# Designing Computational Materiality: A Preliminary Study to Explore the Lived Experience with transTexture Lamp

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## ABSTRACT

This paper articulates the design, manufacturing, and deployment of transTexture, a digital lamp features dynamic changing textures and changeable lighting effects. We deployed transTexture in the homes of two domain expert participants in a preliminary study to explore how computational materiality of interaction can fit a changing everyday environment. We conducted two semi-structured interviews with domain expert participants at the beginning and end of the field study. Based on the lived experiences uncovered in our initial findings, we elaborate on two notions that


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describe types of user engagements with computational materiality: *coordination* and *transformation*. We conclude with lessons learned from our study that will guide our future research on computational materiality.


## KEYWORDS

Computational materiality; materiality experience; temporal form; textures; lights


**Figure 1: the transTexture Lamp**

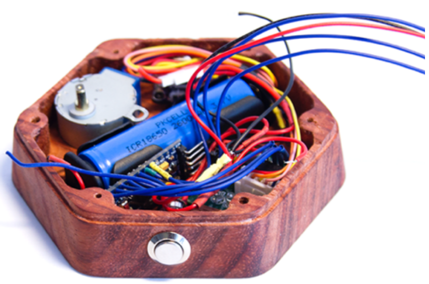

**Figure 2: Sensors and components are all embedded in transTexture**

## 1 INTRODUCTION

The growing application of interactive systems in the home provides a space for computers to intersect with a range of materials. Previous research, such as computational composites [10] and material-centered interaction [14], opened up a new agenda which was known as material turn [8]. This turn resulted in the exploration of digital materials [9] and immaterial materials [7] as resources in computational artifacts design.

Nevertheless, the composition of these materials result in the emerging of materiality, which pose challenges to HCI due to the complexity of computational materiality in interaction [13:p.119]. Pierce materialized one of immaterial materials (i.e. energy) through a digital design practice in order to support focal engagements at home [7]. Indeed, it is crucial for HCI community to have an in-depth understanding of the materiality experience in the context of everyday. In this study, we aim to contribute an understanding of how the materiality of an interactive system intersects with the unfolding contexts of everyday domestic life.

To deal with these issues, we designed and crafted transTexture (see Fig. 1), an interactive lamp that features changing textures and interactive lights. We deployed this research product [6] in two domain experts' homes for six weeks as a pilot study. The field research surfaced two types of user engagements with materiality: coordination and transformation.

This paper contributes to the HCI community with two main points. Firstly, it reports on experiences of living with an interactive lamp designed with computational materiality in mind. Secondly, based on the empirical data we contribute design considerations supporting future designers and researchers to understand the human-materiality relation and thus intentionally leverage materiality in interaction design and HCI.

## 2 BACKGROUND AND DESIGN RATIONALE

HCI community has a long history of exploring novel interfaces, spanning from graphic user interfaces (GUIs) to tangible user interfaces (TUIs). These studies aimed at enhancing interactivity of computing and unveiling a material turn [8] from metaphor representation to material manifestation [13:p.30]. Previous works recruited theoretical and practical methods elaborated on


**Figure 3: Seven alternative colours of Texture lamp**

the mechanisms of form-driven interaction [5], temporal-form of interaction [11], and material-centered interaction [15]. These explorations are mainly aimed at exploring how to develop methods for computational design through the lense of materials. Furthermore, strategies for materiality were also investigated in order to understand how to enhance the role of materiality in interaction design, like material probe [4]. In summary, the methodologies of material exploration and threads of materiality, and interaction inform our materiality experience study.

In transTexture, we selected lights and textures as two main features for three reasons: firstly, lights are used widely but also offer diverse material expressions (e.g., color, intensity, and saturation); secondly, we focus on the temporality (i.e. expressing temporal state actively [11]) of textures in order to generate a richer experience [11]; thirdly, the composition of lights and textures may bring possibilities to trigger various user engagements with the materiality, which could help us gather rich empirical data regarding human-materiality interaction.

The goal of the design was to manifest computational materiality through cumulative interaction and computing. Specifically, we intended to craft a temporal form [11] with textures, movement, and light changes to explore the lived experience of computational materiality. The design and manufacturing process of transTexture utilized computer-aided design (CAD), 3D printing, and computer-aided manufacturing (CAM) [12]. Arduino was used to design the varying scales of the controlling of textures. Sensors, such as an Arduino Pro mini, a stepper motor, a USB charger, a rotatory encoder, and a push-button switch, are all embedded in transTexture (see Fig. 2). Seven alternative colors and intensity range of lights can support a wide scope of purposes of use (see Fig. 3). One notable feature of this rechargeable and portable lamp is that multiple changing textures dynamically shape the fabric lampshade. These textures can be actuated by an electro-mechanical system (see Fig. 4).

## 3 PRELIMILARY DEPLOYMENT STUDY

Our preliminary study deployed transTexture in two design researchers' home for around six weeks. We consider our participants to be *domain expert* [3] since they have extensive related experiences in designing tangible user interfaces. Our aim was that this experience allowed them to more effectively gather in-depth insights into materiality experiences encompassing lights and textures. During each deployment, we conducted two semi-structured interviews for one hour for each at the beginning and the end of the study. Lastly, the participants were encouraged to report on their lived experiences with texts, photos, and videos through a WhatsApp group. Our two participants were (each of them is described with pseudonym): Vanessa (27) a design researcher with experience in designing tangible user interfaces and "hands-on" skills with sewing and knitting that make her familiar with the textures and patterns of textiles; and Emily (28) who has professional experience in designing interactive products and software engineering.

We adopted ground theory [1] as the method to analyze data which we already video recorded and transcribed. We utilized focused coding to synthesize the initial codes into potential categories. In what follows, we present our findings on how transTexture fits or "coordinates" with its surroundings and how the perceptions of materiality transformed through the cumulative

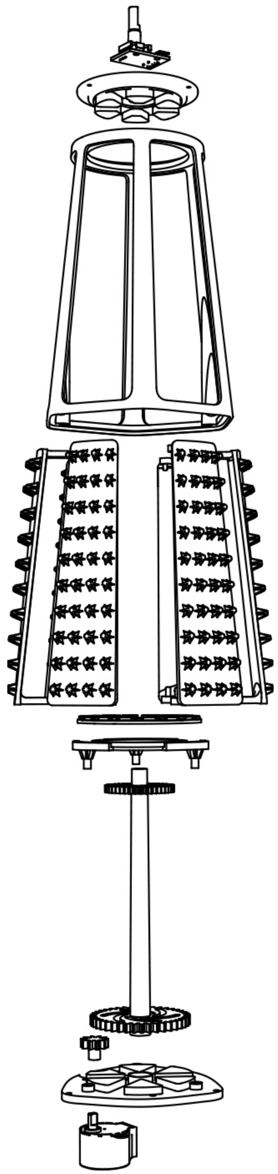

**Figure 4: The exploded view of electro-mechanical system.**

interactions and computing over time. We see in these insights guidance for our future research in computational materiality.

## 4 FINDINGS

### 4.1 Materiality coordination: between things and surroundings

The idea that digital artifacts like transTexture, can materially fit or adjust with its situated surroundings is what we call "coordination". Specifically, coordination unveils the interplay between materiality of the surroundings and computational materiality of transTexture through engaged interactions. Here is an example, Vanessa described how transTexture fit into her home (see Fig. 5 (a)): *"I like the yellow the best. ...because it fit with the sun through my window. Everything turned the same color. ...It fits my home".* Such coordination represents the flexibility of transTexture. This property enables transTexture to shift and adapt to the changing environments of everyday for those living with it. For example, Emily stated, *"l like the flexibility of lights. ...I can also change the location of transTexture to fit the environment".*

Material coordination also represents how transTexture becomes part of participants' everyday living over periods of time. For instance, Vanessa used transTexture as a functional lamp at the beginning of the study: *"I used it as a light lamp for a little bit".* Weeks later, transTexture turned to be a nonfunctional lamp for her: *"But I then got another one [light lamp]. ...So I would say that [transTexture] was a sort of lantern for me because it was portable".* In the process of use, transTexture faded into Vanessa's social activities as well as in this example from a party Vanessa hosted in her home: *"In the social context of a party event, transTexture wasn't a functional light. It was just put with other stuff. We were not trying to read something. It stayed there to provide atmosphere".* Coordination occurs as a ranger from direct interaction between transTexture and its surroundings, to the fading of transTexture into the background of participants' everyday lives (e.g., like the role music plays at a party).

In conclusion, *coordination* describes how transTexture faded into the surroundings in the home. Inspired by Odom et al's *ensemble* theory: "As intersections accumulate, qualities emerge that go beyond the individual artifact, often becoming experienced among an ensemble of things and people within their local environment" [5]. We argue that the term coordination highlights the intersection between computational materiality of transTexture and the constantly changing materiality of surroundings.

### 4.2 Materiality transformation: from action to interaction

We found that the computational materiality of transTexture was always in a dynamic state. Over time, this materiality gradually transforms during the process of participants' engagements. Such transformation may accumulatively happen from participants' initial actions towards transTexture. Vanessa: *"That was a funny moment, especially when they [her friends] turn it [transTexture] on and it moved. ...they played with this [textures] for a little bit".* Emily: *"They tried to touch the fabric to see how sharp the textures were".* The interactivity of transTexture made computing into an augmented material experience that is more dynamic than usual materiality.


**Figure 5: The transTexture lamp in: a) Vanessa and b) Emily's home**

Interestingly, the materiality of transTexture transformed through cumulative haptic interactions over long periods. Here is an example from Emily, the lampshade of transTexture accumulated residues from the constant touching, which created patterns on its surface: *"Overtime, the fabric became more and more dirty because I frequently touched it. ...maybe the dirty of the lampshade was the clue of my usage".* Such a transformation added a new layer of interactivity for transTexture, which was not part of the initial intent of the design. Instead, this transformation manifested during the long-term engagements and was first discovered by participants instead of designers, like the patterns on the textiles of jeans over months of use. Also, digital lights always shone through the spotted lampshade, which created unique shadow patterns in Emily's room: *"[Due to] the color of my table was dark, it made the textures and shadow of the lights clearer. ...the lights were the brightest at the first day. Over time, it became darker (see Fig. 5 (b))".* Such a transformation was caused by the projection of digital lights over time.

Collectively, *transformation* exhibits how the dynamic state of computational materiality changed over time. The concept of transformation is inspired by Wiberg, who states "how the materiality of interaction might change over time, depending on both the threads of interaction and the threads of computing" [13:p.136]. In this sense, the transformation of computational materiality manifest through textures' material change and the shadows created by the digital lights.

## 5 LESSONS LEARNED

### 5.1 Designing computational materiality

One important goal of this preliminary study is to explore how computational materiality can fit the changing environment of everyday. The field study showed the interrelation between transTexture and its situated surroundings through the notion of *coordination*. We learned from this finding ways to possibly extend our future designs of computational materiality. Firstly, the design outcome of computational materiality should provide open-ended space for engaged interaction. The word open-ended draws on the flexibility and adjustability of transTexture that we see in our findings. Secondly, encompassing the materiality of surroundings in design may enhance the materiality of coordination because computational things are constantly at interplay with their surroundings.

As the *transformation* of computational materiality emerged from cumulative interactions, we would like to further explore two aspects that can contribute to computational materiality design: firstly, enhancing the temporality (i.e. expressing temporal state actively) of material form in design can enrich the transformation of computational materiality (e.g., the initial haptic interaction with transTexture was stimulated from the form state change of transTexture). Secondly, the designed material form should support long-term interactions. For example, the transformation of transTexture was manifest through cumulative interactions over several weeks.

### 5.2 Rethinking our research question

Based on participants' engagements with transTexture for over six-weeks, and building on our preliminary findings of coordination and transformation, we plan to draw on Dourish's theory of embodied interaction [2] to investigate further the human-materiality relation within computational materiality. With this goal, we aim to rethink our research question in order to understand further how the manifestation of materiality embodies the engaged experience of transTexture in the context of everyday. We also aim to further explore the implications of potential findings for computational materiality design and research in HCI.

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