

# Material & Meaning in Tangible Interactions

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## Abstract

Tangible interactions have incorporated new materials into interaction design as well as new perspectives on how those materials can be made useful. The dissertation research I discuss in this paper examines materials and forms in terms of how they both mediate information but also can represent meanings in their own right. My work emphasizes these meanings as an important aspect of the experience of tangible interactions.

## Author Keywords

Materiality; Material Culture; Form; Experience

## ACM Classification Keywords

H.5.2 Information interfaces and presentation (e.g., HCI): User Interfaces – theory and methods

## Introduction

In the design of tangible interactions, it is materials that are used to give physical properties to computational devices. While these materials can be productively considered in terms of making systems more intuitive through affordances, there are also new concerns and opportunities that come with the introduction of new materials and forms [10]. Looking at such devices in terms of experience, it becomes increasingly important to consider how the different properties of materials contribute to experiential aspects of interaction.

Building off of my previous work, my dissertation will focus on materiality in HCI, specifically examining the material culture of the physical forms of computation, particularly in tangible interactions, as they pertain to concepts of quality, value, and meaning and how these affect user experience. Here I present an initial investigation—through the design and deployment of three critical de-

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signs—into how formal qualities of designs can be used to add new and possibly contradictory meanings to artifacts, as well as how users make sense of these elements. The goal of my work, both broadly and in the case described, is to *advance understanding of how the sensual aspects (that is, the aspects that can be seen, touched, smelled, or tasted) of tangible interactions affect the experience of both interacting and living with such devices*.

## Context and Motivation

In their seminal work on tangible interactions, Ishii and Ullmer describe Tangible User Interfaces (TUIs) as “an attempt to bridge the gap between cyberspace and the physical environment by making digital information (bits) tangible” [11]. This process emphasizes how physical objects can serve as both controls and representations of data. In this sense, materials can be seen as furthering the functioning of tangible interactions as well as serving as a medium for informational content. This functioning, however, may not be as clean as simply applying affordances to interaction – with physical materials giving the perception of interactions that may not be supported by the system they control [10]. Similarly looking at the relationship between materials and perceptions, Horn et al. describe the use of *cultural forms* – “social constructions or conventions that are linked to recurrent patterns of activity” [9]. Taking “form” as the “visual, physical, or temporal appearance of a design” [12], physical materials can be seen as related to the social constructions and conventions of cultural forms. Rather than trying to make devices that function transparently, such designs emphasize the “presence” of materials, forms, and the artifacts that they compose [8]. Such concerns are an important part of making computational devices that emphasize the creation of experiences in addition to the completion of tasks.

Materiality has been presented as a lens with which to examine digital devices [14, 2, 12]. Of particular relevance, Wiberg points to “material culture” as a means of examining “meaning” in interaction design: “While wholeness can be understood from a perspective that accounts for what something contains, the notion of meaning is about how this container is perceived and understood” [14]. More specifically, meaning here refers to “a subjective interpretation about qualities and values of a material artifact, in-

dicating how material artifacts are experienced and understood in personal and social life” [12]. Thus, material culture offers a means to examine the physical form of tangible interactions in terms of what that form itself means in terms of quality, value, and situation within a user’s life, giving materials a dual role as mediator and active participant in the experience of interaction [2]. My previous work examines the material culture of tangible interactions, including how medium-specificity can be used as a lens to examine material as a medium for informational content [4,5,6], how style makes meaningful connections between materials and values by connecting artifacts and their creators [7], and how functional forms can become stylistic as skeuomorphs, connecting artifacts across time [3]. Across this work, meaning and value relate material form, informational content, and function in interaction experience.

### Research Focus

Broadly, my work seeks to further investigate this question: *In what ways have tangible interactions come to propose a unique set of materials, meanings, and values over time, and how can these concepts be continued and challenged as part of a generative design process?* Unpacking that question, in addition to serving as functional controls and mediation of information content, materials and forms develop senses of value and meaning. My previous investigations have looked at how theories of medium-specificity and style can be useful for analyzing materials in terms of meaning. Moving beyond this, the next step is to explore how these theories can be applied to a generative design process.

### Research Goals and Approach

Drawing insight from the description of research through design as an approach to examining materiality in HCI [2], my approach to researching these issues of material culture is through constructive design research – “design research in which construction — be it product, system, space, or media — takes center place and becomes the key means in constructing knowledge” [13]. In short, my ambition is to create artifacts that both embody and confront concepts of value, quality, and meaning in tangible interactions and use them as a means to further develop these concepts through the reactions of others.

In addition to constructive design research as a general approach, the issue of meaning can be described in terms of interpretation [12]. With respect to this, I adopt a critical approach in my work, using critical design [1] as a specific form of constructive design research. This means that the artifacts created are not necessarily presented as a solution to a specific problem, but rather as a means of raising issues and initiating discussions surrounding tangible interactions.

### Critical Design for TEI Research

The three artifacts described here were created to critically examine the role of technology in self-tracking. In addition to tracking the activities of their users through photos and video, the forms of these artifacts were designed with particular attention to conveying meanings and experiences that could somehow augment or even contradict the function of tracking.

**The Candy Camera** (CC) is a candy machine that has been augmented to take pictures when candy is dispensed. The machine’s normal function – dispensing candy through the turn of a crank- has been augmented so that it causes a camera on top of the machine to capture an image, store it to a Raspberry Pi board in the base, and then push saved images to an LCD screen in the machine’s bowl. The formal aspects of the device are at once a reference to a nostalgic piece of Americana as well as a contradiction to the notion of transparency in the design of digital artifacts. The design’s form is predominantly based off of a Carousel gumball machine, reminiscent of the kinds of coin-operated candy machines common to the streets of mid twentieth century America. It is a kind of nostalgic kitsch – something so common that at its original time it faded into the background and now serves as a reminder of a bygone period. Digitally augmenting this device only serves to heighten this anachronism, particularly in the way that the camera, screen, and connective wires all are visible, but blended into the form of the design. The formal qualities of the machine, particularly its color and shape, not only refer to a bygone era, but also that era’s sense of what is fun and child-like. As a device that tracks users’ candy consumption through pictures, this approach contradicts the tendency of designing artifacts that emphasize function minimally in the name of transparency [4]. This design, then, can be seen as both modifying an odd object digitally, but also emphasizing form to enhance an enjoyable experience.

**The Melody Bot** (MB) takes video captured by a custom web camera and uses it to generate custom music videos. The custom camera connects to the user’s computer where video is analyzed and stored. Once enough video has been collected, the user can upload songs that the MB application analyzes and then combines with automatically cut video clips to make a custom music video. The MB application is, for the most part, very standard and based off of the GUI options that are a part of the Processing environment with which it is built. However, the physical component of the design - the web camera - more actively engages form. Similar to the Candy Camera, the web camera takes on a playful form – a three inch tall, stylized and cartoonish human form with the actual camera embedded in its television-shaped head. Clear epoxy resin makes the



**Figure 1** Candy Camera, Melody Bot , Fractured View

functional circuits of the web camera's PCB visible, using it as an aesthetic element, rather than something to be covered up. Unlike the Candy Camera, which takes an object and augments it digitally, this can be seen as emphasizing the “presence” [8] of the application. Instead of adding digital elements to a pre-existing object, this takes different elements of toy design to extend the application into the physical world.

**The Fractured View (FV)** is a camera that is activated by squeezing. Inside the custom cast latex shell, sensors detect when the device is squeezed, resulting in a camera capturing an image that is then distorted based on the strength and duration of that squeezing. The design is presented as a kind of stress ball that creates beautiful or exploded images when it is used. The form of the FV has less of a point of reference in trends of industrial design and more of a metaphoric relationship with its functioning. Given that the design “explodes” images, it was desirable to represent this explosive quality in the form as well. However, explosions frequently carry with them a connotation of destruction, which would emphasize only one particular facet of the designs use (destroying a photograph as opposed to making it different). An organic, plant-based form was chosen to represent this duality – the cracks in the surface representing either the internal destruction of the plant, or the bursting forth of a pod to disseminate seeds as a source of new life. In this case, natural metaphors of form situate the design in relation to concepts by means of connection to natural phenomena.

### Making the Designs Public

The designs were deployed into the field in six households for six months each. The designs were deployed in two pairs – the CC and MB for three households and the CC and FV for three. This was done to encourage greater engagement with the theme of self-tracking while avoiding taking up too many USB ports on the participant's computers. Data was collected through monthly, unstructured interviews, culminating in a final structured interview after the sixth month.

For the households that received the CC and MB, the designs were frequently described in terms of fun over functionality. Speaking to the MB, Leslie, a middle-aged administrator and photographer who shares her home with her teenage son remarked: *I thought it was kind of interesting. It made it more interesting to be on the computer and have the little bot, like, looking at me.* While playful, there was also an element of simplicity conveyed by the forms of the designs as Kelly, an early 30s interaction designer who shares a household with her husband Andrew, points out: *I think it appears more child-like in nature, both devices actually.* This perceived simplicity carried over to the functioning of the design. For Leslie, this meant that the MB would best be used to capture happy memories rather than simply tracking activity at her computer. Sarah, an early 30s student who shares a household with her husband Dale, on the other hand used it as a tracking system but found it limited: *I'm hoping that the camera sitting there will make me more productive. I almost wish that as soon as the computer turned on the camera would automatically start capturing image. I feel like it would be more of an accountability tool for me.* What is perhaps most interesting about this response is the desire to have less control. Its presence was sufficient to serve as a reminder, but giving it greater autonomy, as if the computer were actually a person watching, is presented here as being something desirable rather than detrimental.

For the households that received the CC and FV, a different relationships between the designs emerged. For Jessica a single mother and administrator, the devices fell along the lines of good and evil with their forms disguising their true intentions – *that [CC] looks friendly and playful but I think that's evil and that [FV] looks evil but its actually friendly and playful.* For Jessica the form and functionality of the designs are a mismatch, but not accidentally. Rather, the designs are evaluated as good or evil because of an attempt to make something undesirable – loss of control of the photo – seem fun in the CC, while the FV conceals a fun activity within an off-putting form. Similarly, Jack, a mid thirties freelance designer and office manager who

shares a household with his wife Laura and their three children saw the FV and CC as playing off each other – *one [CC] takes a nice clear picture and gives us candy when we turn the crank. It's already setup and plugged in. The other one, the Fractured View, you have to interact with it longer and the more, the longer you interact with it, the worse the image gets. Or maybe the more fractured it gets.* Rather than speaking to the form of the device itself, here the form of the information captured, the photos as a medium, are compared with the CC's images and accompanying candy serving as a reward, and the destruction of the FV's image a kind of punishment for interaction. For Ben, a writer in his 60s who lives with his wife Karen, the comparison was subtler: *think about the tiny screen on the Candy Camera—who can use something that small... the Fractured View images are way cool, but I don't really care.* Neither design fulfilled a functional need for Ben, but in spite of this there still was an emphasis on the strange-looking Fractured View as being fun and cool. In these cases, it's not only the forms, but the informational content and function of the designs getting compared. However, as especially notable in Jessica's response, no single one of these elements is deterministic, rather they all, to varying degrees, affect the experience of interaction.

## Conclusion

Responses to these designs varied regarding value and meaning across participants, but they are unified in how interpretations were made in reference to prior designs and, when those were insufficient for making connections, across the deployed designs themselves. New uses of materials became situated through these connections and how forms reinforce or confront expectations. Moving forward, I will continue to examine this process of meaning-making through (dis)connection in terms of how it can be applied to generate new design forms. As TEI examines the use of novel materials in the construction of interactions, in terms of function and cultural situation, such an understanding becomes increasingly important to the creation of new experiences of using and living with tangible interactions.

As an attendee of this consortium, I will benefit from feedback from senior TEI researchers and fellow students as I continue from the substantive theoretical foundations developed in my qualifying exam into the development of my dissertation research project. Additionally, I hope to explore the practical issues of combining theory and practice in TEI with consortium attendees. In return, I offer the consortium attendees my experience in bringing together critical and social science methods and my theoretical background in art and media theory as it pertains to tangible interactions.

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