Philosophers Living with the Tilting Bowl

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ABSTRACT

This paper reports on a postphenomenological inquiry of six trained philosophers, who as study participants lived with and reflected on a research product we designed known as the Tilting Bowl: a ceramic bowl that unpredictably but gently tilts multiple times daily. The Tilting Bowl is a *counterfactual artifact* that is designed specifically for this study as part of a *material speculation* approach to design research. A postphenomenological inquiry looks to describe and analyze accounts of relationships between humans and technological artifacts, and how each mutually shapes the other through mediations that form the human subjectivity and objectivity of any given situation. This paper contributes an empirical account and analysis of the relations that emerged (background and alterity) and the relativistic views that co-constitute the philosophers, Tilting Bowl, and their specific worlds. The findings demonstrate the relevance of this philosophical framing to fundamentally and broadly understand how people engage digital artifacts.

Author Keywords

Material Speculation, Co-speculation, Postphenomenology

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous;

INTRODUCTION

This research empirically investigates through design research the phenomena and implications of technological mediations that emerge in living with digital artifacts. In our view, detailed descriptions and analytical accounts of the relations, perceptions, and ethical questions raised by philosophies of technology, in particular postphenomenology, will better enable HCI and design researchers to deeper understand how the technological artifacts we make play a pivotal role in the co-construction and mediation of our everyday experiences.

In this study, we deployed concurrently for three months, a *counterfactual artifact* we refer to as the Tilting Bowl,

Figure 1 The Tilting Bowl

among the households of six trained philosophers. The Tilting Bowl is a ceramic bowl that unpredictably but gently tilts multiple times daily. The study draws on a form of design research we refer to as *material speculation* [41]. In material speculations, artifacts are designed to be lived with over long periods and are crafted to embody research questions or propositions through what we call counterfactual artifacts. A counterfactual artifact is a fully realized functioning product or system that intentionally contradicts what would normally be considered logical to create given the norms of design and design products, like a tilting bowl. This countering of norms, opens the possibilities to empirically investigate multiple alternative existences (or what-ifs) as lived-with realities of the counterfactual artifacts. Here we propose that experiencing the alternative existence of a Tilting Bowl, surfaces desirable, nuanced, complex, and even confounding relations with digital artifacts other than those characterized as use, functional, or emotional.

In addition to our material speculation approach, we recruited trained philosophers who have the competencies (e.g. critical thinking, ethical training, philosophical vocabulary, etc.) to help us speculate, reveal, and describe human-technology relations with the Tilting Bowl. We believe speculation of this nature requires the bringing together of lived-with experiences and philosophical work. We refer to this additional methodological approach as *co-speculation*. Co-speculation is the recruiting and participation of study participants who are well positioned to actively and knowingly speculate with us in our inquiry in ways that we cannot alone. This approach aligns with increasing interest to involve study participants in shared speculations in design research (e.g. [5,8,42]).

Digital technologies integrate with almost all aspects of our lives. As a consequence, our social relationships and views of reality are co-shaped or mediated by digital technologies that invariably take on ethical, political, and cultural dimensions. To overlook, misunderstand, or simply ignore these relations would risk impoverishing our experiences, agency and creativity with respect to constructing an everyday world we value. In order to address these matters, we need to enlist and develop new ways to conceptualize and analyze the things we make in HCI.

A strand of philosophy of technology, postphenomenology, understands technologies as mediators of human experiences and practices, rather than functional and instrumental objects [16,31,34]. In simple terms, postphenomenology views the relationships between humans and technological artifacts as mutually shaping each other through mediations that form the human subjectivity and objectivity of any given situation. Design is bound up in this understanding, since digital technologies do not come to us in a *"raw"* form but in a *designed* form. Designed artifacts manifest technologies and directly influence the mediation of our experiences and practices.

An overarching aim is to further open a dialogue between philosophies like postphenomenology and HCI since they are in many ways complementary (see for example [37]). Postphenomenology brings to HCI an epistemological orientation, concepts, and concerns not traditionally considered in analyzing and designing interactive artifacts. This affords HCI researchers a powerful and complex view of the deeply fundamental role technologies and humans play for each other. In turn, as we hope to demonstrate in this paper, HCI brings to postphenomenology the opportunity to proactively design artifacts tuned to a postphenomenological inquiry. Further, HCI research offers powerful and innovative empirical methods and techniques that provide concrete and rich material for analysis that can potentially refine and shift postphenomenological thought.

This paper contributes an empirical and reflexive account of technological mediations with a counterfactual artifact, the Tilting Bowl. It analyses and reflects specifically on the human-technology relations that emerged and postphenomenological accounts of the Tilting Bowl that maintain a relational ontology orientation. Additionally, it contributes an "argument by example" for the value and use of philosophical concepts and concerns for considering artifacts and systems in HCI. Lastly, it offers an approach to do the work of philosophy within HCI through the use of co-speculation as an augmented approach to material speculation.

BACKGROUND

In providing a background for the Tilting Bowl study we discuss philosophy in HCI and more specifically, related HCI research that considers philosophies of technology including postphenomenology.

Philosophy and HCI

In recent discussions within both interaction design research and practice, we see a growing need to integrate philosophical perspectives. In large part, the aim is to articulate deeper ways of understanding how technology fundamentally shapes people's lives, practices, and behaviors over time, beyond surface level needs and desires. HCI researchers have called upon theoretical and analytical perspectives for some time now, including hermeneutics and cybernetics [46], pragmatism and postmodernism [4], phenomenology [7], and pragmatism [19]. These inquiries generally aim to better understand the experiences of technologies and design, the implications they hold, and future directions in HCI. The particulars of each argument are substantive and have deeply informed and positively influenced HCI research with new epistemological concepts from which to act; and given HCI researchers new questions to investigate. There is however, more to draw on from philosophical perspectives, particularly those that are extant and actively evolving in our present-day academic discussions. Even more so, in certain cases, HCI can be an important partner to contemporary philosophical inquiry.

Philosophies of technology and HCI

Drawing on the philosophies of technology such as those of Ihde, Verbeek, Borgmann, and Latour [1,15,18,36] is not new to HCI research (see for example [9]). Postphenomenology specifically has been used mostly as an analytical lens such as Fallman's argument for new values in HCI [10]. Research like Odom et al. [20] describes attachment as a key factor in human-technology relations for future design implementations. Wiltse and Stolterman [44] use a postphenomenological framework to analyze the interaction architectures of instant messaging and file sharing revealing how these interactive spaces mediate human activity. Pierce and Paulos [26–28] aim to describe the materializing of technologies and its implications from the material awareness of everyday things to embodied relations within technologies. Furthermore, concepts like personal informatics [24] have been analytically reexamined through the utilization of a postphenomenological framework to discuss the changing agency of users. More broadly, Tromp et al. [33], reflect on the social consequences of mediated relations and argue that designers should make more informed decisions to design for socially responsible behavior.

In previous work, we have drawn on postphenomenology and investigated the ontological gap between humans and things in thing-oriented inquiries [42], social practices [39], and the representation of things from a postphenomenological perspective [25]. Our investigation in this paper shares similar concerns and starting points as those discussed above however dramatically take a different turn by framing the inquiry as a design driven philosophical inquiry.

THE TILTING BOWL

We produced six identical versions (five were used in this study) of the Tilting Bowl for long-term deployments in people's homes. The Tilting Bowl is similar to any other ceramic bowl in that it is food safe and washable, but it cannot be used in a microwave or washed in a dishwasher. The battery lasts seven to nine months on a single charge so the Tilting Bowls required no charging during the study.

The tilting of the Tilting Bowl is of varying degrees raising the artifact by as much as 9.5-millimetres or hardly at all. A small wheel is attached offset from its center to a motor (see motor assembly in Figure 2 (right)). The motor rotates at varying fractions of turns or duration each time it activates. The combination of the time of rotation and varying distances from the outside rim of the wheel to the motor shaft determines the height and amount of tilt each time. Over time there are enough opportunities to see the Tilting Bowl tilt but more often than not the experience is of hearing the motor and noticing the tilt after the fact.

The form of the Tilting Bowl is a ceramic double-walled, multifaceted surface. The form was designed through a lengthy series of prototypes and iterations utilizing cardboard and paper prototyping, 3D printing, CNC, and laser cutting. We fabricated the final form in ceramic earthenware in two separate pieces that were slip cast separately and joined together, bisque and glaze fired. For details on the making of the Tilting Bowl see [40]. On the bottom of the Tilting Bowl is an MDF plate (oiled with butcher block oil to protect it) that houses the motor and electronics (see Figure 2). The design is composed of a single microcontroller (Attiny 84) and a motor driver (DRV8835) embedded on a custom CNC milled circuit board. The motor driver controls the DC motor that is attached to the wheel. The entire system is powered by two lithium polymer batteries. To optimize battery life, the processor is put to sleep and effectively cuts power to the motor driver. An algorithm governs the frequency of tilting by generating a range for each sleep cycle with a 15 percent chance of the motor activating when the circuit wakes, causing the Tilting Bowl to tilt. Similarly, the length of each motor rotation is determined as a matter of probability.

We were motivated in the design of the Tilting Bowl for it to be a vastly familiar and mundane object like a bowl, that unquestionably is part of everyday life. At the same time, we aimed through digital technologies to make the bowl

Figure 2 (l) Tilting Bowl underside and (r) motor assembly

unfamiliar, challenging expectations and assumed roles, however in such a way as not to overshadow its familiarity. This approach to defamiliarizing was with the intention of making it simultaneously familiar and strange, and therefore best open to reflection and analysis of the particularities of non-normative perceptions of human-technology relations and qualities of experience. To support these aims and in keeping with a counterfactual artifact [41] and research product [23], we crafted the Tilting Bowl with a great deal of purpose and quality so it would fit with and be robust enough for everyday settings over time. Additionally, we drew on ideas of unawareness [22], and unselfconscious interaction [38] to guide the design in which the artifact required no human attention nor user interface to function, and the Tilting Bowl suggested more incremental engagements or *intersections* rather than explicit interaction. Furthermore, it could easily become a part of ad hoc and changing configurations in a home with other objects in what is referred to as *ensembles* [22,38]. In these respects, the Tilting Bowl was designed specifically to inquire through lived-with experience into the types and qualities of relationships beyond use and functionality that may emerge.

BRIEF OVERVIEW OF POSTPHENOMENOLOGY

We now turn to the theoretical context for this research by describing the important concepts of postphenomenology that we utilize in our study.

Background and commitments

There is no one postphenomenological approach rather it can be seen as an ongoing and related discourse and theoretical articulations that share much in common [16,32,36]. Further, these varying positions draw on phenomenology's prioritizing of the concreteness of human experience yet postphenomenology differs fundamentally from phenomenology in how it conceptualizes the role of technology. Postphenomenology also draws on and is related to a range of philosophies and studies of technology including Winner [45], Ihde [15], Borgmann[1], Feenberg [11] and Latour [18]. In this context, a critical position of postphenomenology is its critique of either separating humans from or conflating with technology [16,31,34].

Postphenomenologists offer an alternative to two prevailing interpretations of technology. One interpretation sees technologies as extensions of humans, as tools or instruments that allow people to do specific actions. In this approach, technology is seen as a facilitator of human actions. This interpretation represents prevailing notions in interaction design of technology as a neutral or near neutral extension of human agency. This interpretation assumes a socializing hold over technologies. At the other end of the spectrum is the dialectic approach that sees humans and technologies in opposition. Here, the relations between humans and technology are approached as humans having to free themselves of enslaving and alienating forces of technology. Postphenomenology presents an alternative to
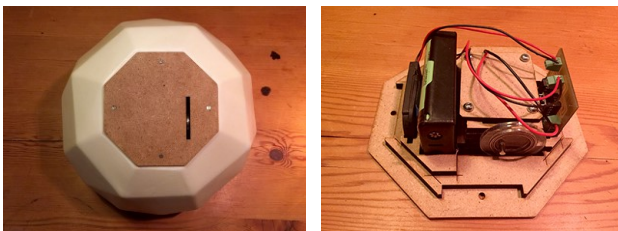
these interpretations that is a hybrid approach that considers humans and technology as inseparable and intertwined.

Postphenomenological concepts in our study
Within postphenomenology, technological actors and human actors are not considered as separate though they are distinct: they co-shape reality [34:28]. In other words, technologies are mediators of human-world relationships. That is, in a hybrid constellation technologies and humans co-constitute subjectivity and objectivity in any given situation. Humans (subject) and the world (object) are not pre-given entities, but constitute each other in the technologically mediated relations that exist between them [34]. In our study, this offers a *relational ontology* in which the Tilting Bowl and the philosopher participant need to be viewed as mutually constituted within lived-with situations. We explore these concepts in detail in our analysis.

A second key concept in postphenomenology is the idea of different structures of human-technology relations. This concept argues that we establish a range of bodily-perceptual relationships with technologies that can be described as *embodiment*, *alterity*, *hermeneutic*, or as a *background* relation [15,37]. *Embodiment* refers to when the world or reality is experienced through means of a technology such as when seeing through glasses or a telescope. A *hermeneutic* relation describes when part of reality is revealed through the interpretation of a technology as in the case of a thermometer or a clock being read and interpreted through a known system. *Alterity* relations are at play when humans interact with a technology through its presence or in a dialogue similar to another human as it is the case when using an ATM machine. The *background* relation happens in cases where technologies become partly absent or part of the background and from there shape our experiences often without being noticed as is the case with a refrigerator or heating system. This framing offers a richer and multi-dimensional conceptualization that goes beyond "interaction" as a description for how humans relate to computing. In our study, the background and alterity relations were the most prominent between the philosophers and the Tilting Bowl.

OUR STUDY
We deployed the Tilting Bowl for approximately three months (the shortest duration was 10 weeks and the longest was 15 weeks) with six trained philosophers in five households. During the course of the study, we conducted 1-2 hour semi-structured interviews at the four-week and eight week points in the study. Most interviews took place in the homes of the philosophers, one philosopher was interviewed over Skype. At the 10-12 week point of the study we presented participants with 4 questions for a written response. The questions were cumulative in nature in that the week 8 questions were shaped by responses to the week 4 interview answers, and the 10-12 week written questions responded to week 8 interview answers. Additionally, each set of written questions were tailored to

comments and concerns of each trained philosopher that arose over the course of the study, while the interview questions were largely the same for each. Lastly, we asked our participants to self-report their experiences and answer follow-up questions through messages and photos in either a private Facebook group or a WhatsApp group chat. This garnered for analysis approximately 9 hours of verbal interviews, 7000 words of written answers, 40 self-reported and researchers' photos, and researchers' notes after each interview and site visit.

The living situations of the trained philosophers in the study varied. Two participants lived together in a short-term rental until the end of the study and one participant lived in two different house sharing arrangements. Similarly, one participant lived with his parents before leaving abroad to graduate school after the end of the study, and two participants lived in their own apartments of which they lived in for more than a year and continued to live in after the study. Participants lived in urban, suburban, and rural regions in Western Canada. Below is a brief summary of each trained philosopher in the study (all participants are given pseudonyms):

Johanna A (40) is trained in hermeneutic phenomenology and its application to studying anxiety and depression among youth diagnosed with cancer. Her philosophical training was part of her doctoral research in social work.

Desmond C (24) holds a Bachelor's degree in political philosophy and is interested in consent, rationality, and agency in a liberal. During the study, Desmond lived with another philosopher in our study (William F) and a third roommate who did not participate in the study.

William F (26) holds a Bachelor's degree in political philosophy and is interested in the ethics of care and the provision of apology informed by feminist ethics, as well as classical liberal and neo-liberal philosophies.

Brenda D (35) holds a PhD in philosophy and is a faculty member in a university in Western Canada. Her research is in ethics and collective action programs with prior work in bio-ethics and in particular, vaccination policies, as well as theoretical questions concerning cooperation and morality.

Franklin J (22) holds a Bachelor's degree in analytic philosophy and is interested in the philosophies of law and language. During the course of the study, Franklin lived in a with his parents and younger brother. Franklin's father, Mark participated fully in the study but since he is not a trained philosopher we did not include his data directly in this analysis and findings.

John R (30) holds a Bachelor's degree in political philosophy and philosophy of religion, and is interested in metaphysics and ethics. During the study John lived with his partner Alanna in two sequential house sharing arrangements.

We recruited participants through a variety of means including public postings on craigslist, Facebook groups, and philosophy related groups at different local universities and colleges. Our recruitment criteria included completed formal training in philosophy at the undergraduate level with an ongoing engagement with philosophy through work or graduate studies (e.g. half our participants pursued a graduate degree after the study). We did not select participants based on philosophical sub-disciplines or branches. Our concern was that they have philosophical training in different philosophical backgrounds and vocabularies, critical thinking and analysis, logical argumentation, and ethical reasoning. The diverse backgrounds and philosophical viewpoints may expose our study to being less tailored to a postphenomenological inquiry yet the diversity allowed for challenging of our assumptions in postphenomenology and opened the study to wider philosophical concerns and concepts.

During recruitment, we explained that we were asking them as philosophically trained participants to be active co-speculators with us while living with the Tilting Bowl. At the start of each study we explained how our material speculation study was an inquiry into design and postphenomenology. We gave a brief introduction to postphenomenology and the philosophies of technology more generally and provided a written description of the study and our research questions.

We utilized constructivist grounded theory to analyze our data [3]. Accordingly, our data analysis progressed from open coding (open ended with no analytical categories), followed by axial coding (to identify relations between data as emerging categories), and finally selective or theoretical coding (development of emergent concepts and related extant concepts) that we performed collectively. We adapted grounded theory so that each interview stage was informed by previous participants' answers, thus making the development of the interview questions part of the open and axial coding. This interaction between researchers and participants emphasizes the dialogue of co-speculation that we sought.

LIVING AND WORKING WITH THE TILTING BOWL

Central to our co-speculative approach, we asked our trained philosophers to live with the Tilting Bowl in their own homes during the study. This follows the empirical commitments of postphenomenology and furthermore ensures that the philosophical reflections and analyses are grounded in the everyday and felt experiences of the Tilting Bowl. Separating the Tilting Bowl from the ongoing experiences of daily living with it, the philosophers singled out the counterfactual artifact for attention with differing frequency and quality over time. More explicitly, the Tilting Bowl received a degree of special attention that we saw as philosophical work. We detail each of these aspects below.

The Tilting Bowl in the different households

Throughout the philosopher households, the Tilting Bowl remained on tables or counters in living, dining, kitchen, or study areas. For the most part, the philosophers considered the placing of the Tilting Bowl in practical and aesthetic terms as to how it best fit in the home. In certain cases, the placement of the Tilting Bowl reflected a concern for the philosophical work (and opportunity to see it tilt) or practicalities such as available space in the home. For example, Desmond and William found it best in the most communal area of the apartment because of the many discussions it created; or John moved it to the kitchen table so he could actively reflect on it over his morning coffee. On occasion the Tilting Bowl was moved, for either practical reasons of making space, carrying food to a party, or simply trying to find a place in the home it fit best. As one might expect, our co-speculators also accepted the functionality of the Tilting Bowl and put a variety of things in it, including fruit, bread, and various other small items that typically find their way into a bowl in a home.

The attention garnered by the Tilting Bowl

As a new and counterfactual artifact in the home, the Tilting Bowl garnered a fair amount of attention from the philosophers at the outset of the study. Two households described the Tilting Bowl as a "conversation starter", either amongst themselves or with guests. The amount and quality of attention naturally varied between the participants but all reported that it began to receive less attention after the first four to five weeks.

Even as the attention received by the Tilting Bowl waned, it was still seen as a unique matter in the home. That the Tilting Bowl independently tilted at random times affected the philosophers in different ways. For Desmond, the fact that The Tilting Bowl would tilt in his absence or while sleeping without consent caused anxiety: "*if I wasn't aware of its movement and I showed up and it's in a different*
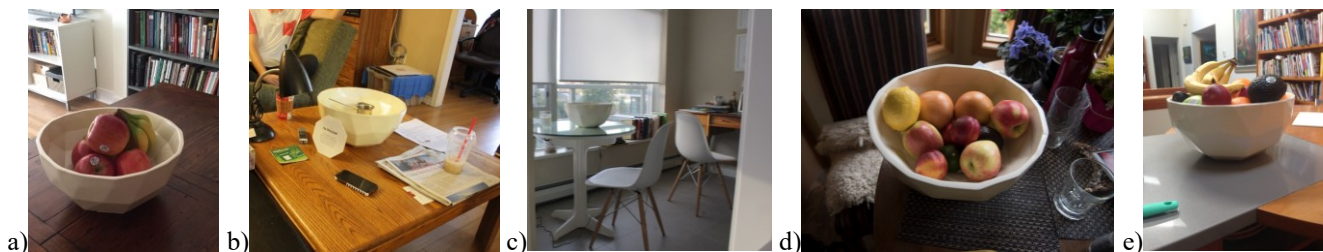
Figure 3 The tilting bowl in Brenda's (a), Desmond and William's (b), Johanna's (c), John's (d), and (e) Franklin's home

position that's kind of creepy."

Johanna maintained a dramatically more positive experience. She saw her relationship with the Tilting Bowl as a matter of "mutual respect". As she reported "*I live with the bowl, as opposed to trying to figure out its utility*." The tilting of the artifact contributed to how she continued to attend to the Tilting Bowl: "*I'm curious to see it tilt…I mean I do look at it quite a lot*" and when she returns to her apartment she "*intentionally goes to see if it's doing anything.*" In the first four weeks John mentioned he "*never had a bowl take this much attention.*" Even as the attention diminished, it did not become a typical bowl: "*it still I think holds more focus than just a normal fruit bowl would. There's still something else there but it's not the constant like checking it that it was before.*"

A noted exception was Brenda who expected she would give significantly more attention to the counterfactual artifact: "*I tend to anthropomorphize things and you know, get really attached to them, so I kind of expected that I would, you know, name the bowl and talk to the bowl…But…I don't even think about it*". Even the tilting of the Tilting Bowl failed to get much attention as she saw it as "frivolous". She expressed interest in keeping the Tilting Bowl if we would let her but she would have the tilting mechanism removed. Interestingly, as we discuss later, Brenda did not see the Tilting Bowl as a philosophical matter in any way.

Philosophical work with the Tilting Bowl
On occasion, this curiosity with the tilting of the Tilting Bowl took on a more explicit, even experimental form that resulted in testing for the tilt of the counterfactual artifact. For example, Desmond and William put a small metallic pot in the Tilting Bowl so that if it tilted, the pot would move and make a sound. For added measure, they leaned a piece of paper against it that would tip over (see Figure 3(b)). John surveilled the Tilting Bowl by creating a pyramid of oranges in it that would tumble when tilted. This explicit work with the Tilting Bowl extended to more abstract concerns that were less experimental and more actively reflective in what John referred to as his "philosophical work".

John compared his reflections, encounters, and engagement with the Tilting Bowl to writing a philosophical essay. He describes his process as dialectic: "*I didn't come with the one, the one sort of theory and then just sit on it. You know, you have the one theory and then you live with it a little bit more and then you think a little bit more about it and then, you know. Critique, better idea, critique, better idea, you know. The classic dialectic conversation with oneself.*"

Franklin and Johanna often applied their philosophical training in their reflections of the Tilting Bowl. For example, in response to our question of which features of the Tilting Bowl is most prominent between the features of tilting, functionality, aesthetics, and materials; Johanna

responded by critiquing the reductivist nature of the question: "*I'm going to sound really Husserlian here, but like I think that doesn't capture the essence of the bowl. I think when we break apart the bowl in those items…you're missing what it is, right?*" She continued to discuss the presence and her relationship to the Tilting Bowl in hermeneutic terms (of which she is trained in): "*could be quite hermeneutic. Is that it, yeah presence, an aspect that might have been otherwise unseen. And you're actively interpreting what you're seeing, which is certainly what this is, I think.*"

Similarly, Franklin explicitly applied his philosophical training in his interview answers. For example, in one instance he carefully navigated around a discussion with us of ethics in relation to intentionality with the Tilting Bowl. He put the matter of ethical concerns manifest as care into stark contrast by comparing our duties to other humans with that of a non-human entity like the Tilting Bowl.

As we noted earlier, Brenda did not view the Tilting Bowl as a philosophical matter. She described herself as being ill equipped to say anything meaningful about the bowl: "*This kind of reflection isn't part of my skillset.*" Stating that those trained in cultural or literary studies would be better able to reflect on artifacts.

There were many times during the study, our participants found themselves explaining the Tilting Bowl to house guests, co-workers, friends, and family. In many respects, these actions objectify the Tilting Bowl in having to consider how someone else might view it. This in turn helped with their own thinking on the artifact. For example, John considered these descriptions to others as a way to work through his own thoughts: "*I've found that trying to explain it to other people has allowed me to sort of work through it more.*" Johanna describes how over time she became more confident in expressing her perspective of living with the Tilting Bowl: "*Yeah, I think a bit more confident… I'm assuming and giving it some identity in how I'm talking about it….*"

Summary of Living with the Tilting Bowl
In summary, living with the Tilting Bowl became an entanglement between philosophical work and the goings on of everyday life. Many issues were raised that we could consider philosophical matters related to the experiences of the Tilting Bowl. In our view, these matters would not have emerged in the ways they did, other than through the embodied experiences of the Tilting Bowl. Our participants are hybridized in the sense that they hold felt experiences from the day-to-day living with our counterfactual artifact while they are also skilled in active reflection, analysis, and expression of philosophical work. Postphenomenology asserts these embodied empirical investigations as the means to conduct inquiries [34]. With this in mind, we now turn to the explicit work of what our study revealed with respect to postphenomenology.

POSTPHENOMENOLOGICAL ANALYSIS
We first provide an analysis of human technology relations and secondly provide a relativistic account of the philosophers, Tilting Bowl, and their specific worlds.

Human-Technology Relations
Earlier in the paper we briefly described four key human-technology relations: *embodiment*, *hermeneutic*, *background*, and *alterity*. The Tilting Bowl can be seen to have an embodied relation in that Franklin used it to carry food to a neighbor's dinner party amplifying his hands; and often the tilt of the Tilting Bowl had a hermeneutic relation in that it signaled that it had tilted from the sound of the motor. However, the two most prominent relations to emerge in our study are background and alterity. We focus on these relations below.

Sharing a background relation with the Tilting Bowl
To remind the reader, a background relation is shared with a technology that shapes our experiences without being noticed and becoming part of the experiential surroundings, like a heating system that automatically turns on and off. A background relation is a good way to describe the relationship between the Tilting Bowl and the philosophers. Brenda described the Tilting Bowl as *"no more special than other things in this house"* and said it *"just blends away"*. Desmond referred to the Tilting Bowl as *"one of the things in our house that moves, it's a tilting bowl…But now it has become so normalized that it's like, it is part of the room."*

Additionally, a background relation, as Ihde explains, is a phenomenologically distinct type of "absence" that has a presence: a *present absence* [15]. This form of absence is readily evident with the Tilting Bowl as it remained present to our philosophers, "at the ready" for active reflection or engaged thought or emotions.

In certain cases, it was purposely brought into focus from its background relation as John discussed moving the Tilting Bowl to the kitchen table in order to do his philosophical work. This bringing into focus of the Tilting Bowl reflects his commitment to do the philosophical work as a co-speculator in our study, his philosophical training, and his overall philosophical interest in the artifact: *"it's an item loaded with sort of potential, and a responsibility as well. Like I do feel a responsibility towards it, that I have to have a bit of the mental process and that I have to have, if not insightful than at least I'm using things to say to you guys."*

However, the *present absence* of the Tilting Bowl could also take felt or emotional forms. We discussed earlier (see The attention garnered by the Tilting Bowl) how if Desmond noticed the Tilting Bowl moved in his absence or while asleep this created a sense of anxiety. Johanna reported that she shared a "mutual respect" with the counterfactual artifact since she felt it had a "living presence". Equally, John described the bowl as an *active* presence, which stood out in contrast to the majority of

passive objects he owned. He expressed that in a future home, he *"would try to curate it more carefully with items that are active in the environment."* This suggests sharing a particular and desirable background relation with certain artifacts.

In the writings of postphenomenology, it is suggested that technologies (e.g. a refrigerator or a heating system) share a background relation by virtue of being a necessity or as Rosenberger and Verbeek characterize it: "they shape our experiences, protecting us from the elements or keeping our food safely chilled…"[31:19]. Our study adds to understanding background relations as more than a relationship of necessity. We describe the background relations with the Tilting Bowl as felt or intuitive characterized as shared out of respect or desire. The honed descriptions of our philosopher participants refine the notion of present absence such that it can be seen to be a "living presence" or "active in the environment." Further, all our participants commented on the positive aesthetic and craft qualities of the Tilting Bowl. As a result, the artifact added to their apartments a quality of warmth and style that could be described as convivial and comforting, going beyond sheltering and safely storing food.

Sharing an alterity relation with the Tilting Bowl
Again, we remind the reader that humans share an alterity relation with an artifact when we relate to it in a manner similar to relating to other human beings. Typically, this refers to artifacts like an ATM machine that is designed with an interface that mimics human-to-human interaction. However, it can also refer to encountering a technology that has "a presence with which we must interrelate." [31:19]. In considering the alterity relations shared with the Tilting Bowl, our study revealed those more closely related to the counterfactual artifact having a presence instead of a direct dialogue with an interface device like an ATM. In this sense, presence is of a direct kind unlike the more diffused present absence of background relations.

This emphasis of presence over functional dialogue emerged early in our study. Initially, John described his relation to the Tilting Bowl as similar to a mobile phone, in that he was always "checking on it." However, he saw this connection to the Tilting Bowl as a matter of care rather than the negative association of looking at one's mobile phone out of boredom or habit: *"I don't necessarily think that that analogy is wrong, the phone but I think it has kind of a negative tone and I kind of thought of other things like houseplants and fountains and like a fish tank, sort of these items that we, you know they are just sitting there and not really doing anything but we interact with them, whether it's watering a houseplant or something like that."* This idea of care, especially with a plant or fish in a tank contrast greatly with the idea of interacting with an ATM machine.

The word alterity in phenomenological terms refers to the unique experience of relating to another human being as a matter of *otherness*. Ihde extends this notion to technologies

as having a *quasi-other* quality [15:98]. Nowhere is this more evident than Johanna's sense of the Tilting Bowl as among other descriptors as having "energy", a "living presence", "integrity" and "identity" that required its own table and space in her office (see Figure 3(c)).

Earlier we described the various experiments Desmond, William, and John performed on the Tilting Bowl to test and surveil its movements (see Philosophical work with the Tilting Bowl). Desmond and William later relayed how they became concerned with their various acts of surveillance, as they came to see themselves as desiring mastery and control over the Tilting Bowl. In seeing their relationship with the counterfactual artifact in *quasi-other* terms, they became very uncomfortable. William stated: *"Politically, think about that politically, that's the way refugees are treated sometimes, the same kind of surveillance, with the bowl, the same suspicion, exactly."*

Franklin and his father Mark, had a similar debate that stretched and circumscribed the degree of concern one should accord a non-human entity like the Tilting Bowl. Mark relayed how he had formed an attachment to the Tilting Bowl, considering it as part of the family. Franklin struggled to see the Tilting Bowl in those terms. He was concerned with the limits of assigning human values or quasi-human values to non-human entities as we discussed earlier when he navigated the question of relating ethics to the Tilting Bowl (see Philosophical work with the Tilting Bowl). However, here his greater worry was the ease to which an artifact as strange as the Tilting Bowl was not only accepted as normal but it's very otherness was made a virtue: *I want to complicate that a little bit by saying there's some things we shouldn't come to see as normal….and it does make me question, I mean the bowl is a bowl, right. But I mean in a grander scale, it does make me question like ok, well if we can get used to this…what else are we used to that's stuff that we shouldn't be used to, stuff that we should have a problem with that is sort of in the back."*

He later clarified in writing his view on what had become a discussion of tolerance when considering the *otherness* of the Tilting Bowl: *"In many cases, tolerance is a good thing, such as when we tolerate different religions in a single society; in other cases, it is a bad thing, such as when we tolerate the perpetuation of societal injustices. [...] And, to be clear, I don't think that tolerance of the tilting bowl is of the "good kind" or of the "bad kind," and I don't really believe that tolerating the tilting bowl raises an ethical concern. I just wanted to challenge the claim that tolerance/indifference towards the tilting bowl represents and unequivocally good attitude."*

In considering how the Tilting Bowl shares an alterity relation we can see how digital artifacts relate as much (if not more) as matters of artifacts themselves as presence that probes the complexities and contradictions of *quasi-otherness* in relation to technological artifacts. This in our view is a welcome contrast to the degree of focus on the interactivity aspects of alterity relations that dominate the exemplars offered in postphenomenology, such as ATM machines, GPS devices, software agents and other user-interface based technologies. Of course, the Tilting Bowl was designed without an interface and obvious interactive functionality to hopefully elicit the type of descriptions on alterity that emerged above.

Relativistic views of the Philosopher-Tilting Bowl
A key commitment in postphenomenology is the relational ontology in which neither subject nor object can be split and separately understood or defined. The hybrid relation of humans and technology means they need to be understood together, mutually constituted through their relations. As one shifts so does the other. As Ihde argues, a more objectivist view that separates and stabilizes for example user, technology, and world, would be "non-relativistic" and would obscure the human-technology relations [15:97].

This is plain to see in how the different philosophical identities of our participants shaped their accounts of or opened themselves to being shaped by the experiences of the Tilting Bowl. As mentioned, Johanna related the Tilting Bowl to hermeneutics and Husserlerian concepts; William and Desmond, trained in political philosophy, framed their consideration of the Tilting Bowl as a *quasi-other* as a political matter; whereas Franklin carefully unpacked the logic of philosophical concepts such as autonomy and tolerance in the tradition of analytical philosophy. These variant interpretations or "hermeneutic strategies" [31] between our different participants can further be seen as the different embodied positions of the philosophers with respect to the Tilting Bowl.

The precarious and temporary nature of the living situations of some of our participants naturally shaped their embodied relation to the things around them and their home. For example, John, who lived in two house sharing arrangements during our study, reflected on how his belongings situated themselves in relation to the belongings of the people whose house he was in and how this affected his understanding of the Tilting Bowl: *"You know there's this sort of line of demarcations whenever, when you are housesitting and you bring your stuff into the space, and there's kind of where your stuff goes, where the people your housesitting goes, and you treat them as two different things. The bowl is this sort of …. independent from all of that."* Brenda, in an opposite manner, reflected on how the temporariness of the Tilting Bowl, the fact that she did not own it, may or may not have inhibited her from forming an attachment with it: *"Yeah I mean it's possible that I, this is reading into it much, but it's possible that I didn't bond with it because I knew it wasn't going to last that long."*

Earlier, we discussed how on occasion, the philosophers would need to explain the Tilting Bowl to others and these explanations helped with their philosophical work (see Philosophical work with the Tilting Bowl). In addition, these explanations forced a self-reflection on how the

philosophers' embodied relations with the Tilting Bowl changed when explaining it. It positioned them and the Tilting Bowl more explicitly as part of a research study as well as something they lived with. For example, Franklin explained that when he encountered skeptical responses to the Tilting Bowl he felt the need to defend it and the study to a certain degree: "*I defend the project to a point and then I say, it's not my study.*" However, over time, he defended the study less but as he became to view the Tilting Bowl as a normal artifact and not the strange or weird artifact that others perceived, he found himself defending this position of indifference or normalcy with regard to the Tilting Bowl. This account of shifting embodied positions and reflections is complex and worthy of a lengthy quotation:

Others (guests, friends) had a much easier time remembering the bowl's strangeness because they had never forgotten it. And when confronted by their appreciation of that strangeness, the absence of such an appreciation of my own itself appeared strange to me. I would be struck by how strange it was that I no longer recognized the bowl as strange. Of course, to recognize that an attitude is strange is not necessarily to change that attitude, and after a few flickering moments of recognizing the strangeness of the bowl, it would once again seem normal; but the sense that that sense of normalcy was strange would linger…It is a form of self-doubt or self-uncertainty to find yourself a stranger to your own attitudes."

There is more to analyze here than we have the space for in this paper. However, it is sufficient to say that for Franklin, the relationship between him and the Tilting Bowl and how this mediates his world is relative to the perspective or embodied position he takes. Unsurprisingly, this relational dynamic led to "self-doubt or self-uncertainty". This account echoes Ihde's concept of *multistability* that is an aspect of the relational ontology of postphenomenology. Multistability refers to the multiple identities an artifact may hold dependent on the embodiment of the observer or user [16]. Similar to Franklin's "flickering" and changing views of the Tilting Bowl, Ihde illustrates multistability by citing the experience of optical illusions and how when we imagine different viewpoints of the same illustration our perception of the illustration dramatically changes despite us believing that the illustration has not changed [17].

With this in mind, our aim has been to account for the variant descriptions of how our philosophers and Tilting Bowl are constituted in relation to each other. These accounts aim to be holistic in nature but never totalizing. For example, these different interpretations should not be viewed as a progression or dimensions of a greater whole (e.g. that eventually add up or lead to an absolute experience of the Tilting Bowl or the life of a philosopher!). This approach to accounting for the experiences of technologies opens consideration and analytic purchase on a much wider territory than HCI generally aspires to but is

well within its domain and capacity. Knowing the subtleties and dynamics of how technologies shape us in constituting our worlds reveals the nuanced and complex ways our everyday worlds are constructed.

DISCUSSION

We conclude the paper with a discussion of the potential for exchange between postphenomenology and HCI based on our study. We also provide a practical outline of our study in methodological terms with the goal of extending the approach and making it easier for other researchers to conduct future postphenomenological inquires in HCI.

A dialogue between postphenomenology and HCI

At the outset of the paper, we said we would like to further open the dialogue with postphenomenology in ways that are mutually beneficial to HCI or design research. In bringing HCI together with postphenomenology, as we do in this study, we afford ourselves an empirically-driven philosophical account of living with technological things. Our philosophical approach brings to HCI a framing and set of concepts not typically considered in understanding how to design with technologies. These include relational ontology, human-technology relations (embodied, hermeneutic, alterity, and background), and multistability for starters. More recent research has extended human-technology relations to include a set of cyborg relations that account for body implants, home automation, and augmented reality [35] that are obviously related to HCI.

HCI in turn, brings to postphenomenology the opportunity to proactively design a technological artifact and tailor it to an inquiry as we did with the Tilting Bowl. This extends the philosophy from its limitations of retrospective studies of existing artifacts to a generative outlook of investigating new or speculative design artifacts. Investigating with artifacts like the counterfactual artifact Tilting Bowl delivers on the promise of postphenomenology to understand things and technologies free of "pre-given normative frameworks" that focus on preconceived behaviors and norms. These normative frameworks obscure less visible or alternative understandings of how mediation occurs with artifacts. Further, counterfactual artifacts like the Tilting Bowl, can be seen as a *super optical illusion* that holds the potential for multiple identities from multiple perspectives that help to reveal aspects and details of human-technology relations. Specifically, in this study, refined and detailed variants of *present absence* in background relations revealed themselves as felt and intuitive, motivated by respect or desire. This was in contrast to the conceptualization of background relations as a matter of necessity. Relatedly, the specific technologies or artifacts that share background relations go beyond shelter and safety to include conviviality, comfort and well-being. With respect to alterity relations, our study emphasized the *quasi-other* encounters with technologies as a matter of *presence* rather than the dominant characterization of dialogue and interface type technologies.

In addition to design artifacts, HCI brings in-depth and innovative empirical methodologies that can be finely tuned to studying the relations between humans and technology. This in turn augments existing postphenomenology methods for studying technologies. As a result, HCI and design research can deeply engage the matter of technological mediation empirically. This approach can surface concrete, particular and detailed accounts of human-technology relations that hold implications that can either richly affirm or problematize postphenomenology concepts.

Methodological considerations for future work
Next, we provide a set of methodological considerations that informed our study and offer constructive guidance for future postphenomenological inquires and HCI research.

Postphenomenological studies always include empirical work as a basis for philosophical reflection: Our study is clearly empirical however as stated earlier, we extend this commitment from postphenomenology by designing a new artifact tailored to the philosophical inquiry that moves from the retrospective to the generative. Relatedly, our material speculation and counterfactual artifact approach [41] addresses the avoidance of normative frameworks as a starting point for postphenomenological inquiries, and lastly our use of co-speculation offers a new empirical approach for postphenomenology (and interaction design). HCI offers a plethora of innovative and design oriented empirical approaches that we believe can readily be adapted to postphenomenology concerns from well-known methods like cultural probes [12] and experience prototyping [2] to more recent approaches like speculative enactments [8].

Postphenomenological studies analyze the roles that technologies play in the relations between humans and world (human-technology relations: embodiment, alterity, hermeneutic, and background). This is the central concern of any postphenomenological inquiry. In our study, novel and rich descriptions emerged with respect to alterity and background relations in particular. As we discussed earlier, there is an emerging body of work that considers human-technology relations in HCI [9,10,20,24–28,33,42,44]. Additionally, much like our Tilting Bowl, design resarch has a history of making reflective artifacts that imply if not directly engage philsophical concerns like key earlier work such as Gaver et al's Drift Table [13] or Redström et al's Chatterbox [30] and more recent research products like Odom et al's Photobox [21] and Pierce and Paulos' Obscura 1C Digital Camera [29].

Postphenomenological studies typically investigate how, in the relations that arise around a technology, a specific "world" is constituted, as well as a specific "subject." This characteristic rests on the concept of relational ontology, asserting the hybrid nature of the inseparability of humans and technology. In our case, any understanding of the Tilting Bowl cannot be separated from the particular philosopher and their contexts and vice versa (their "specific world"). Additionally, given the concept of multistability, we expected variant interpretations of these hybrid relations that can be as contradictory as they are diverse, yet always represent their "specific world". We previously cited broader philosophical framings of HCI [2, 5, 14, 37] that introduce notions of subject-object relations and embodiment. Recent work has investigated how design-oriented practice can ground and further inform these notions, particularly embodiment relations, including somaesthetics [14] embodied practice [43] and more closely related investigations of relativistic investigations of wearables [6]. Such efforts hold value and insights for postphenomenological concerns.

Postphenomenological studies typically make a conceptual analysis of the implications of technologies for one or more specific dimensions of human-world relations. The various accounts of the Tilting Bowl in this study are interpretations or resources to anticipate or reveal implications of the way in which we design with technologies. In this study, we looked to our various accounts of the human-technology relations with the Tilting Bowl as material that can inform future interaction design and HCI research.

These considerations are drawn from Rosenberger and Verbeek's methodological framework for postphenomenology [31]. Each consideration is related and should be taken together. Fortunately, each naturally falls from the other beginning with a commitment to empirical work aimed at a relational view of human-technology relations from which one can analyze and draw implications. We believe these considerations can be readily applied and productively adapted for the benefit of HCI research and as a step to more of a dialogue with philosophical approaches like postphenomenology.

CONCLUSION
An aim of this study is to enhance our philosophical understanding of digital artifacts through exploring alternatives with a counterfactual artifact and lived-with reflections of trained philosophers. We provided descriptive and analytical accounts of background and alterity relations shared with the Tilting Bowl that focus on different qualities of presence within these relations. We provide detailed and rich relativistic views of our philosophers, Tilting Bowl, and their specific worlds that account for technologies in new ways for HCI. Additionally, we detailed the characteristics of our material speculation and co-speculation approach in the light of the post-phenomenological studies, which we see as having great potential to be extended with the support of other HCI and design research methods. More generally, we aimed to further a mutually beneficial dialogue between HCI and postphenomenology.

ACKNOWLEDGMENTS

REFERENCES

1. Albert Borgmann. 1987. *Technology and the Character of Contemporary Life: A Philosophical Inquiry*. The University of Chicago Press, Chicago.

2. Marion Buchenau and Jane Fulton Suri. 2000. Experience Prototyping. In *Proceedings of the 3rd Conference on Designing Interactive Systems: Processes, Practices, Methods, and Techniques* (DIS '00), 424–433. https://doi.org/10.1145/347642.347802

3. Kathy Charmaz. 2014. *Constructing Grounded Theory*. SAGE.

4. Richard Coyne. 1995. *Designing Information Technology in the Postmodern Age: From Method to Metaphor*. MIT Press, Cambridge, MA, USA.

5. Markéta Dolejšová and Tereza Lišková. 2017. StreetSauce: Nurturing Speculation in Service Design. *interactions* 24, 5: 34–39. https://doi.org/10.1145/3121346

6. Pauline van Dongen, Ron Wakkary, Oscar Tomico, and Stephan Wensveen. Forthcoming. Beyond Functionality in Wearables: A Material Aesthetics Analysis.

7. Paul Dourish. 2001. *Where the action is: the foundations of embodied interaction*. MIT Press, Cambridge, Mass.

8. Chris Elsden, David Chatting, Abigail C. Durrant, Andrew Garbett, Bettina Nissen, John Vines, and David S. Kirk. 2017. On Speculative Enactments. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems* (CHI '17), 5386–5399. https://doi.org/10.1145/3025453.3025503

9. Daniel Fallman. 2010. A Different Way of Seeing: Albert Borgmann's Philosophy of Technology and Human–Computer Interaction. *AI Soc.* 25, 1: 53–60. https://doi.org/10.1007/s00146-009-0234-1

10. Daniel Fallman. 2011. The new good: exploring the potential of philosophy of technology to contribute to human-computer interaction. 1051. https://doi.org/10.1145/1978942.1979099

11. Andrew Feenberg. 1991. *Critical Theory of Technology*. Oxford University Press, 北京.

12. Bill Gaver, Tony Dunne, and Elena Pacenti. 1999. Design: Cultural Probes. *interactions* 6, 1: 21–29. https://doi.org/10.1145/291224.291235

13. William W. Gaver, John Bowers, Andrew Boucher, Hans Gellerson, Sarah Pennington, Albrecht Schmidt, Anthony Steed, Nicholas Villars, and Brendan Walker. 2004. The Drift Table: Designing for Ludic Engagement. In *CHI '04 Extended Abstracts on Human Factors in Computing Systems* (CHI EA '04), 885–900. https://doi.org/10.1145/985921.985947

14. Kristina Höök, Martin P. Jonsson, Anna Ståahl, and Johanna Mercurio. 2016. Somaesthetic Appreciation Design. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems* (CHI '16), 3131–3142. https://doi.org/10.1145/2858036.2858583

15. Don Ihde. 1990. *Technology and the Lifeworld: From Garden to Earth*. Indiana University Press, Bloomington.

16. Don Ihde. 1993. *Philosophy of Technology: An Introduction*. Paragon House Publishers, New York, NY, USA.

17. Don Ihde. 2009. *Postphenomenology and Technoscience: The Peking University Lectures*. SUNY Press.

18. Bruno Latour. 1992. Where are the missing masses? The sociology of a few mundane artifacts. In *Shaping technology/building society: studies in sociotechnical change*, Wiebe E. Bijker and John Law (eds.). MIT Press, Cambridge, Mass, 225–258.

19. John McCarthy and Peter Wright. 2004. *Technology as experience*. MIT Press, Cambridge, Mass.

20. William Odom, James Pierce, Erik Stolterman, and Eli Blevis. 2009. Understanding why we preserve some things and discard others in the context of interaction design. 1053. https://doi.org/10.1145/1518701.1518862

21. William Odom, Mark Selby, Abigail Sellen, David Kirk, Richard Banks, and Tim Regan. 2012. Photobox: On the Design of a Slow Technology. In *Proceedings of the Designing Interactive Systems Conference* (DIS '12), 665–668. https://doi.org/10.1145/2317956.2318055

22. William Odom and Ron Wakkary. 2015. Intersecting with Unaware Objects. In *Proceedings of the 2015 ACM SIGCHI Conference on Creativity and Cognition* (C&C '15), 33–42. https://doi.org/10.1145/2757226.2757240

23. William Odom, Ron Wakkary, Youn-kyung Lim, Audrey Desjardins, Bart Hengeveld, and Richard Banks. 2016. From Research Prototype to Research Product. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems* (CHI '16), 2549–2561. https://doi.org/10.1145/2858036.2858447

24. Fredrik Ohlin and Carl Magnus Olsson. 2015. Beyond a Utility View of Personal Informatics: A Postphenomenological Framework. In *Adjunct Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2015 ACM International Symposium on Wearable Computers* (UbiComp/ISWC'15 Adjunct), 1087–1092. https://doi.org/10.1145/2800835.2800965

25. Doenja Oogjes and Ron Wakkary. 2017. Videos of Things: speculating on, anticipating and synthesizing technological mediations. In *Proceedings of the 35th Annual ACM Conference on Human Factors in Computing Systems.* (CHI'17).

26. James Pierce. 2009. Material awareness: promoting reflection on everyday materiality. 4459. https://doi.org/10.1145/1520340.1520683

27. James Pierce and Eric Paulos. 2011. A Phenomenology of Human-electricity Relations. In *Proceedings of the*

SIGCHI Conference on Human Factors in Computing Systems (CHI '11), 2405–2408. https://doi.org/10.1145/1978942.1979293

28. James Pierce and Eric Paulos. 2013. Electric Materialities and Interactive Technology. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (CHI '13), 119–128. https://doi.org/10.1145/2470654.2470672

29. James Pierce and Eric Paulos. 2015. Making multiple uses of the obscura 1C digital camera: reflecting on the design, production, packaging and distribution of a counterfunctional device. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems* (CHI '15), 2103–2112. https://doi.org/10.1145/2702123.2702405

30. Johan Redström, Peter Ljungstrand, and Patricija Jaksetic. 2000. The ChatterBox: Using Text Manipulation in an Entertaining Information Display. In *Proceedings of Graphics Interface 2000*.

31. Robert Rosenberger and Peter-Paul Verbeek. 2015. A Field Guide to Postphenomenology. In *Postphenomenological investigations: essays on human-technology relations*, Robert Rosenberger and Peter-Paul Verbeek (eds.). Lexington Books, Lanham, 9–41.

32. Evan Selinger (ed.). 2006. *Postphenomenology: A Critical Companion to Ihde*. State University of New York Press, Albany.

33. Nynke Tromp, Paul Hekkert, and Peter-Paul Verbeek. 2011. Design for Socially Responsible Behavior: A Classification of Influence Based on Intended User Experience. *Design Issues* 27, 3: 3–19. https://doi.org/10.1162/DESI_a_00087

34. Peter-Paul Verbeek. 2005. *What Things Do: Philosophical Reflections on Technology, Agency, and Design*. Penn State Press.

35. Peter-Paul Verbeek. 2008. Cyborg intentionality: Rethinking the phenomenology of human–technology relations. *Phenomenology and the Cognitive Sciences* 7, 3: 387–395. https://doi.org/10.1007/s11097-008-9099-x

36. Peter-Paul Verbeek. 2011. *Moralizing Technology: Understanding and Designing the Morality of Things*. University Of Chicago Press, Chicago ; London.

37. Peter-Paul Verbeek. 2015. COVER STORY: Beyond Interaction: A Short Introduction to Mediation Theory.

interactions 22, 3: 26–31. https://doi.org/10.1145/2751314

38. Ron Wakkary, Audrey Desjardins, and Sabrina Hauser. 2016. Unselfconscious Interaction: A Conceptual Construct. *Interacting with Computers* 28, 4: 501–520. https://doi.org/10.1093/iwc/iwv018

39. Ron Wakkary, Sabrina Hauser, and Doenja Oogjes. In press. Attending to the Role of Things Beyond a Human-centred Perspective in Practices. In *Social practices and more-than-humans*. Palgrave Macmillan, London.

40. Ron Wakkary, Henry W. J. Lin, Shannon Mortimer, Lauren Low, Audrey Desjardins, Keith Doyle, and Philip Robbins. 2016. Productive Frictions: Moving from Digital to Material Prototyping and Low-Volume Production for Design Research. In *Proceedings of the 2016 Conference on Designing Interactive Systems* (DIS'16) , 1258-1269. https://doi.org/10.1145/2901790.2901880

41. Ron Wakkary, William Odom, Sabrina Hauser, Garnet Hertz, and Henry Lin. 2015. Material Speculation: Actual Artifacts for Critical Inquiry. *Aarhus Series on Human Centered Computing* 1, 1: 12. https://doi.org/10.7146/aahcc.v1i1.21299

42. Ron Wakkary, Doenja Oogjes, Sabrina Hauser, Henry Lin, Cheng Cao, Leo Ma, and Tijs Duel. 2017. Morse Things: A Design Inquiry into the Gap Between Things and Us. In *Proceedings of the 2017 Conference on Designing Interactive Systems* (DIS '17), 503–514. https://doi.org/10.1145/3064663.3064734

43. Danielle Wilde, Anna Vallg\a arda, and Oscar Tomico. 2017. Embodied Design Ideation Methods: Analysing the Power of Estrangement. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems* (CHI '17), 5158–5170. https://doi.org/10.1145/3025453.3025873

44. Heather Wiltse and Erik Stolterman. 2010. Architectures of Interaction: An Architectural Perspective on Digital Experience. In *Proceedings of the 6th Nordic Conference on Human-Computer Interaction: Extending Boundaries* (NordiCHI '10), 821–824. https://doi.org/10.1145/1868914.1869038

45. Langdon Winner. 1980. Do Artifacts Have Politics? *Daedalus* 109, 1: 121–136.

46. Terry Winograd and Fernando Flores. 1987. *Understanding computers and cognition: a new foundation for design*. Addison-Wesley, Boston.