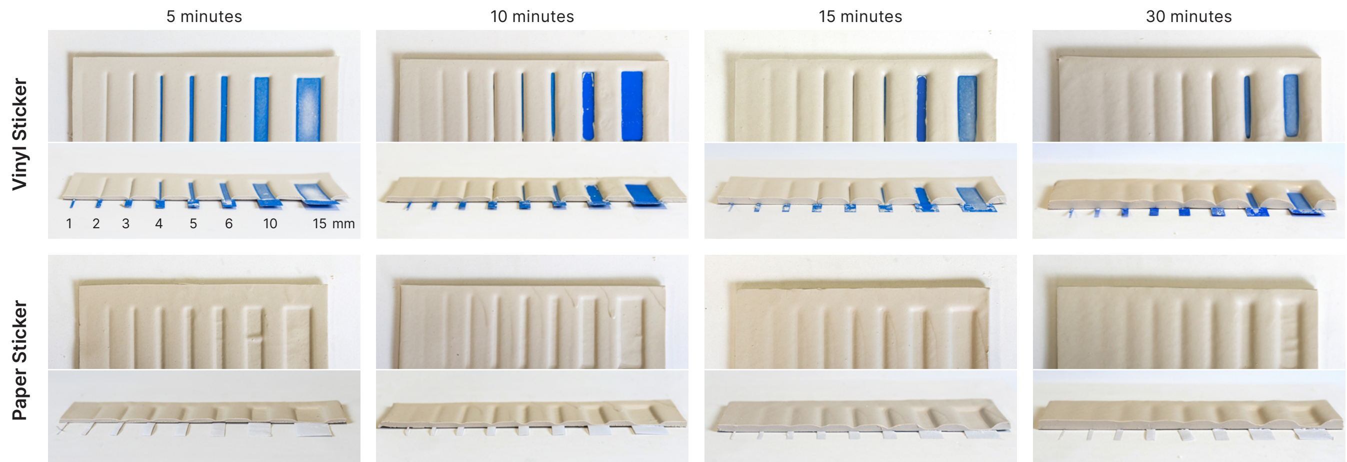

Figure 11: Experiment results illustrating the effects of varying mask widths, casting times, and the use of two different masking materials. Longer casting time and increased mask width results in a thicker cast body. All the test samples were cast using the same batch of slip, diluted to a specific gravity of 1.66.

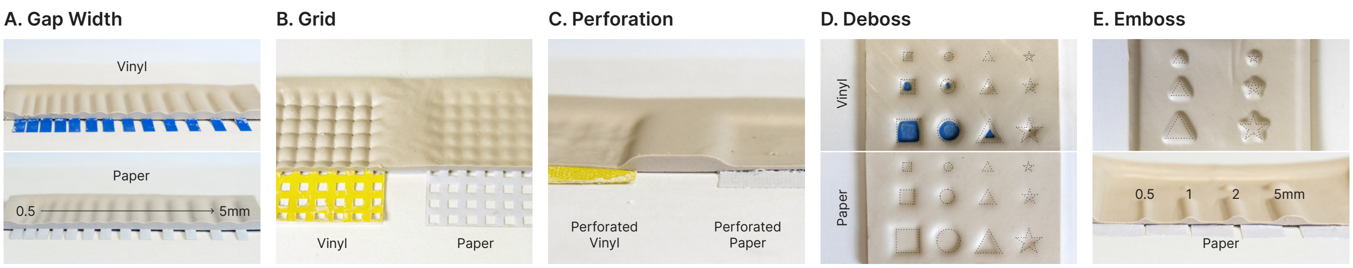

Figure 12: Experiment results. All the test samples were cast using the same batch of slip, diluted to a specific gravity of 1.66, with a casting time of 20 minutes. A: Effect of 4mm wide mask with varying gaps, using both vinyl and paper as masking materials. B: Effect of grid pattern mask with 3mm wide lines with 3mm gaps, using both vinyl and paper. C: Effect of perforated vinyl and paper masks. D: Effect of shape masks of varying sizes, using vinyl and paper. E: Effect of negative masks for embossed shapes with paper.

these issues, we release the clay body from the mold at the earliest opportunity so that we can remove the stickers from the cast object, a departure from traditional slip-casting where the cast is typically left in the mold to naturally release as it dries.

5.3.3 Embracing non-linearity. We initially anticipated a more direct relationship between mask patterns and the resulting textures. However, our experiments quickly revealed the bleeding effect caused by masking patterns, where the edges of the mask influenced the accumulation of clay in three dimensional ways. This non-linear relationship between mask and texture makes defining specific texture outcomes that have not been tried before challenging, as we had to project in our minds the three-dimensional ways in which clay will accumulate on the mold surface when designing mask patterns. To better understand this interplay, we adopted a systematic approach to explore the effects of simple mask parameters (Figure 11, Figure 12). This served to develop our working understanding of the different textures possible with simple geometries, which we then applied to more complex patterns (Section 6).

In our review of resist slip-casted textures with Genevieve, she also offered a valuable reframing—suggesting that the bleeding effect need not be seen as a limitation but rather as a distinctive surface detail unique to resist slip-casting. She highlighted how this effect could serve as a signature feature of the process, one that is difficult to replicate with other manual detailing techniques.

We build on these insights in the following sections, where we discuss the library of textures developed from our experiments with resist slip-casting and the applications these textures inspired us to create.

6 Resist Slip-Casting Texture Library

Based on our understanding of its fundamental capabilities, we directed resist slip-casting to explore different ceramic textures that we could make with this approach. While what we present from our exploration is a non-exhaustive list, they offer an overview of the range of textures that can be fabricated with resist slip-casting. We summarized our exploration in the following texture library.

We organized our ceramic textures into four categories—lines, variable lines, shapes, and holes (Figure 13). These categories represent the two-dimensional geometric primitives that our textures were built on top of.

(1) ***Lines:*** A thin strip of vinyl mask will result in a debossed line (a1), while a negative line cut out from a paper mask, will produce an embossed line texture (a2). From these two basic line elements, we can compose more intricate line patterns and graphics (a3, a6). Additionally, texture regions can be created by arraying lines in close proximity and different

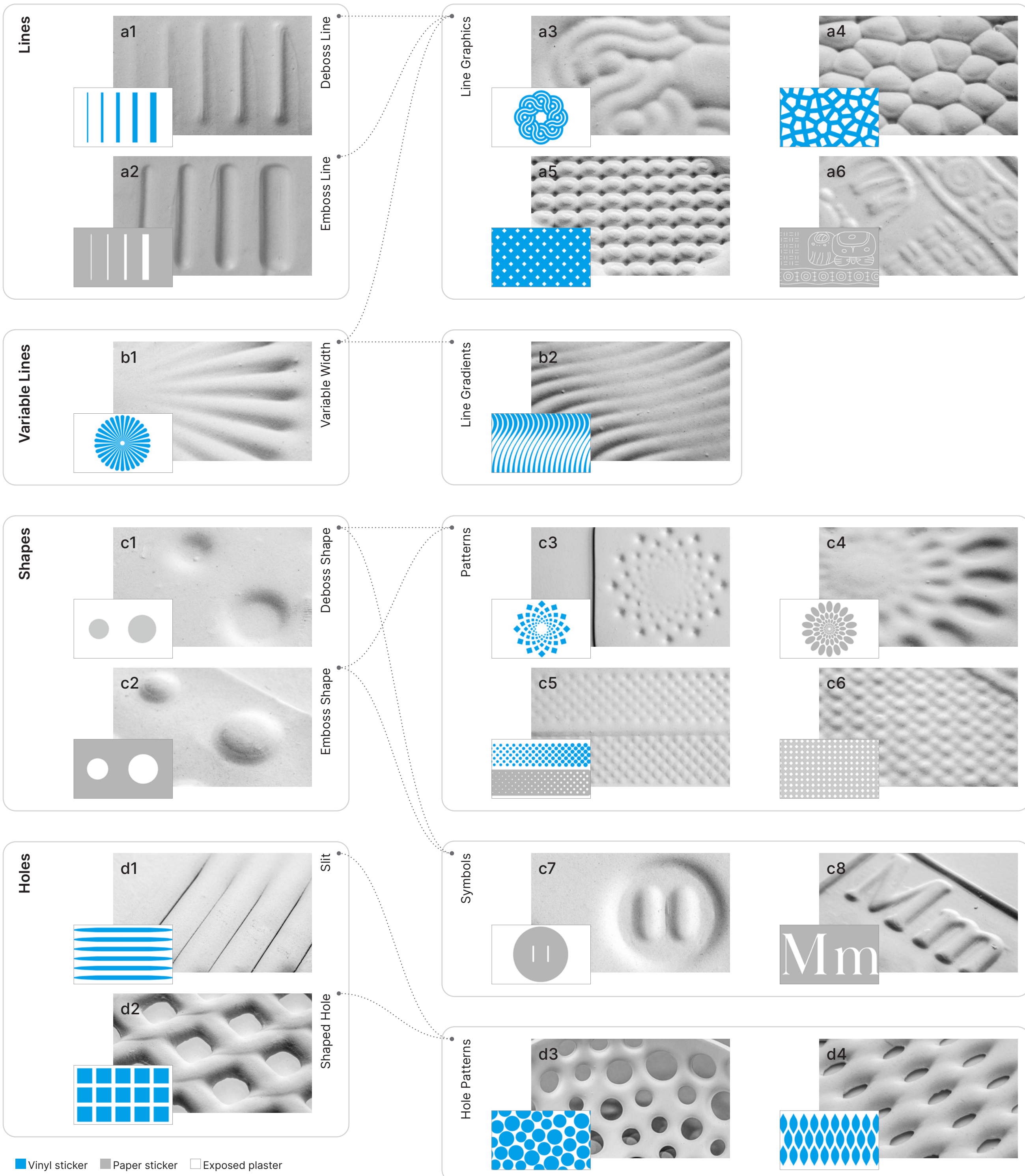

Figure 13: Ceramic texture library annotated with the corresponding mask patterns in relation to lines, variable lines, shapes and holes. Elements may be combined for added depth and dimension to create line graphics, line gradients, shape patterns, symbols and hole patterns.

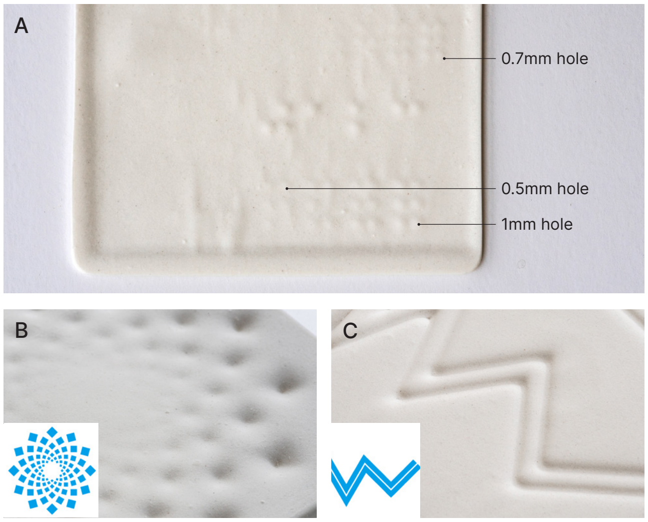

Figure 14: Constraints in texture creation using resist slip-casting. A: Small dots fail to form properly, while larger dots expand due to bleeding. B: Small shapes lose definition as the corners bleed. C: Sharp corners are rounded off due to the bleeding effect.

directions, such as a voronoi grid (a4) or an array of bumps (a5).

(2) ***Variable Lines:*** A variable line is a thin line that has a non-uniform width along its length. Such lines add variation to the width and depth of a debossed/embossed line texture. From variable lines, we can also create line gradient patterns (b2).

(3) ***Shapes:*** Similar to lines, we can also create debossed (c1) or embossed shapes (c2) with a positive or negative mask respectively. More complex shapes such as symbols (c7) or text (c8) can be made with masking as well. Simple shapes can also be arranged in a regular fashion with slight variations to their scale to create textured patterns and gradients (c3–c6).

(4) ***Holes:*** By expanding the width of lines and shapes beyond the bleeding diameter, we can deliberately create seams (d1) and shaped holes (d2) on the surface of a clay body. Additionally, hole patterns of various shapes can be created by arraying them across the mold surface (d3, d4).

6.1 Texture Constraints with Resist Slip-Casting

During our exploration, we also identified several constraints that resist slip-casting imposes on making ceramic textures. The most significant constraint is the effect of bleeding on small or sharp patterns. For example, we attempted to create embossed braille dots using paper stickers (Figure 14A). Dots smaller than 0.8 mm in diameter failed to surface as textures, while those larger than 0.8 mm bled to form a larger bump, exceeding the recommended braille dot size [7]. The smooth transition of the dot's edge also reduced its tactility, thus making it less distinguishable. Bleeding along the tangential direction of the mold's surface also softens shape corners, causing many small shapes to lose their clarity. For instance, small square shaped masks result in round depressions (Figure 14B). Similarly, the sharp corners of debossed lines are rounded off (Figure 14C).

6.2 Positioning Resist Slip-Casting within Broader Ceramic Practice

We reviewed the resist slip-casting texture library with Genevieve to understand how such textures might be positioned within broader ceramic practice. During this discussion, she highlighted two key strengths of the approach in comparison to other texture making techniques.

First, she saw value in the "precision of pattern transfer". While she noted that most patterns shown in the texture library can be achieved through other means, realizing such textures—especially over large surfaces like in the case of a4, a5, c5, c6—are particularly tedious and time-consuming. In addition, she commented that resist slip-casting is most appropriate in cases like a4 and c5 due to the "continuously changing geometry throughout the pattern", which is challenging to create by hand.

Second, she highlighted that "the ability [of resist slip-casting] to easily create different patterns encourages the ceramicist to design unique patterns and prototype more efficiently without wasting molds or being limited to existing templates". To create precise textures, Genevieve currently embosses patterns with template molds such as textured silicone sheets that are applied with a rolling pin or by applying pressure on textured timber blocks placed on clay.

7 Applying Resist Slip-Casting

We furthered our exploration of the textures possible with resist slip-casting and applied it to a variety of prototypes for a range of contexts within interaction design and industrial design. Prototypes help to frame and explore a design space by *filtering* "qualities of interest" for designers to examine and develop, as well as *manifesting* ideas through materials into real world artifacts [26]. In our applications, we used prototypes as *filters* to understand the types of things that we might build from the textures we explored, paying particular attention to the design contexts that these textures draw us towards. Second, we used these prototypes as *manifestations* to understand how resist slip-casting ceramic textures participate in broader real-world contexts, such as by integrating with other components including sensing circuits and household fixtures.

7.1 MIDI Controller

The range of ceramic textures possible with resist slip-casting inspired us to develop a set of MIDI control panels that support different interactions with corresponding textures to match. These panels include a controller for play/pause, an octave keyboard, audio tuning sliders, and music sample selection (Figure 15).

The prototypes were all made from the same plaster mold with different mask patterns to demonstrate the customization capabilities of resist slip-casting. We used a mix of debossed and embossed lines to surface the play and pause buttons, reflecting their conventional symbols used in digital interface design. The octave keyboard made use of debossed lines to delineate each different key, while an area of bumps served to differentiate the natural keys for the sharps which are flat. For the audio tuning panel, we made gradient textures with line width, shape size, and shape density to indicate the directionality of functions such as volume control. We used a variety of patterns for the textures on the music sample panels. The

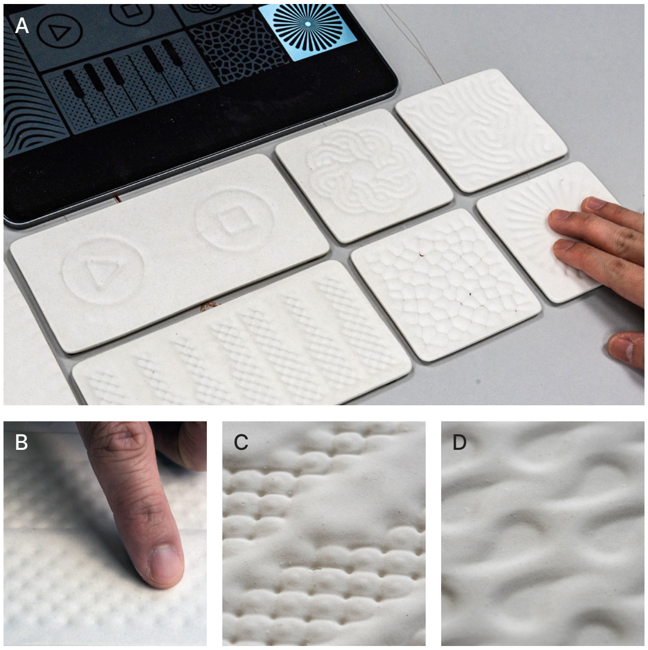

Figure 15: MIDI controller. A: Interactive ceramic tiles sensing human touch with textures providing both visual and tactile feedback. B: Gradient shape density indicates the direction when sliding a finger across the surface. C: Octave keyboard texture details, featuring debossed areas and bumps to indicate different keys. D: Example of a textured tile representing different music styles.

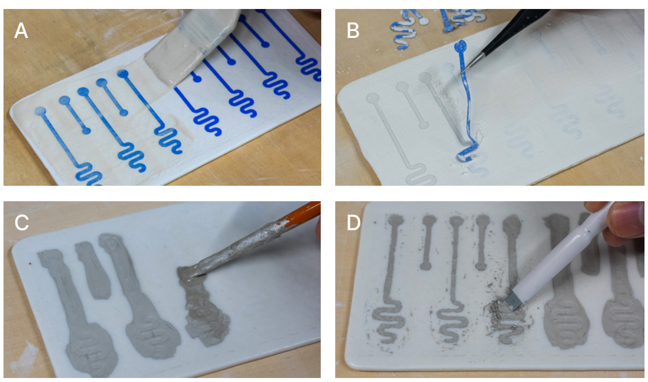

Figure 16: Process of incorporating circuits onto textured ceramic panels. A: Glaze is applied on the ceramic panel with vinyl stickers. B: Vinyl stickers are removed after the glaze dries and the rough unglazed areas are exposed. C: After glaze firing, conductive ink is painted onto the ceramic surface. D: Excess dried ink is scraped off the glossy glazed areas.

different textures qualitatively differentiate each sample, which we chose based on the music styles that they represent.

7.1.1 Incorporating Circuits. For this application, we also explored adding conductive traces to the underside of the ceramic panels for capacitive touch sensing (Figure 16). We extended the approach demonstrated in [43] and developed a different approach to create traces for conductive ink. First, we masked the back of the fired ceramic panel with vinyl stickers in the form of the circuits, and applied glaze to this masked surface. The vinyl was then removed and the piece fired. The unglazed areas of rough porcelain were therefore in the shape of the circuit traces and conductive paint can be easily applied to the rougher ceramic traces, while keeping off the smooth glaze.

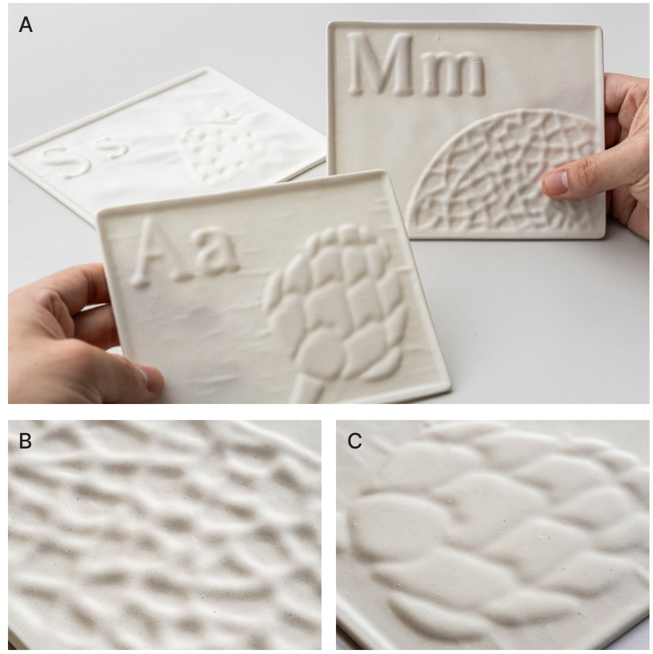

Figure 17: Three pages of the tactile graphic book that were made with the same mold. A: a pair of uppercase and lowercase letters as well as a corresponding fruit. B: Close-up of the netted surface textures of a melon. C: Close-up of the layered petal textures of an artichoke.

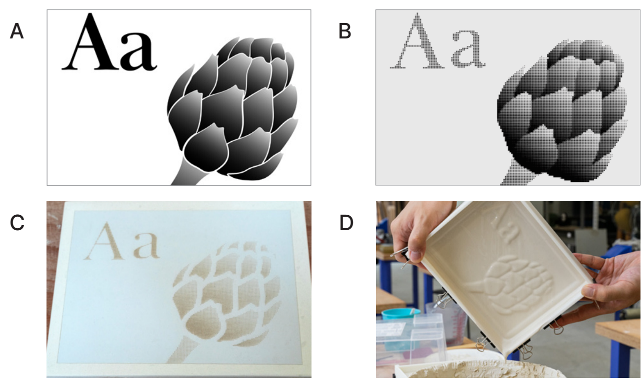

Figure 18: Snapshots of making a textured ceramic page. A: Grayscale image as input to grasshopper script. B: Generated hole pattern. C: Applying the laser cut paper mask to the mold. D: Resulting texture after draining the excess slip.

7.2 Tactile Graphic Book

Tactile graphics are an immediate way to apply the ceramic textures we explored. Such graphics support learning information through touch, and we were inspired by related work that used 3D printed textures to support learning for young children with visual impairments [29].

For this specific application, we adapted the content and graphics found in the book "Eating the Alphabet" [12] and designed three ceramic pages with textures that display a pair of uppercase and lowercase letters as well as a corresponding fruit (Figure 17). We

Figure 19: Holey Bowls: Circular hole pattern (left), Grid pattern (right).

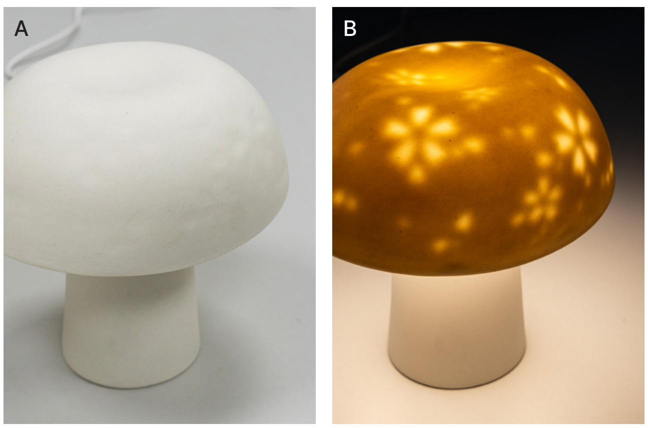

Figure 20: Sakura Lampshade. A: Unlit lampshade. B: Sakura petals emerge from illuminated lampshade.

chose fruits with distinct textures—the layered petals of an artichoke, the netted surface of a melon, and the dimpled skin of a strawberry.

We developed a generator in Grasshopper that takes a grayscale image as input and generates a patterned mask as output (Figure 18). To capture the texture gradients (such as for the petals of the artichoke), we made use of gradated perforations on the paper mask.

7.3 Home Products

We also explored creating 3D objects with resist slip-casting to showcase the potential of resist slip-casting beyond flat interfaces. For this series of applications, we drew from our background as industrial designers and focused on building products for the home. We made a two-part hemispherical plaster mold and used this same mold to customize a variety of textures for the objects fabricated in this section.

7.3.1 Holey Bowls. Fruit and vegetable colanders often feature holes for ventilation to maintain the freshness of the produce they hold. We used resist slip-casting to deliberately puncture the surface

Figure 21: Applying different masks on same bowl mold for different types of holes. A: Varying circles in vinyl. B: Varying rectangles in vinyl. C: Varying sakura petal shapes in paper.

of the clay bowl with hole patterns (Figure 19). The first bowl features an array of holes of different sizes that we manually placed onto the plaster mold (Figure 21A), while the second bowl features a grid-like pattern to mimic a woven basket (Figure 21B).

7.3.2 Sakura Lampshade. We were also inspired by delicate porcelain ware that can be shaped into vessels with translucent textures that show up with light. We made a decorative light that appears flat in the day, and light up to reveal decorative elements in the form of sakura flower petals that we adapted from CHI 2025's logo (Figure 20). To create this texture, we used paper masks for the pattern which forms a thin clay surface (Figure 21C). We also used a wet sponge to smooth the other surface to remove traces of the masks—exaggerating the transition between dark and bright states.

We kept the walls of these three dimensional objects as thin as possible to capture a visually light quality for the bowls (Figure 19) as well as to bring out a good contrast between bright and dark spots on the surface of the lampshade (Figure 20). However, we noticed that these thin walls were also prone to warping despite our multiple attempts at producing a consistent form, evident in the dimpled base of the hemispheres as well as their slightly eccentric rims. We discussed this issue with Genevieve, who highlighted the difficulty of producing thin walled ceramics—especially for novices. Our ceramics supplier also suggested that we could use a saggar (a type of kiln furniture) to distribute heat more evenly around the object. These insights reinforces our appreciation of the deep material and process knowledge embedded within ceramics craft that we should pursue—and balance—while applying the newer approach of resist slip-casting.

8 Discussion

As we reflect on our exploration in this research, we consider our evolving relationship with slip-casting, along with the materials

Figure 22: Genevieve making a textured ceramic cup. A: Creating textured ceramic slabs using resist slip-casting. B: Hand-shaping the textured ceramic slab into a cylinder form. C: Finished ceramic cup featuring intricate Voronoi texture.

and tools integral to this craft. In this section, we close the paper by discussing our insights around two broad themes: first, our perspective of resist slip-casting as a tool that serves both novices and experts alike; and second, our view of resist slip-casting as a creative and collaborative machine that entangles people, materials, and time.

8.1 Resist Slip-Casting as a Tool for Novices and Experts

As discussed in Section 2.2, we were inspired by the materiality of ceramics for HCI, particularly for tangible interfaces. We were keen to contribute to the growing body of fabrication work in this area and aimed to expand the expressiveness and functionality of interactive ceramic interfaces. As researchers with a background in industrial design, we were naturally drawn to the slip-casting process. Slip-casting offered a reliable way to fabricate ceramic objects, much like other molding processes commonly used in product design.

Resist slip-casting extended our perceived convenience of traditional slip-casting and gave us the ability to reliably create intricate physical textures on surfaces—a task that is non-trivial to achieve manually, even by a skilled ceramics crafter. As our expert collaborator, Genevieve affirmed this simplicity and the potential of resist slip-casting. She was particularly drawn to the non-uniform textures (e.g. the voronoi texture in Figure 13a4) made from resist slip-casting. She also valued the opportunity for customizing the process to create objects with unique, one-off textures with the same mold, therefore avoiding mold waste and the limitations imposed by using ready-made templates.

The artifacts we explored in Section 7 exemplify our use of resist slip-casting based on our investigations thus far. We relied heavily on the mold and the water-resistive properties of the masks, striving to create artifacts with as much defined by resist slip-casting as possible. However, we inadvertently encountered challenges inherent in the broader ceramic craft process—such as trimming, drying, and firing the cast objects—which as reflected earlier, presented numerous "risks" [36] to the outcomes we had envisioned. For example, trimming the edges of each hole in the Holey Bowl (Figure 7) required us to decide how much material to remove, while firing larger pieces in the kiln led to many warped outcomes.

This transformation of clay across multiple steps and material actions facilitated by the maker reinforces the iterative dialogue and mutual informing of design "image" and material, as described by Ingold as an unfolding process inherent in making [21]. These experiences, though challenging, deepened our appreciation for ceramics and craft in general. Trimming each individual hole in the Holey Bowl allowed us to control the softness of every edge in relation to the overall form, enabling us to intimately engage with the details on the bowl in pursuit of the "highly refined objects" that craft facilitates through "deep, embodied engagement" [13]. This was a texture that was not automatically developed through the resist slip-casting process, emphasizing the role of resist slip-casting as just one tool among the myriad of tools and processes that ceramicists might use in their practice. This insight was further cemented by our ongoing collaboration with Genevieve, who incorporated resist slip-casting into one of the objects she was developing as part of her exploration of walled ceramic forms (Figure 22). For this object, Genevieve employed resist slip-casting to make a slab that she then used to form a closed cylinder, deftly shaping the drying clay texture just as it reached the right hardness—combining resist slip-casting with slab pottery techniques to make more complex three dimensional forms.

8.2 Resist Slip-Casting as a Machine

Initially, we perceived slip-casting as a process capable of replicating ceramic forms—much like an injection molding machine producing the same part over again. In this view, our development of resist slip-casting transformed slip-casting from a machine for mass production into a "digital fabrication" machine that accepted reprogrammable input (the resistive masks) to produce unique outputs (the textured objects).

However, as we became more familiar with slip-casting and resist slip-casting, our relationship with the question of "what is a machine?" evolved significantly. The significance of our labor, the time-sensitive nature of the process, and the agency of materials, shifted our perspective towards viewing resist slip-casting as a system that assembles and aligns makers, materials, and processes into a productive and attentive relationship—"crafts-machine-ship" as argued by Andersen et al. [3]. In this section, we close this paper by reflecting on our evolving relationship with resist slip-casting as such a machine. To do so, we connect our earlier reflections on investigating traditional slip-casting and developing resist slip-casting—to the concepts laid out in crafts-machine-ship and other related theories from the HCI design community.

8.2.1 *Resist Slip-Casting as a Repertoire.*

HCI researchers have argued for a change in design activities in light of human's unsustainable impact on the world—one that decenters the human maker and instead considers the design of things and systems through the concerted effort of humans and non-human actors [41]. They suggest the development of *repertoires*, "actions that human designers can take to enable nonhuman participation in designing things" [34], in addressing the challenges of posthuman design.

In this research, we began to see resist slip-casting as the start of a possible repertoire within ceramics making practice. Across the course of our work, we shifted from seeing ourselves as designers who control fabrication processes, to appreciating resist slip-casting as a collaboration between us as "speaking subjects" and the "non-speaking subjects", including the equipment, tools, and materials involved, as well as the spaces and furniture that we occupied. Engaging with resist slip-casting often felt like a dance between these non-speaking things, where we acted as translators, moving things from one place or moment to another to facilitate the transformations from slip to clay to ceramic.

In particular, we realized that controlling the specific gravity of the slip alone was insufficient to ensure consistent castings. Factors such as how well the slip was mixed and sieved, how the slip was poured into the mold, or the humidity of the room and molds, all played active roles in the casting and drying process. This demanded our attention to material disturbances—subtle differences across iterations of the same process that we became more sensitive to with more experience—prompting us to recognize when it was time to move the materials along to the next step. More specifically, resist slip-casting required us to respond to the agency of the materials and amplified the significance of time throughout the process.

8.2.2 *Resist Slip-Casting as Materials with Agency.*

Resist slip-casting involves many materials agents working together as a system, including the "independent" materials of cast plaster, various types of masking stickers, and the slip itself. These materials interact to remove water—the "dependent" material in the slip-casting equation—from slip to form a clay body. As discussed in Section 4, the transformation of slip into clay textures through water-resistive masking is not a straightforward process. The omnidirectional water absorption of plaster introduces bleeding of the clay, creating gradients that affect the geometry of the clay formation around neighboring masks.

Moreover, these material are not just parts of a closed system that act upon each other, but are also agents that act upon us. Within resist slip-casting, the mask sticker is a critical agent that is transferred from cutting machine to plaster mold to clay body. We (as makers) perform this transfer and had to contend with the adhesive forces between different material agents as part of the larger process that enable (or disable) different textures to be generated by this material-maker system. "Crafts-machine-ship joins body and material, the self with the apparatus, and makes and remakes all those involved." [3] Our pursuit of new and better textures with resist slip-casting occurs not only in the design of new and better "inputs", but in our maturing negotiations as makers with the material agents at play.

Our experiments with resist slip-casted textures (Section 6) only begin to explore what is possible with this approach. We are excited by the potential to explore other material agents with resist slip-casting, such as different types of clay slips, varied geometries of plaster molds, and other masking materials, such as fabric or three-dimensional masks. We believe these variations will move the process in unexpected ways that will expand the possibilities of resist slip-casting and direct makers toward new design contexts and applications.

8.2.3 *Resist Slip-Casting and Temporality.*

"This feels like a seventeen-minute cast"—First Author

Time was the most salient aspect of our experience with resist slip-casting that helped surface the agency of the materials and tools that we were working with. Understanding the cadence of the process was critical to its success. Oogjes and Desjardins [33] emphasize the importance of "temporal attunement" in research-through-design, proposing a new vocabulary to articulate the diverse events and their qualities that contribute to generating knowledge and material insights during the design process. Within this vocabulary, the terms *other-time* and *encounters* resonated with our experiences in this research. *Other-time* refers to the "temporal lifeworlds of non-research actors and processes", while *encounters* refer to events where separate actors (human and non-human) come together.

Our experience with resist slip-casting can be characterized as a rhythm of long waiting periods for materials and processes to take shape (*other-time*), and rapid actions (*encounters*) governed by the agency of the materials at play. Long waiting periods for the clay body to form from slip were punctuated by intense bursts of activity: draining the excess slip rapidly to prevent further clay formation—but gently to avoid disturbing the wet clay surface. Even after draining excess slip, the wet clay continues to transform as moisture is drawn out by the plaster mold—marking another period of waiting. When the clay has sufficiently dried, we then cut and removing the excess clay walls to facilitate uniform drying and shrinking; and removing the clay body from the plaster when it is sufficiently hard (but not too hard) to avoid cracking due to variable shrinkage. There was then further waiting as the clay body dries out sufficiently for post-processing, and another period of waiting before kiln firing. The rhythm of waiting for *other-time* and engaging in *encounters* provided a reflective cycle between us as makers and the materials of the situation [38]. Waiting periods gave us space to reflect on how materials were responding to our past actions, and the growing anticipation towards our next encounter prepared us for future actions, as well as how we might respond to new challenges and surprises that might be revealed.

Resist slip-casting is capable of producing intricate textures on ceramic objects. When framed as a fabrication machine that accepts input and automates output, these temporal concerns can be seen as typical limitations that designers need to manage as part of the making process. However, more critically, attuning to the events along resist slip-casting informs our actions as makers, and has a strong bearing on the success (or failures) of outcomes. From the perspective of crafts-machine-ship, the temporal sensitivity of resist slip-casting is what cues us to the agency of the materials, shifting our relationship with materials from *working-on* to *working-with* them [22, 41].

In this sense, the temporality of resist slip-casting includes us as makers into an inextricable relationship with materials as one machine unit that shares autonomy—and responsibility—in terms of what we produce.

9 Conclusion

In this paper, we introduced resist slip-casting as an approach for creating customizable textured ceramic interfaces. By selectively masking areas of a plaster mold, we controlled water absorption during the slip-casting process, enabling the production of customizable textures on the resulting ceramic pieces.

We presented the resist slip-casting process and its expanding library of textures, including shapes, patterns, symbols, and text. Additionally, we outlined experiments with various mask materials, casting times, and patterns to support others in replicating and building upon this work. These experiments also demonstrate the versatility of the approach across different design contexts, such as tangible user interfaces and home products. Through this exploration, we reflected on the our evolving relationship with the materials we worked with, recognizing resist slip-casting not merely as a fabrication method, but as a machine that weaves the agency of both makers and materials in the pursuit of producing a successful outcome.

We hope this work contributes another approach to broaden the potential of physical materials for interaction design, and that our insights contribute to the broader discussion of crafts-machine-ship in HCI.

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