Repertoires for designing with nonhumans

by

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Abstract

HCI and design researchers are increasingly seeing limitations to human-centeredness in design. As a result, researchers are turning to new explorations that emphasize the need to see design and computing within a broader set of more-than-human relations and values. In this shift toward posthumanism, related theories and philosophies have long pointed out the need and challenge of *decentering the human*. In design, this challenge falls to the human designer. It requires design practitioners to critically and introspectively rethink their relations to methods, practices, and nonhumans such as tools and materials.

The work in this dissertation investigates possible actions that the human designer can take to increase the participation of nonhumans, or what is referred to as *repertoires*. The work presented in this dissertation develops repertoires through three design cases: Videos of Things, which looks at how to *better account for nonhumans* through narrative strategies; Morse Things, which reconsiders design journeys as a way to *pay attention to nonhumans* in the design process, and; Woven Things, which draws from anthropological approaches to develop three repertoires to *actively work with the nonhumans of design*. The work takes a first-person approach to design with a commitment to thing perspectives.

The contribution of this dissertation is as follows: firstly, it articulates and mobilizes three repertoires. It also offers the process of developing such repertoires, strengthens their position amongst existing methods and activities of design in HCI, and illustrates the nuances and attitudes necessary to engage in more-than-human design.

Keywords: More-than-human design; Thing-perspectives; First-person design research; Research through design; Design videos; Internet of things; Textile fabrication

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List of Acronyms

HCI	Human Computer Interaction
IoT	Internet of Things
RtD	Research Through Design
SFU	Simon Fraser University

We call it a grain of sand,

But it calls itself neither grain nor sand.

It does just fine without a name,

Whether general, particular, permanent, passing,

Incorrect, or apt.

— excerpt from ***View With a Grain of Sand***, Wisława Szymborska (Szymborska 1998, 185).

Chapter 1. What is good design, and for whom?

In everyday life, it is not hard to see how things can escape from our understanding or control: socks, Tupperware lids, bobby pins, and pens inevitably get lost; headphones get tangled in our pockets. In design practice, we understand this too. Prototypes stop working right when you are about to give a demonstration, things break or get lost in the mail, and models don't translate neatly to actuality. What would happen if designers would actively listen to, and work with, such manifestations? In this dissertation, I turn to posthumanism to better understand how to work with nonhumans of design practice.

HCI researchers are turning toward work that recognize broader relations and implications of computing. One strand of these approaches has proposed turning to the more-than-human world, and engaging with nonhumans. In design, this challenge falls to the human designer. It requires design practitioners to critically and introspectively rethink their relationships to methods, tools, materials, and practices. Yet, this is no straightforward task, as nonhuman worlds are not always easily accessible, and deeply rooted human-centered assumptions that are difficult to overcome. This work requires a shift in thinking about design practice.

A little over ten years ago, Shaowen Bardzell presented the seminal paper "Positioning Feminist HCI" (S. Bardzell 2010) in which she recognized a commonality in feminism's central commitments of agency, equity, empowerment, positionality, diversity, and social justice, combined with interests and approaches of what has often been described as third-wave HCI (Bødker 2006; Harrison, Sengers, and Tatar 2011). Feminist work in HCI has brought questions to the field of intersectionality, positionality, situatedness, and equity, and asks the "for whom?" question in design (Muller 2011; A. Ahmed and Irani 2020; S. Bardzell and Bardzell 2011; Schlesinger, Edwards, and Grinter 2017). Around the same time, Daniel Fallman presented a related inquiry into the values of HCI (Fallman 2011). He argued that what can be considered *good design* has become less apparent and assessable in the midst of this range of works. Fallman proposed drawing from the philosophies of technology to open the field up to broader definitions of "good." This question of what can be considered good is (and should be) always an ongoing inquiry — one that can shift and dynamically change without it

necessarily being at the center of the research. There is an ongoing need to stay critical of what we strive for in design, and consider this question from multiple perspectives.

A more recent strand of research has looked into aspects of computing from a much broader perspective that challenges the fundamentals of the field by going not just beyond use, functionality, and direct interactions, but also extending the concept of *the human.* HCI and design researchers are increasingly seeing the limitations and harmfulness of human-centeredness in design. We can see this in the intersections of HCI studies and postcolonial studies (Irani et al. 2010; Sultana and Ahmed 2019), intersectional feminism (Schlesinger, Edwards, and Grinter 2017), critical race theory (Ogbonnaya-Ogburu et al. 2020), queer studies (A. Light 2011; Spiel et al. 2019; DeVito, Walker, and Birnholtz 2018; Gatehouse 2016), disability studies (Laura Forlano 2017b; C. L. Bennett and Rosner 2019; Williams et al. 2021; Mankoff, Hayes, and Kasnitz 2010), political economies (H. Ekbia and Nardi 2016), and sustainable interaction design (Blevis 2007; DiSalvo, Sengers, and Brynjarsdóttir 2010; S.-Y. (Cyn) Liu, Bardzell, and Bardzell 2019b). What becomes clear through these works is that the way humans and technology have been positioned in HCI is much too narrow. These works, and the theories that they draw from, bring a new perspective to Fallman's question of what can be considered as *good* — extending it by asking: *good for whom?* In the work presented in this dissertation, I engage with this question through the perspective of nonhumans.

There have been various efforts in design that I loosely group as works that bring posthumanist and more-than-human theory to practice. For example, the rethinking of processes of design, in light of distributed agencies (Frauenberger 2019), questioning ontologies (Leahu 2016; H. R. Biggs, Bardzell, and Bardzell 2021; Escobar 2018), and accounting for, or being inclusive of, nonhumans through concepts from posthuman literature such as natureculture (S.-Y. (Cyn) Liu, Bardzell, and Bardzell 2019b; Smith, Bardzell, and Bardzell 2017). The challenge of decentering the human was articulated early as posthuman theories were introduced into design research (Ann Light, Powell, and Shklovski 2017; L. Forlano 2016; DiSalvo and Lukens 2011; Smith, Bardzell, and Bardzell 2017). This challenge has been taken up, for example, by using a thing-perspective as a strategy to oppose human perspectives (Davoli and Redström 2014; Giaccardi et al. 2016; Jenkins et al. 2016; Wakkary et al. 2017), methods or tools for noticing differently (Cho, Devendorf, and Voida 2021; S.-Y. (Cyn) Liu et al. 2019; J. Liu, Byrne, and Devendorf 2018) embodied speculations (Devendorf, De Kosnik, et al. 2016;

H. R. Biggs and Desjardins 2020; J. Liu, Byrne, and Devendorf 2018), and posthuman material engagements (Dew and Rosner 2019; S.-Y. (Cyn) Liu, Bardzell, and Bardzell 2019a). Such decentering strategies aim not to exclude the human fully, but rather, to commit to its entanglements. Still, deeply rooted human-centered understandings, assumptions, and framings remain very difficult to de-prioritize in design. There have been works that aim for a deeper rethinking and reorienting of design as a practice that is less focused on progress, production, profit, and other related human-centered goals. These include fabulations (Rosner 2018), un-designing (Pierce 2012), removal (Homewood, Karlsson, and Vallgårda 2020), designing for trouble (Søndergaard and Hansen 2018; Encinas et al. 2018; Lawson et al. 2015), or care (Key et al. 2021), and amusements, such as non-contributions (Devendorf et al. 2019). While these works don't necessarily all share a posthuman framing, they indicate the deeper task at hand of not only finding methods, but to rethink design, humans, computers, and the interactions between them.

1.1. Research questions

My design and research engages with the above works, and aims to look deeper into design practice from a perspective that is engaged with more-than-humans, such as materials, tools, and software. While there is a growing body of design work drawing from posthuman literature, the design processes themselves are predominantly described from a perspective of human intent, and often don't account for the creative capacities of nonhumans such as materials, tools, and software. In a material practice like design, how can we engage with posthuman discourse, both conceptually and materially? What are the challenges of escaping human-centeredness *as* a human designer?

In this dissertation, I ask: **how might designers increase the participation of nonhumans?**

I utilize Wakkary's designing-with theory that addresses the challenge of the human designer in the midst of a nonhuman and human assembly. Wakkary, in his book ***Things We Could Design***, outlines a posthuman design practice of designing-with in which design is reconsidered as a practice that sees *"humans and nonhumans bound together materially, ethically and existentially"* (Wakkary 2021, 5). Wakkary introduces

the term repertoires as processes that aim to increase the participation of nonhumans. While there are other theoretical works that also address posthuman shifts in design (Escobar 2018; Redström and Wiltse 2018), I chose to work with the framework of designing-with in this dissertation. An important note here is that I also played a part in the development of this theory, through my work on projects such as the Morse Things and the Tilting Bowl. The work in this dissertation uses the designing-with theory retrospectively, but the thinking developed and matured throughout the projects.

Through the concept of repertoires, Wakkary's work establishes the connection between posthumanist theory and activities of design researchers, and allows for a generative approach. While his book offers starting points for repertoires, there is an unaddressed need to develop these repertoires, and to offer more worked-out examples that can provide nuance to the terms provided in designing-with. My secondary research question builds on these points and is as follows:

How can the concept of repertoires be developed in design practice?

The work presented in this dissertation will develop repertoires through three design cases from my own practice: Videos of Things, Morse Things, and Woven Things. The work is situated in the context of design research, and will therefore have some limitations regarding how it translates to design practice more generally. However, the work does intend to speak to design practice in a broader sense. I will ask the following sub-questions in the design research cases:

- *How can designers better account for nonhumans in everyday life?*
- *How can designers bring attention to nonhumans in their processes?*
- *How might designers actively work with nonhumans?*

The development of repertoires, the collaborations (speaking with, participating with, and caring with) with non-speaking nonhumans, and the documentation of this in large part does not involve other people such as participants or users, but relies on self-reflection of design practice. Therefore, the research challenge can be considered first-person, and I take this opportunity to investigate first-person practices to develop repertoires. While methodologically first-person design approaches are well suited for developing repertoires, given their commitments to situated research, unique standpoints, and critical self-reflection, within a posthuman framing, the dominance of

the human voice (in data collection, analysis, and documentation) does not sit very well, and needs critical navigation to ensure the inclusion of nonhumans. As well, there is an ongoing tension of using language and writing to communicate nonhuman perspectives. The work presented is a first-person research that is on the lookout for nonhuman agency and participation.

1.2. Positionality

While I will later elaborate on my road to, and motivation for, posthumanism in the context of this dissertation, I find it essential to provide a more personal statement of positionality on my research. I am trained as an Industrial Designer, and the program that I graduated from focused on tangible interaction design. During my Bachelor's and Master's degrees, I grew interested in indirect, nuanced, accidental, unintended, and longer-term relations with technologies. Initially, this pursuit was probably mostly aesthetic or poetic, motivated by my own positive experiences of being enchanted, surprised, or humbled by nonhuman agency and creativity. A plastic bag dancing in the wind, finding new appreciation for a forgotten record when packing up my collection for a move, and even (sometimes) those headphones getting tangled in my pocket—because out of the thousands of ways they could roll up, why would they do so in the one way that works for me? I found that the design methods that I learned, and knew how to apply, often fell short in bringing in these aspects into interaction design. As I started to explore other ways of doing design, challenging concepts such as personas and 'the user', I increasingly distanced myself from human-centeredness, and realized that ideas of control and intention are not only limited in designing more nuanced and poetic interactions, but also did not really help me as a designer to engage with complex topics — I started understanding the larger problem of seeing the human as the center of a world that we share with so many.

I am grateful to have practiced my work on the unceded ancestral territory of the xʷməθkwəy̓əm (Musqueam), Skwxwú7mesh (Squamish), and Səl̓ílwətaɬ (Tsleil-Waututh) Nations. I am a settler on this land. Moving here from Amsterdam, the Netherlands, has been a journey of recognizing my own and my ancestors' accountability for colonialism. I further acknowledge that the knowledge of more-than-human-centered worlds, while only recently introduced to the field of design and HCI, has always been foundational in many Indigenous forms of knowledge and practices.

Significant parts of this dissertation engage with storytelling and weaving, practices that have long Indigenous traditions, and are ongoing modes of knowledge creation.

It is important to me that I keep learning, both personally and through design research, from a position of humility, generosity, and inclusivity.

1.3. Contribution, audience, and overview

The contribution of this dissertation is as follows: firstly, I articulate three repertoires that contribute to work in HCI on more-than-human design (J. Liu, Byrne, and Devendorf 2018; S.-Y. (Cyn) Liu, Bardzell, and Bardzell 2019b; Nijs et al. 2020; Prost et al. 2021; H. R. Biggs, Bardzell, and Bardzell 2021), as well as those exploring thing-perspectives (Chang et al. 2017; Reddy et al. 2021; Robbins, Giaccardi, and Karana 2016; Wakkary et al. 2017), and material driven design research (Goveia da Rocha and Andersen 2020; Leahu 2016).

Secondly, I contribute detailed and self-reflective descriptions of the process of moving toward the repertoires. I take a first-person, propositional approach that allows me to engage with posthuman theory through design. Describing the process of developing the repertoires helps to further position them with existing methods and activities of design in HCI, and illustrates the nuances and attitudes necessary to engage in the development of repertoires. This work will be of interest to researchers working on first-person approaches (Desjardins and Ball 2018; Devendorf, Andersen, and Kelliher 2020; A. M. Mackey et al. 2017), as well as those working on intersections of theory and design (Hauser, Wakkary, et al. 2018; W. Odom, Stolterman, and Chen 2021; Redström 2017) as I contribute an exploration in working with theory in design from a first-person perspective.

The dissertation is structured as follows:

Chapter 1 introduces the background, topic, and contributions of the dissertation.

Chapter 2 covers related works. I will introduce posthumanism more broadly, and elaborate on how I've arrived at this theory. I explain my choice(s) for working with the designing-with theory, elaborate on important concepts, and detail its use in this dissertation. This chapter also covers works from HCI and design literature that are

related to the work of developing repertoires, such as methods of posthuman design, storytelling and narrative, and speculative design.

Chapter 3 presents the methodological approach of this dissertation. I take a propositional approach that is well fitted to do the work of simultaneously better understanding and developing repertoires. In this chapter, I also introduce the three cases of this dissertation: Videos of Things, Morse Things, and Woven Things. I explain the design work used for these cases, the methods used, and each case's propositions. I also detail my epistemological commitments of first-person research and thing-centeredness, and describe how they form the basis for doing the work of increasing participation of nonhumans in design research.

Chapter 4 describes the Videos of Things case, in which I propose using narrative strategies to decenter human-centeredness in design videos to better account for nonhumans that may be encountered in everyday life: a percolator, furniture, food, pots and pans, laundry detergent, a set of keys, a ventilator, houseplants, headphones.

Chapter 5 goes deeper into the Morse Things case. The Morse Things are internet connected cups and bowls that communicate with each other over the internet and in Morse code. This is an ongoing project that has been committed to a thing-centered design approach from the start. In this case, I follow through on a loss of control in the project as a result of this commitment, particularly through the retracing of broken cups and bowls. Here, I focus particularly on nonhumans of design practice: packaging design, LiPo batteries, Sugru, elastic bands, and ceramics.

Chapter 6, Woven Things, presents the development of three repertoires. The context for this case is two ongoing design projects, Wi-Fi-no-Wi-Fi and Woven Wi-Fi antenna, where I engaged with weaving. In this case, I set out to explore what it could mean to develop repertoires unbound from common design structures such as projects, outcomes, failures, and successes, by introducing the notion of *design events*. I further employ three anthropologically derived methods to understand their potential as repertoires. I engage with nonhumans such as: cotton thread, two TC2 looms, Elektrisola conductive thread, a spool rack, a tension box, denim cloth, photoshop templates, and weaving drafts. This chapter presents the results of the dissertation and answers my research questions.

In Chapter 7, I summarize the work, and further discuss the impact and possible future directions. I put forward three lessons that I learned about my human position through the development of the repertoires, which will allow researchers to apply them, including taking positions of humility, allowing nonhuman temporalities to guide practice, and embracing disturbances. In this chapter, I also reflect back on my use of the designing-with theory, and provide starting points for researchers who want to develop their own repertoires.

In Chapter 8, I conclude the dissertation. I summarize the findings and answers to the research questions, and elaborate on how I intend to include this in my future work.

Chapter 2. Posthumanism, and designing-with

While much work is underway towards a more relational understanding of technology and design within HCI, where researchers are developing more-than-human design methods, there is little research that takes on the challenges of posthumanism within design practice itself. That is, seeing design and HCI as more-than-human practices, paying as much attention to its materials and tools as nonhumans, and the inherent challenges for the human designer that comes with admitting to a more entangled position.

In this chapter on related work, I first orient my approach to posthumanism, summarize the particular strand of posthumanism that I draw from, and describe how I've arrived at it from a position of relationality, as informed by postphenomenology. I then summarize works in HCI that have engaged with more-than-human theories, and focus in on Ron Wakkary's *designing-with* (Wakkary 2021) theory, which will serve as the main theoretical framework for this dissertation. I will unpack important terms: *the speaking subject, repertoires,* and *the constituency.* This dissertation presents the work of developing repertoires to increase nonhuman participation in design research processes.

From here, I will outline a variety of design activities within HCI that relate to *repertoires,* as a way to work towards further understanding where they are conceptually situated. This section will include more-than-human methods, storytelling practices, and speculative design as a critical and generative form of design.

2.1. Posthumanism from a relational perspective

In this dissertation, I have arrived at posthumanism from a relational perspective. In this section, I briefly elaborate on postphenomenology, posthumanism, and feminist-technoscience, and a critical and affirmative posthumanism.

Postphenomenology

My earlier work in this dissertation was informed by postphenomenology, a philosophy of technology that considers how technologies mediate experiences through relations. This was well suited for my pursuits of understanding interaction design more

broadly, beyond the more dominant understanding of relations of use and functionality (Verbeek 2015). Important concepts of postphenomenology include human-technology relations, relational ontology, field of awareness, and multistability (Rosenberger and Verbeek 2015). Postphenomenology sees technologies and humans as intertwined and mutually constitutive. It also sketches out a particular role and responsibility for the designer, as Verbeek puts it as *"doing ethics through technology"* (Verbeek 2006). Postphenomenology has been applied in design and HCI as an empirical-analytical framework to understand existing and emerging relations (Hauser, Oogjes, et al. 2018; W. Odom et al. 2009; Ohlin and Olsson 2015; Wiltse and Stolterman 2010), at times utilizing design methods such as annotated portfolios (Hauser, Oogjes, et al. 2018) and design journeys (van Dongen et al. 2019b).

In a similar way to posthumanism, postphenomenology destabilizes notions of control and the centrality of the human, to propose a more porous understanding, articulating how humans and nonhumans co-constitute relations to the world. Postphenomenology, as an analytical lens, is able to expand established notions of interactivity; however, it is limited in its ability to be applied actively in design processes. As well, in its focus on *human*-technology relations, or the importance given to human designers doing ethical work through things, it, at times, is still too human-centered for the purposes of this research, and falls short in exploring thing-to-thing relations and nonhuman participation.

From feminist techno-science to critical posthumanism

Posthumanism is a branch of theory and philosophy that de-prioritizes the human as the center of knowledge and being in the world, and aims to open up to more porous, blurry boundaries. The term "more-than-human" was put forward by ecologist and phenomenologist, David Abram, to draw attention to the many nonhumans that have preceded humans, and that now share the earth with humans. Abram also called for a new humility on the part of humankind to recognize how these more-than-humans are in community with humans, but also exceed human understanding (Abram 1997). The field includes a broad variety of perspectives such as object-oriented ontology, distributed assemblages, the Anthropocene, and others, that I loosely bring together here as posthumanism.

I was introduced to posthumanism by works of feminist techno-science, including authors such as Rosa Braidotti, Karen Barad, Donna Haraway, Katherine Hayles, and Jane Bennett, who introduced important concepts such as hybridity, performativity, agential cuts, material vitality, and assemblages (Barad 2003; 2007; J. Bennett 2009; Braidotti 2013; Haraway 1991; 2016; Hayles 1999). There are nuances and different understandings within posthumanist studies that are important to understand.

Transhumanism, for example, focuses particularly on human-enhancement technologies, such as extensions of the senses through body modification and self-improvement. Hayles' posthumanism focuses, somewhat similarly, on boundaries between bodies and technology, and within the field of informatics, explores the possibility of human consciousness existing outside of the material body (Hayles 1999). However, Hayles distances herself from concepts of immortality through digitalization, notably different from ideas within transhumanism that ultimately strive for progress and innovation in favour of human survival.

Donna Haraway — perhaps most well known for her essay on the metaphorical figure of the hybridity of the cyborg (Haraway 1991) — urges the reader to enjoy the confusion of binaries, to learn to see from both sides at once, and to stay with the trouble (Haraway 2016). However, Haraway herself has critically reconsidered the term cyborg, as well as posthuman discourse, and the anthropocene. She distanced herself from how these concepts distinctively set apart humans from other species, and proposes instead the terms *com-post, humus,* and the *chtchulucene,* to emphasize entanglements, ongoing-ness, and companionship (Franklin 2017; Haraway 2016). To summarize, there are many critical nuances and tentacular tangents in the emerging field of posthumanism that, as a designer, I recognized partly for their strengths, but simultaneously made it challenging to grasp and put into practice.

My position within posthumanism is guided by Braidotti's critical posthumanism. Braidotti summarized three strands in posthuman thought (Braidotti 2013). The first strand stems from moral philosophy, and is a reactive form. This strand considers the posthuman condition as a solvable notion, and promotes humanist visions — it includes transhumanism, as previously discussed. The second posthuman strand takes an analytical form, and is rooted in science and technology studies. Braidotti also included Verbeek's postphenomelogical analyses of the morality of technology (Verbeek 2011) as

a part of this analytic posthumanism. In Braidotti's view, these approaches carry a lingering humanism in how they superimpose humanist ethics. While bringing in practical insights about advances in technology as they relate to moral and ethical issues, Braidotti critiques these approaches for their political neutrality, and their lack of an account for subjectivity. The third strand of posthuman thought, which Braidotti aligns herself with, is critical posthumanism. Braidotti particularly stressed the affirmative nature of this strand.

The primary goal of this critical posthumanism can be understood as an effort to reject individualism in order to bring a new understanding of the subject as a relational and embedded part of a whole. This strand of posthumanism accepts the human as an intertwined and entangled being in the world, which is shaped by, and shapes, its surroundings. It is no longer a question of whether the posthuman exists or not, rather, it is a question of how we might act differently with this new understanding when acting from new forms of subjectivity. Braidotti sees opportunities in *"the decline of the unitary subject"* (Braidotti 2013, 54) for a new conceptual creativity: *"affirmative politics combines critique with creativity in the pursuit of alternative visions and projects"* (Braidotti 2013, 54). This strand of posthumanism is well suited for my design research project, as it does not stunt creation, but is generative through its critique.

2.2. Posthumanist design research

Posthumanist theory speaks to design practice with its focus on situatedness and materiality, yet simultaneously challenges it by destabilizing established understandings of users, humans, and interactions. HCI researchers have drawn from works such as those summarized above, and others, to rethink the field's processes through distributed agencies, to question its ontologies, and to account for, or be more inclusive of, nonhumans (L. Forlano 2016; Laura Forlano 2017a; Frauenberger 2019; Giaccardi and Redström 2020; J. Liu, Byrne, and Devendorf 2018; S.-Y. (Cyn) Liu, Bardzell, and Bardzell 2018; 2019a; 2019b; Nijs et al. 2020; Prost et al. 2021; H. R. Biggs, Bardzell, and Bardzell 2021; Wakkary 2020; 2021; Akama, Light, and Kamihira 2020). For example, Frauenberger proposed *entanglement* as the next paradigm shift for design and HCI, drawing on works of Latour's actor-network theory, post-phenomenonology, object-oriented ontology, and agential realism. He argues that we should leave behind user-centered design, and commit to a practice that addresses accountability,

responsibility, and ethics: "*designing technology means creating hybrid things with ambiguous boundaries and proposed programs of actions that seek to reconfigure agency and power with moral responsibility*" (Frauenberger 2019, 22). Giaccardi and Redström similarly outlined a shift in technology and more-than-human design. The authors considered digital technologies such as the internet of things, artificial intelligence, and machine learning, as a new complexity for designers. They recognized an increased agency in these technologies in the way that they are constantly becoming, and draw from posthuman concepts to propose shifts for new design practices that move, for example, from delegation to co-performance, and from functionality to responsiveness. In a similar vein, but moving away from shifts or waves, Wakkary *conceptualizes nomadic practices* as a posthumanist epistemology for design that sees design as more expansive (Wakkary 2020).

Others have examined particular terms from posthumanist discourse in their design work. For example, Leahu and Sengers examined the concept of *performativity* in the context of affective computing through the design of Freaky, attending to the ways in which they are shaping subjectivity and objectivity, and study entanglements (Leahu and Sengers 2015). Several HCI scholars have worked with Haraway's term, *natureculture*s; a term that collapses the dichotomy between nature and culture, and seeks to examine what is constituted between, through, or with, instead. The implications of this term in design research have been examined through photography (S.-Y. (Cyn) Liu, Bardzell, and Bardzell 2018), tactics for decompositions (S.-Y. (Cyn) Liu, Bardzell, and Bardzell 2019a), and understanding relations in different contexts where humans and nonhumans cohabitate (S.-Y. (Cyn) Liu, Bardzell, and Bardzell 2019b; Smith, Bardzell, and Bardzell 2017).

Arguably one of the most resonant calls from posthuman theories is the notion of decentering the human within design and HCI, to make space for nonhuman perspectives. This was a concern that was articulated early (DiSalvo and Lukens 2011; Laura Forlano 2017a; Smith, Bardzell, and Bardzell 2017; Ann Light, Powell, and Shklovski 2017), yet this is not a simple task for a field that traditionally places humans at its center. I turn to a long quote from Disalvo and Lukens, to further illustrate the deep commitment and narrative shifts it will take to overcome anthropocentrism:

> This momentary overcoming of anthropocentrism requires us to imagine the world anew and involves imagining movement outside of our own patterns, outside of things like being bipedal. […] Ultimately, it involves our overcoming the narrative fallacies and rationalizations that we use to place ourselves at the top of a chain, and instead placing ourselves in a web in which the components are impossible to isolate from the whole (DiSalvo and Lukens 2011, 433).

The notion of the more-than-human has been included in a wide range of topics, including, for example, the built environment (Clarke et al. 2019; Smith, Bardzell, and Bardzell 2017), sustainability (H. R. Biggs and Desjardins 2020; J. Liu, Byrne, and Devendorf 2018; H. R. Biggs, Bardzell, and Bardzell 2021), agriculture (H. Biggs et al. 2021; S.-Y. (Cyn) Liu, Bardzell, and Bardzell 2019b), human-food interaction (Cho, Devendorf, and Voida 2021; Prost et al. 2021), animal-computer interaction (French, Mancini, and Sharp 2020; Hauser, Wakkary, and Neustaedter 2014; Lawson et al. 2015; Mancini, Lawson, and Juhlin 2017; Mancini and Lehtonen 2018; Mancini et al. 2016), plant-computer interaction (Angelini et al. 2016; Aspling, Wang, and Juhlin 2016; Kuribayashi, Sakamoto, and Tanaka 2007; Sareen, Zheng, and Maes 2019; Steiner et al. 2017), things such as voice-assistants (Reddy et al. 2021; Søndergaard and Hansen 2018), and things in everyday practices (Kuijer and Giaccardi 2018).

As I will argue in this dissertation, design practice itself, with its things, tools, materials, methods and processes, is a practice that is *already and always* entangled, and is more-than-human. The distinction between the terms “more-than-human,” and “posthumanism,” lies in the recognition of the human designer as a posthuman subject that does not merely include the more-than-human in her design process, but recognizes herself as more-than-human too. My interest in posthumanism, within the context of design and HCI, is in the notion of removing the human as the center of control of events and relations in designing, and bringing such materials, tools, processes, and other nonhumans, that have a say in design outcomes, to the fore.

2.2.1. Things We Could Design

The theoretical background for this doctoral work comes from Ron Wakkary’s book, **Things We Could Design.** Motivated by the unsustainability of human exceptionalism, and the impacts of climate change, Wakkary argues for a rethinking of design that displaces the human at the center of thought and action. There are other

approaches that take on similar challenges of rebuilding design, similarly moving away from the dominance of the human-centeredness.

For example, Arturo Escobar critiques universalist claims of human-centered approaches, and proposes autonomous design as a way towards plurality in design (Escobar 2018). Escobar lists posthumanism as one of the points of the approach, further unpacking it as postdualist, while emphasizing that what has previously been understood as human has excluded many. The pluriversal approach that Escobar argues for is an example of decolonizing design, and questions euro-centric assumptions. While the work does touch upon nonhumans in design, its main focus is on community and culture, which falls outside of the realm of my research questions.

Daniela Rosner's Critical Fabulations is another rebuilding of design, achieved here through feminist correctives. Rosner investigated what it would take to redefine and re-root design in ways that are more inclusive of methods, people, contexts, and (his)tories that have thus far not been central to the field. This is an excellent example of feminist techno-science in design practice, however, for my research questions, it remains too retrospective and focused on the human and the social aspects.

Lastly, Redström and Wiltse's Changing Things (Redström and Wiltse 2018) more directly speaks to design practice, and considers things as part of fluid assemblages. The work is motivated by the observation that things are becoming increasingly connected and intelligent, and are changing in ways that require new approaches from designers. Their work applies to systems such as Spotify playlists and IoT devices. However, beyond these emerging technologies, I also see a need to better understand existing, more mundane things and how they shape the world. In line with Braidotti's affirmative posthumanism, humans and things have always been co-constituted, and while this increasing complexity certainly increases the relevance of my research question, the research aims to engage with nonhumans as they are encountered in design processes more inclusively.

I chose to work with Wakkary's framework, as it addresses the challenge of the human designer most squarely within a posthumanist understanding. The work emphasises the designer as an assembly of humans and nonhumans, and speaks to responsibility and actions of this new subjectivity. This is well suited for my research, as

it speaks directly to actions that the human designer can take, in the form of *repertoires*. In this section, I will give a brief summary of the book, and an overview of its important terms, as they will be used in the dissertation.

Wakkary draws from posthuman philosophical concepts to arrive at the supporting terms of mediating technologies, assemblies of vital matter, and matters of concern and care. Things and humans are interconnected, things are transformative, and things are relational. Turning towards the posthuman designer, Wakkary conceptualizes a reworking of design practice as designing-with, in which the assumption of the designer as exclusively human is abandoned (Wakkary 2021). Instead, the designer is co-constituted between humans and nonhumans. The book proposes four sense making terms to help the reader to grasp this: the designer as biography, the designer as force, the designer as speaking subject, and the designer as intensities and origins.

The **designer as biography** accounts for the human and nonhuman life forces that co-create themselves and the world. The term biography acknowledges the vitality of nonhumans. By emphasizing the entanglement of humans and nonhumans, Wakkary aims to *"make the designer of things accountable for what it designs into the world and what it leaves behind"* (Wakkary 2021, 114). Within this accountability, he is clear to describe that biographies are not to be considered as descriptions of past events – rather, they are always becoming. This perspective speaks particularly to the responsibility of the designer, for example, when it comes to maintenance and repair, unintended consequences, or the end-of-life of the designed thing. Biographies also propose a timeline to design that is not retrospective or future-oriented, but rather considers designed things as ongoing in the present. In design research practice, this brings up questions of appropriate documentation and representation. How might we account for design as biography, in ways that make sense for its ongoing nature? How do we present design work in ways that is less 'finished'?

In describing the **designer as force**, Wakkary draws on Jane Bennett's concept of *agentic capacities*. Bennett describes two qualities of agentic capacities as *efficacy* – the creative force – and *trajectory* – the direction of this force. Wakkary also uses Simondon's concept of *concretization* as a quality of the designers as force to account for interactions of artifacts that come into existence through nonhuman interactions

between their relations and their environment. Lastly, Wakkary builds on Latour's *scale one* to describe how the "designer as force" operates at *full scale, and in real-time* – meaning that the boundaries between the designer and what is designed are not always clear, or easy to represent.

The designer as force speaks to the ability to create as human and nonhuman assemblage, and offers particular concepts to distinguish the different ways in which this happens. These concepts will be used in this dissertation when collecting data to investigate the contribution of nonhumans in design research; for example, moments of concretization, anecdotes of entanglements caused by scale one, and ways of recognizing and actively engaging with efficacies and trajectories.

In describing the **designer as speaking subject**, Wakkary turns to the role of the human as the designer of things. This human is understood as a posthuman subject – one that is porous, relational, and more-than-human in and of itself. The human designer of things understands the designer as biography, and the designer as force. It knows it is not the only being that is actively designing; it is a part of the ongoing nature of the design.

These understandings motivate the humility of the human designer. The human designer has a unique quality amongst its nonhuman others: it has the ability to speak amongst muted agents. Wakkary clarifies that this is merely a matter of articulation, not a perception of full agency, or control: *"the speaking subject has the power to express claims of purposefulness and desires on behalf of the designer of things"* (Wakkary 2021, 121). These claims of the speaking subject are always open to be contested.

To speak on behalf of something or someone becomes a matter of equity and politics: *"equity and politics with respect to who is seen to participate agentically, who speaks on behalf of whom, what is said, and what matters of concern arise in answers to these questions."* (Wakkary 2021, 187). The concept of the designer as speaking subject speaks to the paradox of doing posthuman design practice *as a human designer.* It speaks to one of the main challenges of my research, navigating human limitations and ways of knowing. It will be used throughout the dissertation to reflect on my role in the design process.

Wakkary further conceptualizes **the designer as intensities and origins**. This perspective turns away from notions such as (lack of) control, or dominance, and, rather, sees the impact of human and nonhuman designers on a scale that can vary, and can change in the process. It acknowledges an interconnected and entangled perspective on designing, in which design steps or events cannot be credited to one entity, but rather an assemblage of humans and nonhumans that vary in their intensities.

For example, a woven cloth, in its simplest description, is an interaction between warp and weft threads (warp refers to yarns on the loom and weft to yarns that are woven in). In a more inclusive view, this would also include the type of fibres, the way that they are spun, the resulting thickness of the weft and warp thread, the moisture in the air, the tension on the threads of the warp, the way the weft yarn is wound onto the bobbin that sits in the shuttle, the weaving draft, and the strength of the human weaver who is beating down the rows of threads.

The resulting cloth is a co-production influenced by all of these processes and entities that can increase or decrease in intensity and presence: for example, the weaving draft may have to be adjusted based on the thickness of the weft thread and the force of the weaver that influences how the pattern is realized.

In other words, the designer (human or nonhuman) is present at varying degrees, rather than present or not present, amidst other ongoing processes. In these understandings, Wakkary draws on Ingold's perspective of the world at a constant boil, asking *to, "pay attention to the flows and processes that create things and not be so blinded by the things themselves"* (Wakkary 2021, 120). The concepts of intensities and degrees of presence acknowledge a shared stage with nonhumans who have their own agency.

The concept of *origins* refers to Bennet's use of Hannah Arendt's distinction between origins and causes, and presents a less linear, or determined, connection between the two. There are agencies, and there are effects, but the way these come into being are through different trajectories and complexities that are not as easily explainable or predictable. The concept of origins points to the starting points of design trajectories, as they are expressed by the speaking subject, while acknowledging these untraceable points of agency that may also be present.

At the moment of origin, the speaking subject has increased intensity in expressing, articulating, and rationalizing the purpose of the design. It is important to understand the humble role of the speaking subject, despite their ability to be more vocal: "*at the origin or moment of intensities, speaking subjects aspire to stand above the mute things and matter, yet this standing above is always open to rebellion or contestation"* (Wakkary 2021, 191). While the speaking subject is able to articulate statements of purpose and direction, it is always speaking on account of things it may not be able to fully understand or represent.

The concepts of intensities and origins are important for my research, as they will aid in collecting data whilst properly paying attention to the power relations of humans and nonhumans. These concepts emphasize the ongoing nature of processes and actors (human and nonhuman) within design research, and emphasize the importance for the speaking subject to practice ways of speaking that are more open and humbler than what is common in design research.

In this dissertation, I will mainly use the concept of the designer as speaking subject as the unique human role within the design of things. The concepts of designer as biography, designer as force, and designer as intensities and origins, will support my efforts, but are not the main focus. The notion of the designer as a *speaking subject* refers directly to the unique capability of the human designer to speak amongst muted nonhuman designers. In Wakkary's view, this capacity comes with a responsibility for human designers: to represent those non-speaking nonhumans with which they are interconnected, and to assemble them within what he calls a *constituency.* The speaking subject has two essential roles: 1) speaking on behalf of the human and nonhuman assembly that is the designer; and, 2) convening a constituency. In the next sections I elaborate on the concepts related to the role of the human designer as a speaking subject*: the constituency* and *repertoires*.

Constituency

Wakkary introduces the concept of the *constituency* as an expanded view of design; an organizational structure and assembly of humans and nonhumans that aims to make nonhumans more participatory, represented, and cared-for.

Wakkary builds on the term *infrastructuring*; originating in participatory design, pointing to activities of collaborative design that aim to produce not finished designed things, but the conditions or environments from which they can emerge. It could be argued that participatory design is a form of decentering in and of itself; in the way it re-distributes agency away from a single designer, and invites other voices into the process. The notion of care, concerned with matters of maintenance, repair, and becoming, shifts these actions further away from framings of progress and futuring, to focus more on the everyday, mundane, and ongoing.

Wakkary conceptualizes a constituency as: *"gatherings of humans and nonhumans to be at the ready to design things, artifacts, objects or products"* (Wakkary 2021, 217). He compares constituencies to a kitchen, where such gatherings may include the food, spices, and other ingredients, cooking utensils, pots and pans, recipes, chefs and sous-chefs, commitments to particular types of food, and more. Through all this, the constituency becomes a specific, unique assembly. For design research, the constituency may include design tools such as paper and pencils, and post-it notes; software such as Miro, and Adobe's creative suite; machines such as laser-cutters, 3D printers, and jacquard looms; people such as members of the design team, university staff, and external collaborators; materials such as ceramics, wood, and fabric; external events such as conference deadlines, pandemics, and time-zones. The speaking subject is a member of this constituency, and has a unique and active role as a convener, bringing together all the elements of the constituency. In what can be understood as a form of infra-structuring, the speaking subject attends to the constituency in constructing and maintaining it, from which the designing of things can happen.

The Everyday Design Studio, within which the work from this dissertation is situated, is a constituency gathered around matters of academic research. There are professors, graduate students, alumni, and collaborators. There are projects (ongoing and finished), boxes of projects, boxes of grad students', alumni, and collaborators' stuff, prototypes and material explorations, and a communal table that sometimes (most of the time) turns into a project table. There are conference deadlines, grad meetings, program milestones, semesters, project meetings, deployments, and faculty meetings. There are proposal presentations, defences, project assembly days, and studio clean-up days. There is a box of scrap materials, plates of MDF and plexiglass cut to the size of the lasercutter bed, 3D printers of various brands, ceramic objects glued or Sugru-ed

together, laser-cut MDF bowls, a corner with electronic components, and a soldering iron. There is a Flickr account with our photos on it, a Slack group, a Zotero group, and a (very large) Dropbox. There used to be a WhatsApp group, but we recently moved to Signal, because of privacy regulation concerns. There are sketches on the wall, 3D renders, and a group photo of the human studio members at a particular moment in time, on their way to dinner. For each project, a different assembly of all of the above, and often more, come together in biographies. There are ways of constructing new parts of the constituency, by welcoming new students, working with collaborators, and starting new projects. And there are activities around maintaining the constituency: cleaning up the studio, having project meetings and grad meetings, and making changes that better represent the humans and nonhumans in the constituency. As will be discussed in the next section, it matters how this convening, constructing, and maintaining takes place.

For my research, it will be important to understand what was gathered in the constituency, how it was attended to, and how design researchers can do so in ways that are more inclusive and participatory for nonhumans.

Repertoires

The term *repertoires,* as proposed in the book, speaks of processes performed by the speaking subject that aim to increase the participation of nonhumans. Wakkary identified the need for further development of these repertoires, and provides three possible working definitions:

- Repertoires that provide *"new techniques and tools as speech prostheses that account for and realize nonhumans in design"* (Wakkary 2021, 229)*;*
- Repertoires as *"processes that seriously and deliberately engage efficacies and trajectories" and "make visible the force of designer"* (Wakkary 2021, 229)*;*
- Repertoires as processes for *"convening constituencies that find ways for nonhumans to be more present, more participatory, more cared-with and lively within the constituency"* (Wakkary 2021, 229).

Wakkary also offers examples of starting points for repertoires, such as Anna Tsing's arts of noticing (Anna Lowenhaupt Tsing 2017), Vinciane Despret's reframing of research questions (Despret 2016), Donna Haraway's multi-species kinships (Haraway 2003) and Bruno Latour's representations and translations of soil (Latour 1999b). He

argues that approaches like these could be developed and experimented with to be mobilized. Wakkary also offers possible attitude shifts for the human designer, such as acting from a position of *not-knowing,* in contrast to design as problem-solving, *horizontality*, a move to equalize and be alongside nonhumans, and *transmogrification*, a shift in understanding the human self, often as an effect of either of these two moves that further emphasize the porous boundaries of posthumanism.

The concepts of the constituency and repertoires are particularly important to my research problem as they speak directly to actions that the human designer can take to make more present and participatory nonhuman designers. The term, *repertoires*, as it is introduced in the book, is not fully articulated in its relationship to other design activities in design and HCI. As well, while Wakkary offers starting points in the book, there are no examples of repertoires as of yet. In this dissertation, I ask what such repertoires might be, and how they can be developed through design projects.

2.3. Work related to repertoires

To better understand how repertoires can be developed, I outline here how they relate to other activities of design within HCI, and where there is space to further develop their positions. I present a growing body of related works on more-than-human design methods that have started to find ways to make more present and lively nonhumans in HCI. Next, I summarize HCI's rich history of storytelling and narrative as a starting point for better understanding the role of the speaking subject, who speaks on account of humans and nonhumans. Design narratives are also related to repertoires in the way that they connect design methods and activities to their underlying worldviews and philosophies. In the third section, I position speculative design as a particular form of designing within HCI that allows for positions of humility and not knowing from which repertoires can be developed.

2.3.1. Methods of posthuman design

More-than-human methods that draw from posthuman theory have been developed and put to use in design and HCI, and are clear starting points for repertoires, as they find ways within design practice to attend to nonhumans. In this section, I review works that can be seen as ways to allow nonhumans to be livelier and more present in

design, through the employment of thing perspectives, practicing arts of noticing, and designing the tools to do so, thus crafting embodied speculations and more-than-human material engagements.

Thing-perspectives

Design researchers have employed *thing-perspectives* as a way to counter dominant human perspectives. For example, Davoli and Redström presented a design study on postal service infrastructure in northern Sweden, and gathered information on the logistical organization by embedding a parcel with a photo camera that captured its route. This process allowed the researchers to access the previously unknown or overseen, illustrating how thing perspectives can narrow gaps of human knowledge (Davoli and Redström 2014; Davoli, Wiltse, and Redström 2015). Desjardins and Wakkary similarly discussed embedding cameras from unexpected positions (such as in the fridge, or on pets collars) to perceive anew the generously researched context of the home (Desjardins, Wakkary, and Odom 2015). Giaccardi and co-authors developed an approach that they called thing-ethnography, in which everyday things are embedded with cameras to provide insights into human routines from novel perspectives (Giaccardi et al. 2016). Building on this work, the method of interviewing things is one in which inanimate objects are asked questions, requiring an imaginative leap toward imagining spoken answers or stories from the perspective of scooters (Chang et al. 2017), broken phones (Sturdee et al. 2020), or voice assistants (Reddy et al. 2021), as portrayed by researchers or actors.

Thing perspectives are also generatively used in design practice, for example by designing with data from derived from things (Nazli Cila et al. 2015; Desjardins and Tihanyi 2019). The Morse Things project (which will be discussed more in chapter 5) employs a thing perspective in its approach to the design of ceramic cups and bowls that communicate over the internet amongst themselves, without being prompted by human actions – countering a human-centered perspective in their design rationale (Oogjes et al. 2020; Wakkary et al. 2017). In a similar move away from the human-centeredness in the design of things, Lee-Smith's Data Hungry Home (Lee-Smith 2020; Lee-Smith et al. 2019) explicitly placed humans at the service of things through the design of data harvesters: objects that need data to survive and function, such as color and photo data, GPS data, and environmental data. There are various other methods incorporating thing-

centeredness, such as ThingTanks (Giaccardi 2018), thing personas (N. Cila et al. 2015), object theatre (Ryöppy 2020), thing care (Key et al. 2021), thing constellations (Huang et al. 2021), and object-oriented ecologies (DiSalvo and Jenkins 2017; Jenkins et al. 2016). Collectively, these works illustrate how thing-centeredness can provide novel perspectives on contexts and relations, and can be generative for design research. However, there are inherent challenges to taking a thing-perspective as a human designer with blind spots that are challenging to overcome, and limits to, or gaps in knowledge that are important to consider. I will get back to these challenges more in section 1.3.2 on narrative and storytelling.

Noticing

In other more-than-human design approaches, researchers have drawn from Anna Tsing's *The Mushroom at* the *End of the World* (Anna Lowenhaupt Tsing 2017), and propose *noticing* and designing the tools to do so as a method for further decentering the human in design (Cho, Devendorf, and Voida 2021; S.-Y. (Cyn) Liu et al. 2019). Liu et al. employed noticing differently to interpret their ethnographic data of field studies in two farming villages in Taiwan (S.-Y. (Cyn) Liu, Bardzell, and Bardzell 2019b). They framed noticing as a way to attend to and develop potential relationships with nonhumans through symbiotic encounters. Biggs and co-authors employed noticing in combination with auto-ethnography in their study on bird-watching in Bloomington, Indiana. They framed the experience of doing so through the concept of abjection – the necessary rejection of parts of the human self, and the conflict that this creates about being in the world (H. R. Biggs, Bardzell, and Bardzell 2021), and point to the inherent challenges of decentering the human as a human designer. Liu and co-authors presented three provocations that promote multi-sensory acts of noticing, to build an understanding of what human-fungi collaborations might look like (J. Liu, Byrne, and Devendorf 2018). They presented three wearables that generatively ask, do we as humans have the appropriate tools to notice nonhumans?

Embodied speculation

Liu's work in particular connects to another strand of more-than-human design research that employs the involvement of the human body, the design of wearables, or prostheses, that enable design researchers to experience nonhuman external events, or to become part of the technology (H. R. Biggs and Desjardins 2020; Devendorf and

Ryokai 2015b; Dörrenbächer, Löffler, and Hassenzahl 2020; J. Liu, Byrne, and Devendorf 2018). Laura Devendorf's Redeform / Being the Machine is one example that aims to redistribute agency and control away from the human within creative practice by employing the human body differently (Devendorf and Ryokai 2015a; 2015b). Redeform is a portable digital fabrication system technically similar to 3D printing techniques. The system visualizes G-Code instructions into a laser point across a path and allows the maker to go through these points step by step. This system allows for more flexibly working with 3D printing technologies, and invites material and situated engagements.

Devendorf et al. reflected on the true product of Redeform as "the process of labor co-performed by human and nonhuman makers" (Devendorf, De Kosnik, et al. 2016). In another example of wearables, Biggs and Desjardins present the High Water Pants – cycling trousers that respond to climate change data about sea-lever rise in areas in Seattle, Washington, USA (H. R. Biggs and Desjardins 2020). The authors detailed their process, including probe-like explorations such as the 'Assemblage Shooter', mind maps overlaid on photos taken during a bike ride of imagined networks of objects related to cycling, and 'In The Elements', a heart shaped hole cut into cycling shorts to create a heart-shaped tan from exposure to the sun during the bike ride. These design activities aimed to give a voice to nonhuman actors such as biking gear, interactions between cyclists' skin and the sun, the asphalt of the road, and seasonal nonhuman species that cyclists encounter.

In another approach including the human body, Helms and co-authors explored human bodily fluids such as urine, menstrual blood, and human milk in the context of collaborative survival (Helms, Søndergaard, and Campo Woytuk 2021). They present four utopian fabulations through visual narratives that expand the use of bodily fluids and extend them beyond a singular human body, and move them towards more intergenerational and interspecies collaborations. In using human bodily fluids as a design material, Helms et al. illustrated a generosity towards what might be considered a material to design with, and for whom. This is a political move similar to the previously described example by Davoli and Redström, where they embedded a parcel with a camera (Davoli and Redström 2014), as the authors speak of their employed thing-perspective and overall design process as materializing infrastructures.

To make material in this case is a move that enables previously mute or overseen actors to join in the center, and allows designers to work with the matter at hand. Considering bodily waste as a design material and the like disrupts common narratives and uses of bodily waste. To make material is to make it accessible and workable for designers.

Posthuman material engagement

Consideration of waste, obsolescence, and decomposition is a common thread of material engagement within more-than-human design. Dew and co-authors have presented a range of work considering attitudes and practices of designing with waste (Dew and Rosner 2018; 2019; Dew, Shorey, and Rosner 2018). Liu and co-authors looked into processes of decomposition a *"a creative process through which nonhumans bring their own form of agency into design to add value, character, function, aesthetics, and sustainability*" (S.-Y. (Cyn) Liu, Bardzell, and Bardzell 2019a, 605). With this understanding, the authors experimented with ceramics and tactics of decomposition. They reported on using waxed paper cups and slip cast, creating polygonal patterns through the behavior of the clay. In their conclusion, they highlighted how designers should be willing to *"listen, observe, and respond to what nature has to say, as well as learning to be vulnerable and amazed in the design process"* (S.-Y. (Cyn) Liu, Bardzell, and Bardzell 2019a, 612). These works also connect to a larger body of work focusing on enabling material expressions in design (Pierce 2009; Pierce and Paulos 2010), including aspects beyond human control such as breakage (Ikemiya and Rosner 2014; Jackson and Kang 2014) and traces (Giaccardi et al. 2014). These can be considered as starting points for developing repertoires that engage similarly with the materials and tools of design research itself.

The above summarized works on more-than-human methods are ways of engaging with nonhuman forces. I have outlined four themes within these methods: thing-centeredness, noticing, embodied speculation, and material engagement. For this dissertation, I will draw from these methods in my design cases, however, as I will outline in the next section, I believe there is a need to engage more deeply and self-reflectively to do the difficult work of decentering the designer, as is necessary in the development and employment of repertoires.

2.3.2. Storytelling and narrative for the speaking subject

In this section of related works, I will review practices of storytelling and narrative within design and HCI. In this dissertation, I will use narrative strategies in the development of design videos, as well as narrative methods derived from anthropological methods to shift perspectives towards nonhumans. More broadly, I see narrative and storytelling as related to Wakkary's term of the speaking subject, which addresses the unique capability of the human designer amongst nonhuman designers *to speak on account of.* As I will argue through this section, it matters not only to acknowledge that position, but also to be aware of *how* one speaks.

Design and HCI have a rich history with storytelling, narrative, and literary influences. For example, Woolgar's work on the metaphor of technologies as texts to be read by users (Woolgar 1990; 1991), McCarthy and Wright's analyses of experiencing movies and their narratives as inspiration for interaction design (McCarthy and Wright 2007; Wright and McCarthy 2005), and Dourish and Bell's comparative reading of science fiction narratives and ubicomp research (Dourish and Bell 2014). Some of the design's well-known methods, such as personas (Cooper 2004), design scenarios (Carroll 1995; 2000) and performances (Iacucci, Iacucci, and Kuutti 2002), draw directly from storytelling practices, or are set out to develop narratives of potential use in a variety of forms (film, writing, storyboards, etc.).

For example, design scenarios are stories of current or hypothetical use, at times informed by observations, field studies, or ethnography. Often, design scenarios are used to present a concept or product, and ultimately sell it. The narrative value of scenarios has been critiqued for being rather limited, lacking criticality and thoughts on longer-term implications of the presented design (Blythe 2014; Linehan et al. 2014). Personas is considered a design method on its own, but is often used in tandem with the development of scenarios, in which people are imagined as users of the proposed technology. Drawing from film script writing, Nielsen developed users into characters (Nielsen 2002), with the aim of deepening the approach. Nielsen unpacked the approach as character-driven, in line with a shift away from a sole focus on utility and functionality in HCI at the time (Bødker 2006). Unpacking these strands of critique on storytelling practices of design methods further, Mark Blythe has called for greater awareness of the common plots used in design research (Blythe 2017). Blythe recognized that HCI

employs four dominant plots (from Booker's seven basic plots (Booker 2006): overcoming the monster, rags to riches, the quest, and voyage and return. For example, design narratives that follow the *overcoming the monster* plot show the user being helped by the hero (the proposed technology) to overcome a burdensome everyday task. This is ultimately a solutionist and human-centered narrative that, in the context of more relational understandings, does not sit well. There is a need to expand the types of stories we tell about designed things.

Design fiction is a generally well-accepted form of non-progressional design (Pierce 2021), existing between the narrative practice of fiction and design. Through the use of diegetic prototypes, designed things that serve as props in the stories design fictions that are set out to create imaginary worlds with speculative technologies. In contrast with the previously described design narratives, design fictions are often critical, and aim to be disruptive. However, Mark Blythe also points out that even these seemingly alternative approaches more often than not follow similar plots. For example, design fiction often uses the same *overcoming the monster narrative,* but frames the technology, or a lack of debate about its potential effects, as the monster that ultimately needs to be overcome (Blythe 2017). While there are clear differences in the aims and leaps of imagination in the stories of design fiction, the plot structures remain similar to those of more traditional design narratives.

There have been numerous works investigating the literary underpinnings and structures of design fiction (Bleeker 2009; Blythe et al. 2016; Blythe and Encinas 2016; Helms and Fernaeus 2018; Tanenbaum, Tanenbaum, and Wakkary 2012; Wakkary et al. 2013; Wong, Van Wyk, and Pierce 2017). For speculative design more broadly, there is a common practice of drawing from literary practice, including for example magical realist design (Schofield, Bowers, and Trujillo Pisanty 2020) that builds on the literary practice of Magical Realism with its roots in Latin America, Wakkary and co-authors material speculation drawing from possible worlds theory (Wakkary et al. 2015; 2016), and critical fabulations (Rosner 2018) are based on Saidiya Hartman's "Venus in Two Acts" (Hartman 2008). Notably in these approaches and the goals of the stories, whether in text or physical designs, are distinctly different from the more traditional related works discussed above. This is in line with a paradigm shift towards the more entangled, situated, philosophical, political and relational of HCI (Frauenberger 2019). For Schofield, Bowers and Trujillo Pisanty, *Magical Realism* offers a challenging view on

design and temporality. The use of intergenerational time-scales in novels such as Gabriel García Márquez's ***One Hundred Years of Solitude***, Isabel Allende's ***The House of the Spirits*** and Toni Morrison's ***Beloved*** and the perspective from which the stories are told (women's voices that are foregrounded by Allende, and the accounts of slavery by Toni Morrison) are seen as an epistemological narrative resource that resonates with Haraway's call for making trouble and using feminist standpoint theory in HCI (Schofield, Bowers, and Trujillo Pisanty 2020). Danielle Rosner asks whose stories have been left untold in design research and HCI (Rosner 2018), and investigates what it would take to redefine and re-root design in ways that are more inclusive of methods, people, contexts, and (his)tories that have thus far not been central to the field. Rosner challenges design's dominant paradigms, and unpacks how its historical and philosophical underpinnings framed design as a practice of rational problem-solving. Rosner argues that for design to be more inclusive, the field needs to understand and reconsider its roots. Rosner proposes critical fabulations, an approach to design that requires feminist reworkings to investigate and reconsider stories of non-dominant perspectives to find new trajectories and the enhancement of existing design methods based on that understanding. These works exemplify how explicitly working with different narratives can be a generative resource for design.

From this perspective, the more traditional design methods, such as personas, scenarios, and performances, often lack imaginary leaps, and rely on the observable and plausible. These more recent and speculative works apply interpretive storytelling that has further been explored, for example in Desjardins and Biggs' Data Epics (Desjardins and R. Biggs 2021), Berger et al.'s storytelling through things (Berger et al. 2019), and Devendorf et al.'s Design Memoirs (Devendorf, Andersen, and Kelliher 2020), which collectively point out the potential of more personal, open, and multi-interpretative stories for HCI. Similarly, Friske, Brock and Devendorf presented Interpersonal Data Narratives (Friske, Wirfs-Brock, and Devendorf 2020), and push for the entanglement and multiplicity of different narratives that can simultaneously hold truths. There is an opportunity to engage more deeply with the crafting of narratives through design, the particular framings we commit to, and the multiple truths it can hold.

Through this overview of narrative in design research, it becomes clear that it is possible to understand paradigm shifts of the field through the stories that are told through design narratives, along with their structures and emphasis. With a posthuman

framing, narratives of progression, use, and efficiency don't necessarily sit well. More so, in the context of more-than-human-centered design, there is the risk of a narrative of 'discovery' that frames the human researchers as heroes to give a voice to nonhumans. How do we consider nonhumans that are not exciting, or do not make a good story? What might be other narrative forms that are not future- or progress-oriented?

While the more-than-human methods summarized in the above section do bring perspective and accounts of nonhumans to the fore, it is important to acknowledge the translations that are always present through human design researchers as speaking subjects. This work is challenged through blind spots of deeply ingrained human-centered framings. For example, while Giaccardi's thing-ethnography aims to decenter the human through the novel perspective of a thing, it is human behavior that becomes the center of attention through the camera. The notion of sight in this context is ultimately a human one that would not inherently be present in understanding the world through the perspective of a thing. Similarly, Liu's exploration of decomposition in ceramics speaks to material agencies, but in the end is assessed through the human concept of aesthetics. In my own design work, I have similarly experienced blind spots that were enforced by deeply ingrained human-centered thinking — particularly in the Morse Things project, which will be the core of chapter 5.

In an example of using narrative to reframe one's understanding, Leahu (Leahu 2016) reconsidered what could be considered a glitch of the Google Inception project. The paper provides a perspective on machine learning as a way to give insight into relations as the algorithm understands them. The Google project inverted neural network systems for image recognition to generate visuals featuring images that it was trained to recognize. Image recognition systems are trained to identify things (a banana, a hammer, a parachute, a screw, etc.) through large datasets of images that feature this thing. Through this, the system learns what constitutes a particular thing. In Google's project, inversion of this software allowed for feeding the system an image that did not feature a specific thing (often just noise) to be computationally transformed into a visual that featured the software's understanding of what constitutes these things. One particular visualization surprised the Google engineers: when generating an image of a dumbbell, the system included not only the dumbbell, but also (parts of) human arms.

Leahu reframes this instance, which was considered a failure or a glitch of the system by the Google engineers, as an opportunity for investigating the relations within the produced image. In the case of the dumbbell, Leahu claims:

> *What characterizes an entity is not the attributes of that entity but the relations that perform the object as such: the relations through which an object's identity is performed – a weight emerges as a dumbbell by being used as a training weight, typically by lifting it with one's arms.* (Leahu 2016, 184)

Leahu takes a project that is known through an existing narrative and restructures it as an opportunity to better understand how the nonhuman sees the world – in this case, the machine learning algorithm. What this illustrates is that it is not so much the tools, but rather the critical and deep reframing that allows designers to access thing-worlds.

To return to Disalvo's quote from earlier in this chapter, the work of decentering the human ultimately involves our overcoming of narrative fallacies that place ourselves at the top of the chain. The related works on narratives and storytelling therefore serve two purposes. Firstly, they can be seen as a resource for the speaking subject to understand how stories can be told in numerous ways and how it matters how we tell these stories. Secondly, to understand how methods are connected to, and deepened by, narrative. It is in the questioning and critical reflection on these narratives that it becomes possible to decenter the human in HCI.

2.3.3. Speculation as not-knowing

Lastly, the work of developing repertoires is related to speculative design in how it takes up Braidotti's call to generatively engage with posthuman theory (Braidotti 2013). Speculative design is an experimental and reflexive form of design that brings matters of care or concern to the fore, including new or previously overseen perspectives and values, and generatively opens up new design spaces. It often has a critical or open-ended orientation, and a commitment to continuously asking and staying with questions. Speculative approaches include ludic design (W. W. Gaver et al. 2004), critical design (J. Bardzell and Bardzell 2013; Pierce et al. 2015), design fiction (Bleeker 2009; Helms and Fernaeus 2018; Søndergaard and Hansen 2018; Wakkary et al. 2013; Wong, Van Wyk, and Pierce 2017), reflective design (Sengers et al. 2005), slow design (Chen 2020;

Hallnäs and Redström 2001; W. Odom et al. 2018), and material speculation (Wakkary et al. 2015; 2016). While there have been ongoing discussions on how more critically oriented design fits into design-oriented HCI (J. Bardzell and Bardzell 2013; Forlizzi et al. 2018; Pierce et al. 2015), it is becoming increasingly common to generously embrace contributions without the necessity of neatly categorizing what type of design is doing so (Pierce 2021; J. Bardzell 2019). In this section of the chapter, I will outline related approaches of speculative design within HCI, and detail how they are suited for the development of repertoires. Explicitly working to increase the participation of nonhumans is speculative work by definition, as there are limits to how much communication or understanding is possible between humans and nonhumans. Speculative approaches enable this speculative leap as well as a perspective change that is needed to decenter the human in design.

Speculative design is often positioned as an alternative to affirmative design (Dunne and Raby 2014), concerned with questioning the preferable futures as being discursive (Tharp and Tharp 2019), or as in tension with other design trajectories (Pierce 2021). Speculation can also be seen as a way to navigate the unknown without necessarily working towards full comprehension. Instead, it is a way of staying in the space of the unknown and acknowledging the limits of human understanding. There are modes of speculative design that are not necessarily frictional, or future-oriented, but take speculation as a way to engage with imaginaries (Blythe et al. 2018; Nijs et al. 2020), open-endedness (Sengers and Gaver 2006; W. Gaver et al. 2010), and ambiguity (Blythe and Encinas 2016; W. W. Gaver, Beaver, and Benford 2003).

As an example of such an approach, Søndergaard and co-authors applied design fiction to *stay with the trouble*, as per Donna Haraway, who proposed viewing trouble as a way to avoid the determinism of the Anthropocene, as well as techno-optimism, and solutionism (Søndergaard and Hansen 2018). Søndergaard's Intimate Futures design project investigated, through design, ethical and philosophical questions that arose through the increasing presence of Digital Personal Assistants (DPA's). The project demonstrated how feminist perspectives can bring a resistance of resolution to speculative design, and instead commits to a more ongoing approach of *"being willing to make trouble, becoming with each other, telling stories and cultivating response-ability"* (Søndergaard and Hansen 2018, 875).

In another non-progressional approach, Devendorf and co-authors framed HCI amusements as a form of para-research, in which they set out to understand what would make a *non-contribution* to HCI (Devendorf et al. 2019). Building on practices of Fluxus, the paper presents three forms of amusements: a designerly mail exchange, a workshop of disruptive improvisation strategies, resulting in a pamphlet, and a cookbook with tactics for engaging with *the old and the already there.* Amusements contest notions of progress or innovation, which is often implicitly the ambition of HCI contributions, as well as its associated goals of evaluation and analysis.

Collectively, the works summarized above highlight how speculation can be seen as a form of designing that is ongoing in the present, which is experimental and reflexive, and is operating from unknown or not fully defined positions. The work of developing repertoires draws from speculative design practices to better understand and articulate affirmative and generative posthuman design.

2.3.4. Concluding remarks

The above sections have outlined works that relate to what repertoires are, and what modes of design are well positioned to start to develop them. In the next chapter, I will state my research questions, and describe how I will *propositionally* work through three design research cases to develop repertoires.

Chapter 3. Accounting for, attending to, and actively working with nonhumans

This doctoral dissertation presents the work of a design researcher developing ways to increase nonhuman presence and participation in design. This chapter details the methodological and epistemological commitments of this research.

My overarching research question is:

How might designers increase the participation of nonhumans?

To answer this question, I turn to Wakkary's term "repertoires": actions that the speaking subject can take to increase the participation of nonhumans (Wakkary 2021, 229). While Wakkary provides several starting points for developing repertoires, as of yet there are no concrete examples, and the research presented in this dissertation is not only about the development of repertoires, but also is an ongoing inquiry of where they sit in relation to other processes and activities of design.

My main research question is:

How can the concept of repertoires be developed through design practice?

This dissertation shows the work of developing repertoires as it happened through three design cases: Videos of Things, Morse Things, and Woven Things. The work is necessarily explorative in nature, by virtue of the novelty of the term repertoires, the loss of control that comes from a commitment to posthumanism, and the nature of the research that focuses on development through practice. This work employs a propositional methodology, and my research question and theoretical framing evolved through the design work.

Through the three cases I will argue that repertoires exist conceptually, between *narrative* and *method*. In Videos of Things, I explore different narrative strategies that can support the speaking subject. In Morse Things, I employ design methods to trace back the agency of nonhumans in a design research project. Lastly, in Woven Things, I arrive at three repertoires that draw from both of these previous cases to increase the

participation of nonhumans. Repertoires allow for the deeper reframing that narratives enable, whilst leveraging the specificity of methods.

The nonhumans of focus in this dissertation are those of design practice itself: tools, materials, software, and systems. More specifically, across the three cases, that means the nonhumans that I encountered in my design processes, such as half an eggplant, a Bialetti percolator, a chess set, burnt toast, elastic bands, Twitter, LiPo batteries, transducers, broken ceramics, Photoshop pattern presets, black and white cotton thread, a TC2 jacquard loom, lots and lots of knots, pins, a multimeter, conductive yarn, and a vector antenna analyzer. In order to increase the *participation* of nonhumans in my research, I followed a process of firstly better *accounting* for nonhumans (in Chapter 4, Videos of Things). Secondly, I acknowledged the agentic capacities of nonhumans, and explored ways to *bring attention* to them (in Chapter 5, Morse Things). Lastly, I articulated the need to *actively work* with these agentic capacities to allow for increased participation (in Chapter 6, Woven Things). Specifically, I will ask the following sub-questions in the design research cases:

- *How can designers better account for nonhumans in everyday life?*
- *How might designers bring attention to nonhumans in their processes?*
- *How might designers actively work with nonhumans?*

I followed a propositional approach, as per Mackey and co-authors (A. Mackey et al. 2020). The propositional approach is able to generate intermediate knowledge through design. The propositional approach is well suited for working back and forth between theory and design, and fits my research, as it can generatively, iteratively, and practically, refine the understanding of repertoires. The three cases in this dissertation tackle the sub-questions through propositions, reflections, and implications that are carried forward to the next case, as outlined below, and are further detailed in section 3.2.

Proposition 1: Narrative strategies that counter human-centered strategies can be used to better account for nonhumans in everyday life.

The **Videos of Things** case investigates the nonhumans that designed things may encounter in day-to-day life, such as those of home life, and how they relate to each

other through video. It proposes counterfactuality – the inverting, or contrasting, of commonly accepted design norms, as an overarching strategy to overcome human-centeredness in understanding relations with and amongst nonhumans. The Videos of Things were developed in 2016.

This case is included in the dissertation as a way to develop repertoires through narrative strategies. The case illustrates how narratives are able to account for nonhumans, but fall short in increasing their participation, as it is used retrospectively. The next case therefore examines the nonhumans of design practice.

Proposition 2: Design journeys can be used to bring attention to the nonhumans of design practice.

The **Morse Things** project is a case in which the design researchers were committed to a more-than-human epistemology from the beginning of the project. On following through on this commitment, the project experienced a loss of control, as nonhumans "took over", eventually leading to broken cups and bowls, and a deployment study that was cut short. The Morse Things is an ongoing design project of the Everyday Design Studio that started in 2017.

This case is included in this dissertation as an opportunity to trace back the agency of nonhumans, and their creative capacities throughout the Morse Things project, to understand what allowed them to be made visible, to "speak", and how this was initially overseen by the design-researchers who fully intended to be open to a nonhuman perspective.

This case thereby illustrates how difficult it is to do the work of decentering the human designer, *as* a human designer. It presents design journeys as a way to recognize the nonhumans of design practice, and proposes to focus on events, rather than plans or outcomes, to be more attentive to encounters with nonhumans.

On reflection, the use of design journeys is too retrospective to engage with nonhumans, and to allow them to participate. In the next case, I applied the lessons learned in the Morse Things case, and actively applied them in unfinished projects.

Proposition 3: Anthropologically-derived writing methods can be used to actively engage with the nonhumans of design practice.

The **Woven Things** case sets out to explore what it could mean to develop repertoires unbound from common design structures, such as projects, outcomes, failures, and successes, by actively working with the notion of design events. The case offers an opportunity to engage with nonhumans during ongoing processes. Three anthropological writing approaches are applied as possible repertoires. The Woven Things case includes projects of the Everday Design Studio that started in 2019 and are ongoing.

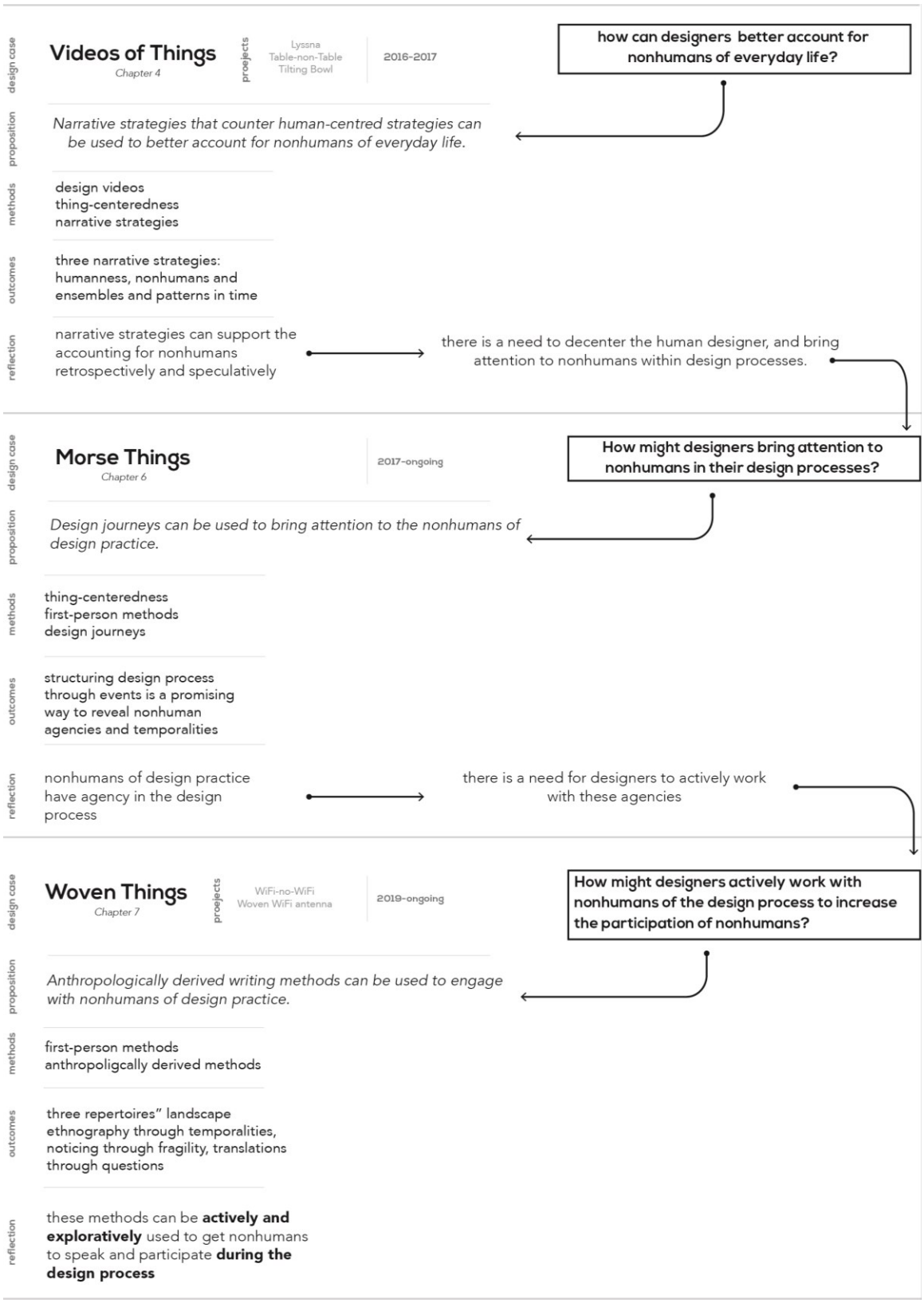

Figure 3.1. Overview of the questions, propositions, and reflections of the three cases in this dissertation.

In Figure 3.1, I illustrate how the questions, propositions, and reflections inform each other.

In the next section, I elaborate further on how I used design in this dissertation, and the specific design cases. Throughout the projects, I have been committed to thing-centeredness as a way to counter the common human focus in HCI, and a first step towards making more space for nonhumans. I also make use of first-person design approaches as they acknowledge a more situated and entangled position that is in line with posthumanism. I describe these methodological commitments in section 3.3.

3.1. Knowing through design

Designed things and design processes are the main mode of knowledge production in this dissertation. Within HCI, this is broadly known as research through design (W. Gaver 2012; Koskinen et al. 2011; Zimmerman, Forlizzi, and Evenson 2007), in which designed objects have been proposed as knowledge contributions in and of themselves (W. Odom et al. 2016), as ways of doing philosophy through design (Encinas et al. 2020; Hauser, Oogjes, et al. 2018), making trouble through design (Encinas et al. 2018; Gatehouse and Chatting 2020; Søndergaard 2020), as well as being involved in more open-ended processes, such as fabulations and amusements (Devendorf et al. 2019; Rosner 2018).

As this field is more broadly accepting types of design, and the questions it can inquire into (Pierce 2021), recent works have also pulled the focus from the outcomes and finished objects of design research to include more detailed processes as forms of knowledge-making (Desjardins and Key 2020; Gatehouse and Chatting 2020).

My use of design is in line with the understanding of creating new knowledge and inquiring into relationships through the making of things. My skills and experience come from a background in tangible interaction design, through which I have learned to acquire and adopt a wide range of creative skills.

Practically, this dissertation includes design activities such as conceptualization, material exploration, preparing for field deployments, collaborating with experts to develop packaging, designing websites, documentation, and creating concept and instruction videos. As my research concerns the role of the human amongst nonhuman

designers, the work is self-reflective, and I continuously examine my relation to the materials I work with in order to communicate the process to the design research community.

As described, I particularly build on Mackey's methodological approach of creating design knowledge through *propositions* (A. Mackey et al. 2020). Mackey and co-authors unpacked this approach as iterative intermediate knowledge-making, in line with conceptual constructs (Stolterman and Wiberg 2010), strong concepts (Höök and Löwgren 2012), and bridging concepts (Dalsgaard and Dindler 2014), in which propositions are formulated at the start of a design case, critically reflected on at the end, and are re-formulated to be taken forward in the next case. In their work, Mackey and co-authors explored the concept of dynamic fabric through a series of consecutive propositions that, by working with the proposition through design, changed into a more nuanced and expanded understanding of what dynamic fabric is, or can be. This approach is well suited for my research as it allows for continuous self-reflection and accumulative development of repertoires over the course of different projects.

The propositional approach allows for working dialogically with theory. There are ongoing discussions on the role of theory in design research (J. Bardzell, Bardzell, and Koefoed Hansen 2015; Beck and Ekbia 2018), and HCI more broadly has drawn from diverse theoretical knowledge, for example, soma-aesthetics (Höök 2018), critical race theory (Ogbonnaya-Ogburu et al. 2020), and mediation theory (Verbeek 2015), to name only a few.

In recent turns, researchers have considered not only how theory can be imported into design practice as well-defined and finished, but also how it can be challenged and expanded on through design — acknowledging the unique insights that can come from reflective practice (Schon 1984). For example, Redström proposed considering theory as unfolding through design as fluid and transitional (Redström 2017). Hauser and co-authors have similarly discussed the ways in which the relation between theory and design research practice can shift throughout an inquiry (Hauser, Wakkary, et al. 2018). They reported on three series of deployments with a material speculation called the table-non-table, and the theoretical shifts that started with theories of social practice and everyday design (Wakkary and Maestri 2007), to Alexander's goodness of fit (Alexander 1964), and unselfconscious interaction (Wakkary, Desjardins,

and Hauser 2015), to eventually postphenomenology (Rosenberger and Verbeek 2015; Verbeek 2010). The paper shows how the study protocols changed with the shift in framing, and how research questions developed throughout. The paper is an excellent example of the dynamic nature of design research as it works with theory, and relates to my work of engaging with posthuman theory through design.

There is a need to not only account for theory in outcomes of design, and how these are studied in deployments, but also to account more for the processes of becoming, and the activities that allow these processes to happen. There is a growing call for attention to unreported, and perhaps, at times, unsuccessful, tangents of design research (Desjardins and Key 2020; Gatehouse and Chatting 2020; Goveia da Rocha and Andersen 2020; Taylor et al. 2021).

For example, Desjardins and Key provided a perspective on the 'through' part of research through design (RtD), and the different forms it can take (Desjardins and Key 2020). Through reflecting on a year-long design project, the authors reported on the messier aspects and lines of inquiry that are not straightforward or oriented towards progression, but can also go in tangents, loops, dead ends, and crosses.

By bringing to the fore the plurality of diverse lines, the pictorial also brings into question the work that goes into the presentation of straight lines of finished, perfect design research stories – the work of making invisible, or neglecting the messier parts of the projects. While this perhaps presents a cleaner, easier to follow story, it is often shaped through a series of assumptions that the design researchers themselves might not be aware of.

Desjardins and Key argued that these messier lines are important to acknowledge in communicating and documenting RtD in order to maintain transparency in creative processes. Reflecting on the position of the designer within these messier processes, Gatehouse and Chatting provided first-person reflections on their design work, and framed inarticulacy as a productive mode of inquiry that allowed them to think about their design projects as problem-making (Gatehouse and Chatting 2020). This paper also showed in detail the work of RtD, and presented it, along with the first-person reflections, as knowledge-making. The paper presented two projects related to networked technologies.

Cally Gatehouse reflected on her process of creating Captive Portals: a project which offers users public Wi-Fi after they've responded to probe-like prompts such as a description of what they've dreamt about. The project aimed to expose data-infrastructures, and to make visible the economic, social, and cultural life of Wi-Fi through exposing the black box of publicly accessible internet.

In the paper, Gatehouse provided a first-person reflection on how she worked through her own inexperience and inability of making the portal function as she imagined, including frustrations *("I began by wanting to open up a black box of technology but ended up feeling like I was inside one")* (Gatehouse and Chatting 2020, 2127) that she later came to see as productive inarticulacy.

David Chatting reflects on his project, in which he set out to hack his Kindle to display William Morris' wallpaper instead of loaded ads when it was inactive. Similar to Gatehouse's reflection, Chatting admitted that the project was put together with *"a degree of chutzpah"* (Gatehouse and Chatting 2020, 2127). The productive inarticulacy that Chatting and Gatehouse speak of resonates with Desjardins and Key's call of seeing the 'prep work', or orientating explorations of research through design projects as valuable, relevant, and insightful.

Particularly, the authors reflected on how their struggles throughout the projects allowed them to access material knowledge: "*we found like any material, the elements that make up network technology are finitely mutable. Just as paper has a grain that makes it easier to tear along one orientation that the other, the network's grain means an ad blocker is easier to build than an ad replacer."* (Gatehouse and Chatting 2020, 2124).

Through this reflection, the authors positioned their work as *"a means to encounter materials that allows to begin to feel possibilities offered by it, but we also become sensitive to what these materials resist articulating"* (Gatehouse and Chatting 2020, 2124). This speaks to the unique type of knowledge that design research is able to access, which is particularly interesting in light of posthuman theory – understanding what the materials (don't) want to say or do.

In summary, my use of design in this dissertation considers the processes of design as knowledge-making, in which theory can be dialogically used and further developed. I will use a propositional approach through which I can develop repertoires.

In the next section, I elaborate on how I do so through the three design cases that are examined in this dissertation.

3.2. Things and propositions in this dissertation

This dissertation includes multiple design research projects, of which some are still ongoing. These projects are all done within the context of the Everyday Design Studio. The projects are material speculations. An important distinction between material speculations and other forms of speculative design is the focus on creating fully functional and material objects. This is different from for example design fictions, that draws from science fiction writing and film and often use photoshop mock ups or representational prototypes that don't have full functionality. This difference is important as I will elaborate on the making of the material speculations in later chapters describing and detailing the design work such as battery testing, programming and other processes.

Material speculations are characterized by how they design norms to enable critical inquiry (Wakkary et al. 2015). The practice has found a discourse within design and HCI and is often accompanied by long-term deployments (W. T. Odom et al. 2014), or co-speculation studies in which domain experts are asked to live with, and participate in, the study (Wakkary et al. 2017; 2018). This participation presents the work of making material speculations while paying attention to and increasing participation the nonhumans within the process. There have also been works that pay attention to the crafting and prototyping of material speculations (H. R. Biggs and Desjardins 2020; Lin, Wakkary, and Oogjes 2019; Oogjes et al. 2020; W. Odom et al. 2019).

This dissertation includes a total of six material speculations in differing stages of the process, which I will examine through three overarching research cases: 1) Videos of Things, featuring Lyssna, the table-non-table, and the Tilting Bowl, B) Morse Things, featuring the Morse Things, and C) Woven Things, featuring WI-FI-no-WI-FI and the Woven WI-FI antenna. Some of the projects in these cases are part of longer co-speculation studies. At times, I will describe the design work in preparation for the deployments, but the co-speculation studies themselves are not part of the dissertation.

While I have paid attention to articulating my processes and the designs in descriptions and imagery, I acknowledge there is an inherent limitation of language when presenting this type of work (Pierce 2014), and some qualities of the design work are better experienced in person or through other modalities.

In the next sections, I will further describe the research cases, and the propositions that were investigated in each of them.

3.2.1. Videos of Things

The Videos of Things project set out to create videos of designed things in an effort to represent them differently than what is common in design videos, such as through scenarios and personas.

The question of this design case is as follows:

How can design researchers better account for nonhumans of everyday life?

As a first proposition to develop repertoires, I suggest countering human-centered narratives of living with designed things.

I chose to work with video as a powerful and flexible tool that is able to communicate the development of relations over time. Video has been able to serve as a means for documentation and analysis. For example, Raijmakers introduced design documentaries (Raijmakers, Gaver, and Bishay 2006), a type of documentary that incorporates *"opposites, paradoxes and ambiguities that are part of everyday life"*. The design documentary approach also aims to inspire design to explore and appreciate aspects that make up the rich fabric of everyday life, rather than resolve them. This form of filmmaking and working alongside documentarians offers a critical third voice for understanding and investigating design work. For example, Gaver deployed cultural commentators (W. Gaver 2007), utilizing the third person perspective of filmmakers to assess the impact of ludic designs in their households.

Video is able to provide rich impressions of imagined scenarios with technologies, focusing on situations of use. For example, Briggs et al. presented

Invisible Design (P. Briggs et al. 2012) – scenarios where characters discussed technologies that were never shown on screen, as a way to focus on the user experience with the design artifact. In another example, Iaccuci et al (Iacucci, Kuutti, and Ranta 2000) explored techniques that situated users and designers in real settings with props or toys to enact future scenarios.

Within more speculative work, video has been used to further probe the proposed future, often exaggerating its strangeness. In the video, *Technological Dream Series: No. 1*, *Robots* (Dunne and Raby n.d.), a woman is shown exploring the Robots in a white room, accompanied by strange "technological" sounds. A similar, though slightly lighter, and humorous approach is used in ECAL's "Delirious Home" (ECAL n.d.), in which a man is shown interacting with extraordinary objects of this delirious home. In both videos, the central focus is on conceptualizing the interactions between the actors and the objects. Relatedly, concept videos are central to corporate visions of new designs and technologies. Ericsson, Google, and Microsoft (Ericsson n.d.; Google n.d.; Microsoft n.d.) have all presented vision videos in which their future technologies are imagined as fluently immersed in the users' everyday lives.

In these instances, video is utilized as a means to situate concepts of technology, use, or even criticism. Our work, while speculative and anticipatory, aims to remain connected to the material nature and particularities of the designed artifact.

In Videos of Things, I consider the making of the films as the research: I exploratively applied different narrative strategies and reflected on what they revealed about the relationship between people and things. The films used in this research feature three material speculations of the Everyday Design Studio.

Lyssna, in 'The Other Half'. Lyssna is a circular wooden sound box that functions as a speech prosthesis for the food in your refrigerator. It is attached to the refrigerator door and rotates every once in a while, to get attention. When it is moved across the door of the fridge, it produces a unique sound for every food item in the fridge. The sounds change over time, representing the state of freshness and the accompanying flavor of the food. Lyssna was created as part of the research for my master's thesis (Oogjes, Bruns, and Wakkary 2016). The thesis aims to reframe the issue of food waste and sustainability in HCI. Rather than building on design theories

based on behavioral theories and human intentionality, Lyssna imagines a role for technology in everyday life that more subtly mediates more sustainable living. The video presents an original script speculating on how Lyssna might be integrated into the main character's everyday life.

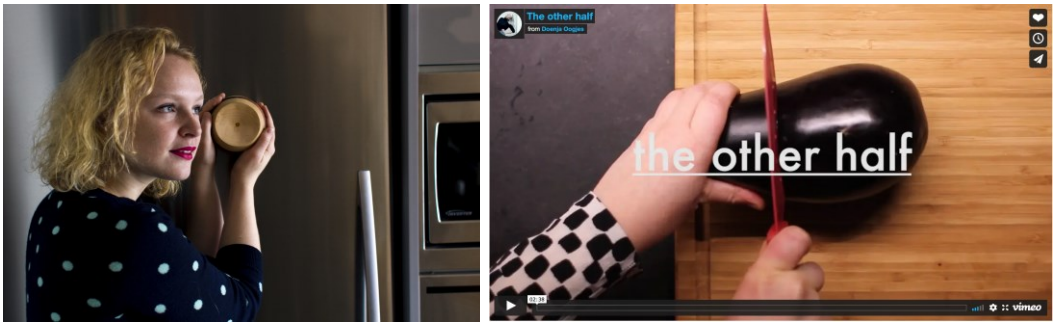

Figure 3.2. Lyssna, in 'The Other Half'

The table-non-table, in '08/08/2016, Vancouver'. The table-non-table consists of a slowly moving stack of paper supported by a motorized aluminum chassis. The motivation for the table-non-table emerged from research on everyday design (Wakkary and Maestri 2007), which primarily included ethnographic studies of people's creativity and resourcefulness in their homes and everyday practices. In a move beyond this empirical work, the table-non-table was developed to theoretically explore, from a material speculation perspective, what could comprise an everyday design computational artifact and what unanticipated resourcefulness and creativity in use may emerge. I was not involved in prior research with the table-non-table, but drew from experiences of involved researchers, their anecdotes, as well as participants' expressions as documented in published works.

Figure 3.3. The table-non-table, in '08/08/2016, Vancouver'.

The Tilting Bowl, in 'Vincent and Vincent. The tilting bowl is a ceramic bowl that tilts three to four times each day. It is an ongoing research project of the Everyday Design Studio that I have been involved with since 2017. The research aim of the tilting bowl was to investigate the nature and type of computational artifacts that can be shaped and given meaning by people as a matter of living with, and performing everyday practices over time. The video was created drawing on anecdotes, experiences and studies with the Tilting Bowl.

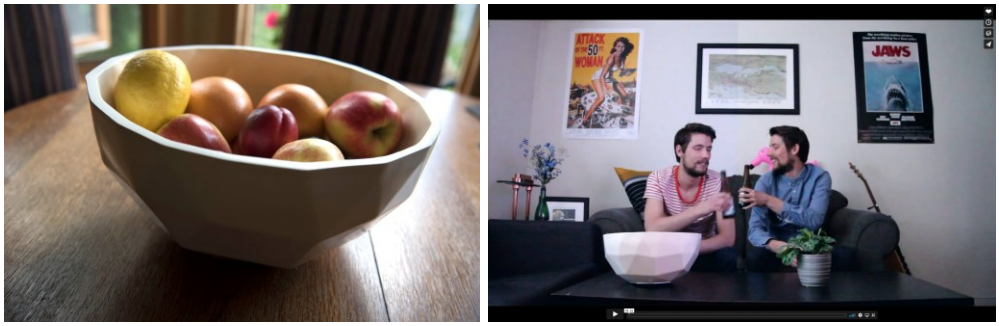

Figure 3.4. The Tilting Bowl, in 'Vincent and Vincent'.

I wrote, directed, filmed, and edited all three videos with the assistance of Ron Wakkary, Anne Spaa, Henry Lin, and Xiao Zhang.

Within these films, I exploratively applied different narrative strategies inspired by posthuman methods such as thing-centeredness, counterfactuality, and nonhuman temporality. In chapter 5, I describe these narrative strategies in detail, and provide a critical reflection on how these were applied in developing the films. The narrative strategies can support the accounting for nonhumans retrospectively, and speculatively, in design dissemination, however, there is a need to further decenter the human designer, and bring attention to nonhumans in the design process. This implication is carried forward to the next research case, the Morse Things.

3.2.2. The Morse Things

The second project in this dissertation is an ongoing design research inquiry that I have been involved in since 2017. This includes parts of the design process, preparation for two deployment studies, and data analysis. The Morse Things project includes the design of sets of internet-connected ceramic cups and bowls that communicate with each other in Morse code. The main focus of the chapter is the

retracing of a loss of control over the project, eventually resulting in the breakage of several of the ceramic cups and bowls.

Figure 3.5. A few of the broken Morse Things.

In this design research case, I ask:

How might design researchers bring attention to nonhumans in their design processes?

With regard to developing repertoires, I propose to trace back the design journey of the Morse Things design research case as the human designers increasingly lost control.

The project is situated within the research on internet-connected devices, and Internet of Things (IoT). Connected devices and things have long been of interest to HCI, building on concepts such as ubiquitous, pervasive, ambient, and seamless computing, aiming to make technology as invisible as possible (Weiser 1991). Internet of Things (IoT) is an active field of interest within this research, and refers to everyday objects that are connected to the internet, often for human-centered purposes, such as efficiency and productivity. There has been a critical response to these concepts, considering, for example, threats to privacy and autonomy (Leitão 2019; Pierce 2019; Strengers et al. 2019). There have also been works that aim to broaden the fields of the site of IoT devices, to uncover new approaches for IoT (Desjardins et al. 2019; Oogjes, Odom, and Fung 2018).

The Morse Things project is led by Ron Wakkary, and has involved members of the Everyday Design Studio: Audrey Desjardins, Henry Lin, Sabrina Hauser, and Tijs Duel, as well as other SFU students: Cheng Cao, Leo Ma, Omid Alemi, Shamim Bakhit, and collaborators through the Material Matters studio at Emily Carr University of Art and Design: Keith Doyle, Shannon Mortimer, Lauren Low, and Philip Robbins. In the

beginning, the research team's commitment in designing the Morse Things was to counter human-centeredness, and follow through on thing-centeredness in design logic. Through its design and deployment, the Morse Things inquiry focused on relations between people and internet-connected things. The first study was co-speculative, with participants from design research and the design industry (Wakkary et al. 2017), and revealed the gap of knowledge between humans and things, and positioned the Morse Things as a "new type of thing" that existed somewhere in between human-centered and thing-centered.

In the next steps of the project, the team set out to strengthen the thing-centered commitment, and deepened the nonhuman orientation through several design activities. My role in the research at this stage was that of a project manager. This position enabled me to access detailed information about the day-to-day aspects of the project, as well as its origins through my previous involvement with the project.

The team's activities included initial concept development, collaborating with Material Matters of Emily Carr University of Art and Design for the ceramic work, developing a computational logic, language, and virtual world for the Morse Things, and a co-speculation study with designers and design-researchers (Wakkary et al. 2017). This required iterations to optimize electronics and create a custom PCB, integration of machine learning, finding participants for a long-term deployment study, developing a website, designing information booklets and instruction videos, collaborations with a local ceramicist, testing batteries for long-term use, and fine-tuning our assembly processes. Throughout these activities, we have learned about the Morse Things in surprising, and, at times, frustrating, turns, exposing the instability of our understanding of what these cups and bowls are.

In this design research case, I reported on three of these activities with the Morse Things:

- integrating machine learning to expand the Morse Things' concepatual world;
- designing packaging to ship the Morse Things to an extended family of five households for a long-term deployment study;
- sending a broken Morse Thing cup to Japan for repair using the traditional kintsugi process.

At this stage of the project, the design team was committed to continuously challenging our human assumptions through design. However, this orientation and the material reality of the Morse Things turned out to be more fragile than the researchers had anticipated, and seven of the Morse Things broke in shipping.

In chapter 6, I trace back the processes (similar to the design journeys described earlier (Desjardins and Key 2020; Gatehouse and Chatting 2020)), and illustrate how this revealed and generated relationships that the Morse Things were a part of that we did not plan for, yet these relationships inadvertently helped us to acquire a better understanding of things and thing-centeredness. I reflect on how things are fragile, and require time to shape themselves. The implication carried forward from this research case is that nonhumans have agency within design processes, at times beyond human control. In order to have productive participation, these agentic capacities need to be actively acknowledged.

3.2.3. Woven Things

The third and last stage of this dissertation involves two ongoing design projects, in which I have engaged in a variety of weaving activities. The two projects use design as a way to inquire into the relationships between people, things, and internet connectivity.

The question of this research case is:

How might design researchers actively work with nonhumans of the design process to increase the participation of nonhumans?

In this research case, I propose to work with design events as starting points for developing repertoires.

This stage of the research is related to works in HCI that are concerned with textile fabrication. The field of smart textiles and wearables is rich and growing, including examples such as project Jacquard, which brought together ubiquitous computing and textile fabrication through a wide variety of techniques (Poupyrev et al. 2016), as well as many examples integrating sensors, actuators, controls, and connectivity with techniques such as knitting, braiding, embroidery, and weaving (Fernández-Caramés

and Fraga-Lamas 2018; 2018; Luo et al. 2021; Nabil, Jones, and Girouard 2021; Parzer et al. 2017). It is clear that it is possible to manufacture computational things in softer materials, however, approaches such as these have also been critiqued as techno-centric and opportunistic (Devendorf, Lo, et al. 2016).

It has also been pointed out that smart textiles, or more simply, working with soft materials in the design of computational things, is not necessarily new, since patents date back to the 1890s (Posch 2020), where jacquard weaving can be seen as an early form of computation (Fernaeus, Jonsson, and Tholander 2012). The field of textiles and computing has further paid extensive attention to its historical and new tools, machines, and materials (Devendorf and Di Lauro 2019; van Dongen et al. 2019a; 2019b; Fernaeus, Jonsson, and Tholander 2012; Friske, Wu, and Devendorf 2019; Posch, Stark, and Fitzpatrick 2019), as well as the ways in which these can be adapted or considered as creative collaborations (Andersen et al. 2019; Devendorf et al. 2020; Goudswaard et al. 2020; Goveia da Rocha, van der Kolk, and Andersen 2021; Nachtigall, Tomico, and Wakkary 2019).

The intersection of textiles and HCI need not necessarily be for “smart” wearable applications – there is an opportunity to expand design’s material focus to include fabrics. In our projects we utilize textile fabrication to design *things*, such as a Wi-Fi-reliant object, and a Wi-Fi antenna. Here too, there is a rich area of related works of internet-connected or radio/frequency-based textile work (Lewis 2020; Psarra and Briot 2019; “Tribe Against Machine Wiki | Afroditi Psarra Swatch” n.d.; “Claire Williams” n.d.; “The Knitted Radio” n.d.). For our research, textiles offer an opportunity for a deeper understanding of nonhuman materials, through its various modes of construction, tools, and the open-endedness and possibility to change direction at various stages of construction. We see that this area of material research, particularly its more speculative orientation, means to engage in ongoing conversations with those materials, tools, and processes – its porous boundaries resonating with our theoretical framework.

In these two projects, I will focus specifically on the processes of the research, and the role of nonhumans within them, such as tools, materials, and software.

The Wi-Fi-no-Wi-Fi project. The Wi-Fi-no-Wi-Fi project investigated relationships with internet connected things. The project involved the making of a soft

portable/luggable/wearable origami pop-up thing that can sense Wi-Fi networks, and is activated only when there are no networks present. As an Internet of Things-thing, it relies on networked connectivity, but reversely functions only when it is not connected. Ron Wakkary, Tiffany Wun, Henry Lin, and I were involved in this project, as well as external collaborator Pauline van Dongen: a fashion designer and postdoctoral researcher at the Technical University of Eindhoven.

Figure 3.6. Woven samples of the Wi-Fi-no-Wi-Fi structure.

My role in this project included the initial conceptualization, and supporting the development of an actuation mechanism. I also conducted explorative weaving on a TC2 jacquard loom, located at TARP (Textile Adaptation Research Program), which is part of Material Matters, at the Emily Carr University of Art and Design.

The Woven Wi-Fi antenna project. This project involved creating a textile Wi-Fi-antenna that could be attached, or become part of, a home router. The goal was to investigate what type of relationship the home router and the home internet might develop if the router had a different spatial and material presence. The project team included Ron Wakkary, Henry Lin, myself, and external collaborator Milou Voorwinden, a jacquard designer at EE Labels, and a design researcher at the Technical University of Eindhoven.

Figure 3.7. First explorations of the Woven Wi-Fi antenna on the TC2 loom at the Unstable Design Lab.

My role in this project included project management, conceptualization, material research and acquisition, designing weaving drafts, and weaving samples. For this project, I visited the Unstable Design Lab at the University of Boulder, Colorado, to weave the first explorations of the antenna designs. I am collaborating with Milou Voorwinden to design the next round of weaving samples and final designs.

In Chapter 6 - Woven Things, I approach three anthropological writing methods as propositional repertoires, and I use my first-person experiences from the above projects as starting points for the writing explorations. While I have some affinity with textiles (particularly through sewing), I was new to weaving, and saw this position of a beginner as a possibly generative way in to learn about the nonhumans of weaving practices within design research. The resulting accounts can be seen as newly generated data-points. I analyzed the produced accounts for what they revealed about nonhumans in design practice (their presence and participation), which could be used to assess their value as participants in repertoires.

3.3. Methodological commitments

Throughout these projects, I am committed to two main strands of design research: first-person design research, and approaches to make nonhumans speak.

3.3.1. First-person design research

The development of repertoires, the collaborations (speaking with, participating with, and caring with) with non-speaking nonhumans, and the documentation of design research, generally does not involve other people, and relies on critical self-reflection. The work presented in this dissertation does not include user studies, deployments, or interviews. As such, this research can be considered first-person. First-person research prioritizes the researchers' first-hand experiences as a form of knowledge inquiry.

A range of first-person approaches are emerging in HCI, including auto-ethnography, autobiographical design, micro-phenomenology, design memoirs, and more. These approaches are descriptive, with a level of granularity that reveals mundane, intimate, and otherwise often overlooked aspects of design practice. First-person methods also acknowledge the researcher's own positionality, and are therefore well suited for introspective reflection on the role of the human in more-than-human design practice.

In their survey of autobiographical design, Desjardins and Ball (Desjardins and Ball 2018) contributed three recommendations for researchers that are considering using autobiographical design as a method. They call for reporting on the origin stories of design project, the decisions, tools and materials, and the personal and academic tensions of the method. The authors also call for an inventiveness in reporting and writing about autobiographical design projects, highlighting the need for a broader variety of writing up research. An example of this within first-person research can be found in *Design Memoirs* (Devendorf, Andersen, and Kelliher 2020). The authors propose this as a method that draws from literary memoirs that through *"an elastic connection to objective truth provides greater space for reflection and poetry"* (Devendorf, Andersen, and Kelliher 2020, 2–3).

In this dissertation, I will be using first-person approaches by collecting data such as project notes, Instagram stories, team communication, design files and sketches, camera documentation, and scans of samples, and progress photos.

In summary, first-person approaches offer opportunities for rendering design researchers capable of asking questions differently, and allowing them to create a space between objective truth and speculation. Methodologically, first-person design approaches are well suited for more-than-human design research, given their commitments to situated research, unique standpoints, and critical self-reflection. However, within a posthuman framework, the dominance of the human voice (in data collection, analysis, and documentation) does not sit well, and needs critical navigation to ensure the inclusion of nonhumans. While I will make use of first-person descriptions and data collection in this dissertation, I am continuously approaching the work from a perspective of posthuman subjectivity, and am positioning myself as what Braidotti refers to as *not-one,* acknowledging that, *"one is the effect of irrepressible flows of encounters, interactions, affectivity and desire, which one is not in charge of"* (Braidotti 2013, 101).

3.3.2. Making nonhumans speak

Making the nonhumans of a design process speak is no easy task: they have no mouths to speak with, let alone a grasp of human languages. Nonetheless, there have been suggestions within design research to aid in the understanding of the perspectives of nonhuman things. In chapter 2, I summarized more-than-human methods of design research.

Throughout the three cases mentioned previously, I integrated thing-perspectives as a strategy to counter human-centeredness. For example, in Videos of Things, I used the perspective of the Tilting Bowl to tell the story. In the video, scenes are temporally structured through frame tilts, and the sound of the motor. Through this, the viewer gets insight into the home, at times when the human characters are not present. This is similar to Giaccardi's thing ethnography (Giaccardi et al. 2016), but takes a more speculative turn, and pays attention to thing-to thing-relationships. I also paid particular attention to nonhuman temporalities throughout the three different cases.

I have paid particular attention to moments of fragility, breakage, and other unexpected material expressions in the design processes, as a way to engage with nonhuman agencies. This relates to work summarized in chapter 2 on considerations of waste, obsolescence, decomposition, and breakage (Ikemiya and Rosner 2014; Jackson and Kang 2014; S.-Y. (Cyn) Liu, Bardzell, and Bardzell 2019a), which are not notions generally aligned with human desires or control. By attending to moments of fragility, I set out to open up to ontological shifts, such as retracing the journey of broken cups and bowls in the Morse Things project in chapter 5, and following a broken thread in the warping process in chapter 6.

Lastly, while this chapter has separated the methodological groundings and commitments of my research, I see them as intertwined: design *is* first-person, and *is* more-than-human centered as a material practice. The challenge is to escape the existing framings of the practice in HCI, and to make this understanding of design research visible. The methodological contribution of this dissertation lies in combining the three commitments to allow for an introspective and reflective account of design research as a more-than-human-centered practice.

Chapter 4. Videos of Things[1]

4.1 Accounting for the nonhumans of everyday life

In this chapter, I describe the Videos of Things case, in which I investigated how to better account for nonhumans that may be encountered in everyday life, such as furniture, food, pots and pans, laundry detergent, a set of keys, ventilators, houseplants, and headphones. This case explores the development of repertoires through narrative strategies. I propose *counterfactuality* as an overarching strategy to overcome human-centeredness in understanding the relationships with, and amongst, nonhumans.

The work in this chapter was motivated by the limitations of typical representations of designed things in concept videos that are often focused on scenarios of use. This is ultimately a human-centered framing that falls short in portraying the complexities and multiplicities of relations in everyday life in which designed things will become entangled. I wanted to understand how video could be used to represent more subtle, everyday encounters of humans, designed things, and other nonhumans; moments that are not reliant on use or other straightforward interactions.

Focusing on the nonhumans of everyday life broadens the scope from those that are more commonly represented, or focused on, in posthuman, or more-than-human interaction design, such as plants, animals, and micro-organisms. Including mundane, everyday nonhuman things is a step towards understanding design practice itself as being more-than-human. In this chapter, I will refer to everyday things and materials as nonhumans. The chapter focuses on how nonhumans can be better accounted for, and represented in, design communication.

The three videos presented in this chapter were created to feature three material speculations of the Everyday Design Studio. While I wanted to emphasize nonhuman things in these videos, I was also aware of the pitfalls of focusing too narrowly on the designed thing. Centering on one particular nonhuman can create similar blind spots as

[1] The majority of this chapter was previously published as a peer-reviewed paper at ACM CHI 2017, entitled: Videos of things: Speculating on, anticipating and synthesizing technological mediations (Oogjes and Wakkary 2017). The text has been edited by adding an introductory section to establish context within this dissertation, elaborating on the narrative strategies, and providing a new analysis using the designing-with framework.

human-centeredness in design. In this chapter, I consider a set of strategies that can focus on the embeddedness of designed things with other nonhumans in everyday life.

I explore the following question in the Videos of Things case:

How can designers better account for nonhumans in everyday life?

This work proposes countering human-centered narratives to make space for nonhumans.

Proposition 1: Narrative strategies that counter human-centered strategies can be used to better account for nonhumans in everyday life.

By utilizing the overarching strategy of counterfactuality, this work challenges human-centered framings of concept videos, and explores what is revealed when opposing familiar narratives. Counterfactuality encompasses the refusal or opposing of commonly accepted norms or practices. It has been employed in speculative design to defamiliarize and generate new design directions (Pierce and Paulos 2014; Wakkary et al. 2015). In Videos of Things, I counter three common strategies present in concept videos. The first strategy, *humanness,* challenges the common use of personas as characters with limited development or arc that ultimately function in service of the proposed technology. The strategy of *patterns in time* aims to move away from design videos that are structured by scenarios of use, framing the proposed technology or design as the main plot point, often neglecting more subtle relations that form between humans and nonhumans over more extended periods. Lastly, the strategy of *nonhumans and ensembles* counters human-centeredness most directly in accounting for nonhumans that are part of everyday life.

I will describe the narrative strategies in section 2, where I reflect on how I used them and their effectiveness in accounting for nonhumans. In section 3 of this chapter, I discuss more broadly how these videos and the narrative strategies contribute to the development of repertoires by describing a concept that emerged through the three narrative strategies: *displacement*. Lastly, I discuss and reframe the proposition of *developing repertoires by countering human-centered strategies* by reflecting on the strategies through Wakkary's designing-with theory. It should be noted that these strategies were initially created without the framework in mind, and so it will be applied

retrospectively. In the conclusion of this chapter, I summarize how the Videos of Things case illustrates how employing narrative strategies successfully accounts for nonhumans, but falls short to increase their participation.

4.2 Three Videos of Things

Videos of Things are videos portraying the everyday, lived world of material speculations. In the upcoming section, I describe the material speculations featured in each video, the goals of the video, and then I break down the video's structure through text and stills from the video. I would like to encourage readers to watch the videos prior to reading the next sections:

- 'The Other Half': https://vimeo.com/148558555
- 'Vincent & Vincent': https://vimeo.com/170852934
- '08/08/2016, Vancouver': https://vimeo.com/178632577

4.2.1 Lyssna, in 'The Other Half'

The first video features Lyssna, a design that functions as a hearing aid for your refrigerator. It is attached to the refrigerator door, and rotates every once in a while, to attract attention. When it is moved across the refrigerator door, it plays a sound corresponding to the food items in the fridge. Lyssna creates a unique sound for every food item that changes over time, representing the state of freshness and the accompanying flavour of the food.

Lyssna was created as part of my Master's thesis, which aimed to reframe the issue of food waste and sustainability in HCI (Oogjes 2016). Lyssna's design approach aligns with others moving away from strategies based in behavioural theories that ultimately put the responsibility of waste in the hands of humans (Strengers 2014). Lyssna promotes a more integrated role for technology in everyday life that mediates more sustainable living. The design of Lyssna was inspired by, and draws upon, Verbeek's mediation theory, which speaks to the mutual influence of technologies and human behaviour (Verbeek 2015; 2010), as well as theories of social practice (Shove, Pantzar, and Watson 2012; Kuijer, Jong, and Eijk 2013). In light of these theoretical positions, I conducted ethnographic studies of domestic food practices. What became

clear through these studies was that food gets wasted beyond human intention or control, and is often the result of a complex coming together of factors that are not quickly resolved in designs that focus on plans and actions to reduce waste. My reason to turn to video within this project was to envision more sustainable domestic food practices that included longer trajectories of food, including shopping, storing, and cooking, as well as other aspects of people's everyday lives that may indirectly impact those activities. I wanted to show how the design, Lyssna, could mediate a more pleasurable, spontaneous, and ultimately more sustainable relationship with food. The video, *The Other Half* (Oogjes n.d.) speculates how food practices can be reconfigured to enable resourcefulness and creativity in cooking practices, and may eventually leave less room for food waste.

The narrative follows Anna, an organized woman who carefully plans each meal, but ends up with leftovers nonetheless. The viewer is first introduced to Anna (Figure 4.1) through some of her daily activities. The video continues to portray Anna's everyday food practices (Figure 4.2). The refrigerator slowly fills up with a half-used eggplant, cherry tomatoes, and zucchini. At the same time, Onno has been texting Anna to arrange a date, but Anna is too busy (Figure 4.3). One day, Onno surprises Anna by spontaneously showing up for a dinner date. Anna is shy at first, worrying that she is not well prepared for this unexpected guest (Figure 4.4). But then she remembers Lyssna. The video briefly portrays Anna using Lyssna (Figure 4.5). Through the inspiration it offers on the combination of leftovers in her fridge, Anna and Onno improvise a meal together (Figure 4.6).

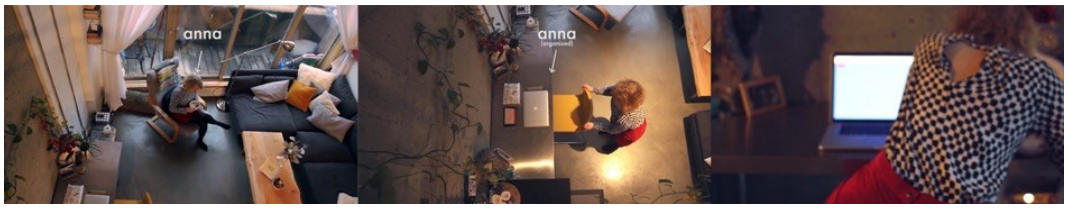

Figure 4.1. 'The other half' introduces Anna as an organized woman.

Figure 4.2. The video portrays her food practices, and shows the leftovers it generates in her refrigerator.

Figure 4.3. Anna has been receiving texts from Onno on different occasions.

Figure 4.4. Onno surprises Anna; Anna panics at first, but remembers Lyssna.

Figure 4.5. Anna listens to the food in her refrigerator with Lyssna.

Figure 4.6. Anna and Onno improvise a meal and have a romantic dinner.

4.2.2 The Tilting Bowl, in ‘Vincent and Vincent’.

The second video features The Tilting Bowl, a ceramic bowl that tilts three to four times each day. The research aim of the Tilting Bowl was to investigate the nature and type of computational artifacts that can be shaped and given meaning by people over time. With this video, I wanted to anticipate how the Tilting Bowl could mediate encounters between humans and nonhumans. In creating the video, I drew on personal experiences of living with the Tilting Bowl to build a story of how it could become a part of everyday life. My experience with the Tilting Bowl was not so much in the direct interactions with it, but in moments of hearing the bowl tilt from another room, seeing

what things were put in the bowl by my roommates or me, and the way it came up in conversations or shared moments with others.

These interactions have been described as *intersections* (W. Odom and Wakkary 2015; Wakkary, Desjardins, and Hauser 2015), nuanced interactions and moments that are not necessarily oriented towards use, and take place between complex sets of people and things. These subtle moments are challenging to represent, especially when explaining the strange yet familiar concept of a tilting bowl. I focused on such aspects in the video by portraying indirect relations and encounters with the bowl. In *Vincent & Vincent*, (Everyday Design Studio n.d.), two men named Vincent are getting accustomed to each other, and their new shared living situation. The video is filmed as perceived from the perspective of the bowl: scenes of everyday situations in the home cut out with the sound of the bowl, and a tilt of the shot.

In the narrative, Vincent is moving into a new place (Figure 4.7). Vincent and Vincent's developing relationship is portrayed through the two of them playing chess (Figure 4.8), and them mutually acknowledging the Tilting Bowl while drinking beer, and watching television (Figure 4.9). Vincent is also shown to grow accustomed to his house by his carelessness in cleaning his spilled beer (Figure 4.10). Throughout the video, a variety of everyday nonhuman actors are portrayed (Figure 4.11).

Figure 4.7. Vincent moving into his new place.

Figure 4.8. Vincent and Vincent are having breakfast, and notice the sound of the bowl.

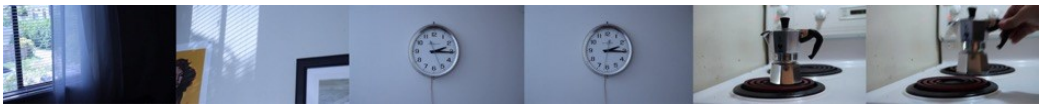

Figure 4.9. The bowl moves, and the video focuses on other everyday things happening in the house.

Figure 4.10. Vincent spills some of his beer, and cleans it with his sock after he makes sure no one is watching.

Figure 4.11. Vincent and Vincent play chess.

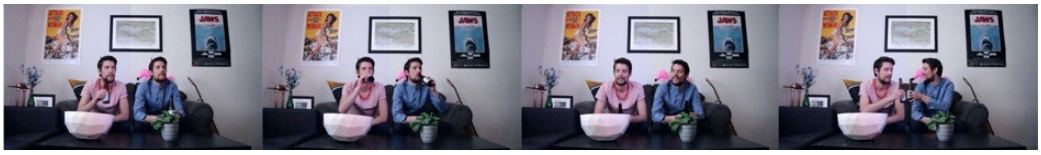

Figure 4.12. Vincent and Vincent are watching TV, and drinking a beer. The bowl moves, and they share a moment.

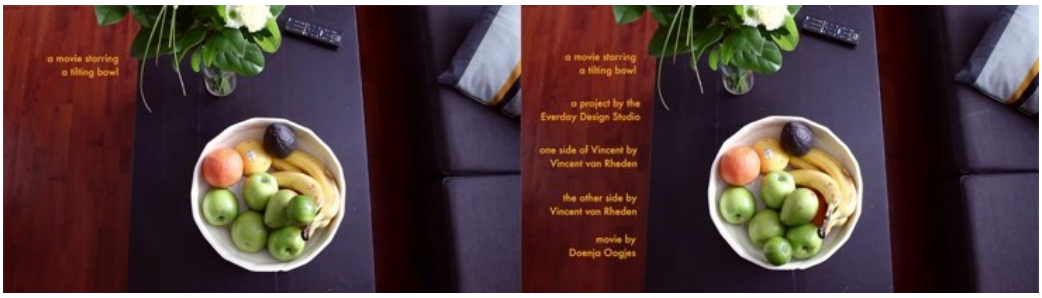

Figure 4.13. The Bowl is pictured during the credits. When it moves, the lime rolls from its place.

4.2.3 The table-non-table, in '08/08/2016, Vancouver'.

The last video features the table-non-table. The table-non-table consists of a slowly moving stack of paper supported by a motorized aluminum chassis. The motivation for designing the table-non-table emerged from research on everyday design,

which primarily included ethnographic studies of people in their homes, and various other everyday practices (Desjardins and Wakkary 2013; Wakkary and Maestri 2007).

Building on this empirical work, the table-non-table was developed to theoretically explore, from a material speculation perspective, what could comprise an everyday design computational artifact, and what unanticipated resourcefulness and creativity in use may emerge (Wakkary, Desjardins, and Hauser 2015; Hauser, Wakkary, et al. 2018). Given this, the stacked paper was used as a core design element, given its familiarity as a material, its flexibility in terms of potential uses, and because stacked paper lends itself to straightforward assembly and disassembly techniques.

In *08/08/2016, Vancouver (Everyday Design Studio 2016)* the main focus was to explore traces of how the table-non-table fit in with everyday practices through its relationships and configurations with other things in the home. This has been referred to as *ensembles:* groups of objects that accumulate over time through human actions, and the relationships between things and their environments (Wakkary, Desjardins, and Hauser 2015; W. Odom and Wakkary 2015). The video was made after a deployment study with the table-non-table, and synthesized the qualitative observations.

In this video, I wanted to communicate the place the table-non-table can take within a household, amongst other nonhuman things. Participants of the study had reported how the table-non-table generally called no more or less attention to itself than other objects. In a sense, this was a measure of its fit within everyday practices, but is distinctively different from common portrayals of technological things as taking center stage, or being especially meaningful. These observations inspired further speculation of how the table-non-table relates to other everyday nonhuman things. I explored an ambiguous human presence as perceived through traces on things in the home.

08/08/2016, Vancouver follows a morning routine of things in the house. The video moves through different areas in the home, and through movement and sound portrays natural elements, human actions, automated objects, and inanimate objects. The video starts in the bedroom (Figure 4.14), moves on to the bathroom (Figure 4.15), kitchen (Figure 4.16), hallway (Figure 4.17), and lastly, the living room with the table-non-table (Figure 4.18).

Figure 4.14. The bedroom depicts a slept-in bed, an ensemble of things on a nightstand, a ticking watch, a vibrating phone, someone opening the shades, bees flying around, a ventilator, and a plant moving from the wind generated by the ventilator.

Figure 4.15. The shower is running in the bathroom. A drip of water is slowly moving down the condensed mirror. The toothpaste is uncapped—the toilet flushes.

Figure 4.16. After an overview shot of the kitchen, the video portrays a squirrel moving across a wire, witnessed through the kitchen window. The percolator makes a boiling sound; the toaster pops out some burned toast. Shadows of various plants from inside and outside the house move across the counter. The video pans out on a stacking of bowls.

Figure 4.17. The house resident grabs their keys and leaves the house, closing the door. The washing machine is in its spin cycle. Its movement makes the detergent bottle shake.

Figure 4.18. The living room features the table-non-table. An empty glass of red wine is placed on the table. The table moves.

4.3 Narrative strategies of Videos of Things

In this section, I further discuss the narrative strategies used in the videos. I describe how I applied each narrative strategy in the videos, and reflect on my approach.

4.3.1 Patterns in time

The narrative strategy of patterns in time aimed to portray particular nonhuman and unexpected temporalities. Video is inherently a temporal medium, yet I sought to emphasize temporality more intentionally, to pay specific attention to lived experiences with the material speculations as they unfold over time.

My approach to the strategy of patterns in time

I defined periods of time as depicted in each video. *The Other Half* takes place over several days, as represented through Anna's changing outfits, various meals she has prepared, and the text messages sent from Onno. *Vincent & Vincent* occurs over several weeks to months, as represented in the transition toward comfort and the settling into a new apartment. *08/08/2016, Vancouver* depicts one day, revealing various traces of a morning routine taken to nightfall through a time-lapse as the video ends. These temporal frames expand the more common short-term scenarios of concept videos.

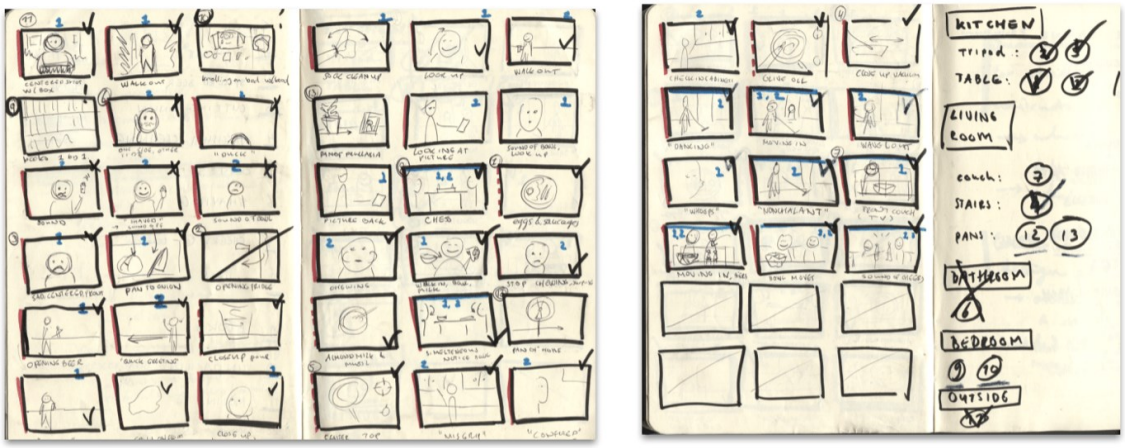

Figure 4.19. Storyboard of Vincent & Vincent that aimed to build their relationship over time.

Explicitly focusing on varying temporal structures is a way to speculate on, and further understand, developing relations, illustrated, for example, in the films of Richard Linklater, that focus on a single day (Linklater et al. 1993; 1997), or revisit characters in different times of their lives (Linklater et al. 1995; 2004; 2013; 2014). This is a strategy used to focus on what changes and stays the same, while giving space for things that may need more time to unfold and evolve.

Figure 4.20. The passage of time in The Other Half, portrayed by Anna's changing outfits and a text conversation that plays out over several days.

In the Videos of Things, narrative is structured temporally through human patterns (see Figure 4.19), cycles, and sequences of routines, like eating, relaxing, and managing daily routines that gave the videos characteristically human rhythms. In *08/08/2016, Vancouver,* I instead explored nonhuman temporal rhythms and movements like weather, the wind, a squirrel running across a power line, or the furious tempo of a washing machine during a wash cycle. In the video, these instances follow each other as

seemingly unconnected, and I played into this absurdity by playing with subtleties of the sound design, for example by letting the sound of a flushing toilet and washing machine play before they appear on screen. I was inspired by Allison Hrabluik's video piece 'The Splits' in which she similarly draws together unrelated instances to tease out parallels, absurd and unlikely relations ("TheSplits" n.d.). The temporal structures aimed to provide a diverse and textured assemblage of human and nonhuman patterns and rhythms, within which the material speculations could become a part of, be shaped by, and in return contribute to, the shaping of the patterns and rhythms.

Reflections on my approach to patterns in time

My use of the strategy of patterns in time contributed to my inquiry into how relations with nonhumans and designed things emerge over time as they are adopted into everyday life. In the videos, my goal was to reveal nonhumans as cumulative and emergent. For example, in *The Other Half* and *Vincent & Vincent*, the expressions of time supported the development of the human relations within the story. In all videos, the patterns in time allowed to explore the small interactions that allow ensembles, whether temporary (such as food leftovers gathering in the fridge), or settled in (such as the Tilting Bowl or the pink flamingo finding a fit with Vincent and Vincent). Patterns in time further enabled my investigation of nonhuman elements and ensembles that I discuss in the next section.

4.3.2 Nonhumans and ensembles

The strategy of nonhumans and ensembles takes on the challenge of accounting for nonhumans most squarely in the three proposed narrative strategies.

My approach to the strategy of nonhumans and ensembles

In each of the videos, I foregrounded nonhumans in the narratives such as food items, utensils, coffee makers, and a chess set. In many respects, this is unavoidable in depicting everyday life, given that we are immersed with nonhumans. However, I gave special attention to nonhuman aspects in *08/08/2016, Vancouver*. In this video, the table-non-table is portrayed as one of the many nonhumans of everyday life. *08/08/2016, Vancouver* features human actions obliquely (opening the blinds, grabbing the keys, closing the door, a dented pillow, an uncapped toothpaste), actions of

nonhuman animals and plants (a bee, a squirrel, and shadows of plants moving across the wall), and actions of automated nonhuman (a ticking watch, a vibrating phone, a flushing toilet, a percolator, a toaster, a vibrating washing machine, and eventually, the moving table-non-table). The video also portrays the interactions between nonhuman elements that complicate these distinctions of actions. For example, the plant and its shadows are moving *because of* the automated ventilator, the water dripping down the condensed mirror would not be there if the shower was not running because of a human, and the detergent bottle is shaking in the rhythm of the violent movement of the washing machine that a human had switched on. I saw this collection of nonhuman activity as part of the texture and connected elements. My aim with using the strategy of including nonhumans was to situate the table-non-table in ways that reveal the various nonhuman to nonhuman relations that configure everyday living.

Figure 4.21. Nonhuman ensmebles in 08/08/2016, Vancouver.

Lastly, in one scene, the pots and pans are swaying, and I intentionally kept it unclear whether this is because of the wind, or turbulent air from human movement, or something else entirely. This serves as a reminder that while we are among nonhuman relations daily, they are simultaneously readily accessible and inaccessible, and there is a limit to what we can know about them.

Reflections on my approach to nonhumans and ensembles

As discussed above, the strategy of emphasizing nonhuman elements is most fully implemented and explored in *08/08/2016, Vancouver*. However, it is also evident and utilized in *The Other Half* and *Vincent & Vincent*. In *The Other Half*, there is a nonhuman ensemble or assemblage of cooking elements in which Lyssna was an integral part. In *Vincent & Vincent*, much of the story was viewed from the perspective of the Tilting Bowl, as the camera angle inexplicably tilts accompanied by the sharp sound

of the embedded motor tilting the bowl (Figure 4.21). In the strategy of nonhumans and ensembles, I was exploring different ways to make present the entanglement of humans and nonhumans.

Figure 4.22. The camera angle tilts from the perspective of the Tilting Bowl.

4.3.3 Humanness

In *The Other Half,* and *Vincent & Vincent,* one of the central narrative strategies that I aimed to develop was humanness in the main characters. My emphasis on human character was to purposely displace the material speculations from center stage to play more of a role as a mediator, amongst other things that also mediate human actions, thoughts, interactions, and relations with their surroundings. This included portraying human characteristics in each character, and exploring the relationships between the characters. At first glance, the humanness strategy may seem to contradict the intentions and goals of nonhuman participation, however, in posthuman theory, it is within these blurry boundaries and the dynamic relationship between humans and nonhumans that are of concern when taken as a whole.

My approach to the strategy of humanness

I decided to cast the same actor in dual roles in each video to underscore the unique humanness of the characters despite their similar appearances, using split screen (Figure 4.23). In *The Other Half*, I paired Anna with her male doppelgänger Onno (Figure 4.24), contrasting their human qualities of organization and spontaneity. In the pivotal point of the video, Anna unexpectedly accepts the unexpected, and invites Onno in for dinner. In my view, Anna acting in this manner (contradictorily) also expressed a degree of humanness in the character, contrasting the logic and reason of characters in concept videos with incongruity and absurdity. After this pivotal decision, Lyssna

emerges as one nonhuman interacting with other nonhumans like the refrigerator, saucepan, knife, and cutting board to support resourcefulness and creativity in cooking dinner on the part of Anna. As a result, Onno and Anna share a spontaneous and romantic dinner.

Figure 4.23. Shots from Vincent and Vincent and the Other Half before adding the second split screen to feature the actor in both roles.

In *Vincent & Vincent,* I portrayed two new roommates (Figure 4.25) who only over time became comfortable, and accustomed to their new living situation, and each other. Their developing relationship is represented primarily through their non-verbal communication, and intersecting daily actions. The video starts with an awkward breakfast. Vincent has eggs and sausages, and the other Vincent has a bowl of cereal with fruit. They exchange looks of apprehension and perceived intrusion into their respective lifestyle and habits. Here, I wanted to emphasize the differences between them as evident and frictional individuals in a living situation. As time moves on, the gap between the Vincents narrows, as their lives continually intersect in their shared apartment.

Figure 4.24. Casting the same actress in The Other Half.

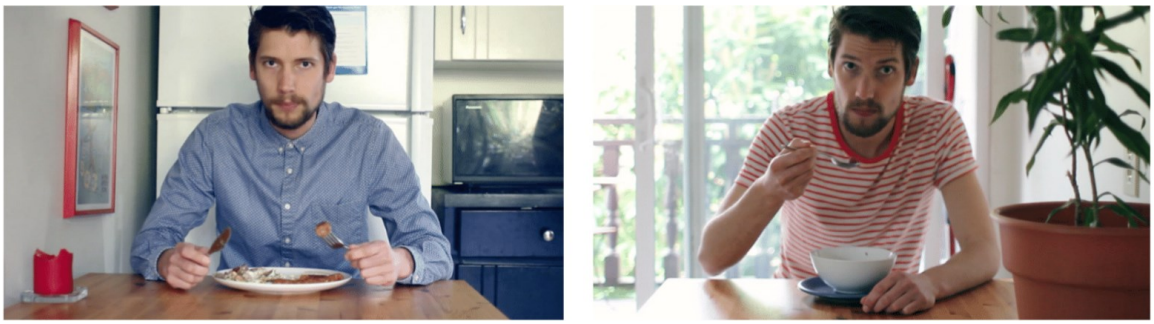

Figure 4.25.Casting the same actor in Vincent & Vincent.

Eventually, the Vincents form mutual acceptance, and even friendship. They play a chess game, and in the final scene, both Vincents are enjoying a beer on the couch while watching TV. The Tilting Bowl was an incidental witness to the two Vincents' navigation of each other. It emerges in the final scene, and tilts. The Vincents exchange a look of recognition, revealing a commonality and shared awareness of each other, the Tilting Bowl, and their surroundings, which had developed over the course of the video.

Lastly, the videos include scenes that portray human messiness, mistakes, or flaws. For example, one of the Vincents in *Vincent & Vincent* spills a drop of beer on the floor when opening the bottle and, after looking to make sure no one notices, proceeds to clean up the spill with his sock. In *08/08/2016, Vancouver*, there is a shot of a toaster that pops out two slices of burnt toast, the bed is left unmade, and there is a trace of a wine stain on the table-non-table. These character trades and how they are represented through both humans and nonhumans were included to break away from ideal portrayals of home life that are common in design videos.

Reflections on my approach to humanness

My intent in the videos was to explore the mediating roles the material speculations of Lyssna and the Tilting Bowl might play within the relations between the individual characters of the Vincents, Anna, and Onno, and their ties to the world around them. I was not looking for how the material speculations would be used; I was more interested in how they contributed to mediating relations and changing contexts. For example, Lyssna was one of many nonhumans amongst others, like a cutting board, knives, a fridge, and food, resulting in resourcefully cooking dinner with leftovers. Similarly, the mutual recognition in the presence of the Tilting Bowl was taken as a sign of comfort and friendship. The mediating qualities of the material speculations that I

wanted to explore or describe would not have been possible without the strategy of character development and expressions of individual human lives and practices.

In my view, the becoming of things into everyday practice is not a foregrounded experience, but rather a background experience, interwoven with motivations, know-how, and the materiality of everyday living, involving particular individuals and their settings. Developing characters in the videos was a way to manifest the particularities of an individual's daily practices, from which the relations with the material speculations could emerge. I appreciate that this is subtle, and perhaps initially seems counterintuitive to the goal of better accounting for nonhumans. The videos foregrounded humans as complex individuals instead of personas, users, or actors of interaction. Despite my intentions, I am cognizant that I was still producing a two-minute (plus or minus) design video that is severely limited in terms of character development. Nevertheless, these videos are promising starts that clearly emphasize expressing humanness in terms of individuality, incongruity, differences, relationships, and unexpectedness as settings in which designed things will invariably find themselves.

4.3.4 Limitations of the strategies

The strategies I explored should be considered as starting points, rather than prescriptive and finalized. Putting the strategy to use will require sensitivities, skills with the medium of video, and experience with expression through narratives. The videos presented in this chapter are a result of sense-making and explorative processes: a storyboard, shotlist and treatment were created for each video (see Figure 4.19 and 4.22), but many scenes were thought of and shot on location. It took several iterations of shooting additional footage and rounds of editing. When putting these strategies to use, it is necessary to consider this extra time.

As I hinted at previously, a two-minute design video is not nearly enough to unfold full, rounded narratives and characters. The humans in our videos can be interpreted in multiple ways: for example, while I aimed for Anna to come across as independent, and Onno as romantic, one might also see her as cold, and him as insensitive. This interpretative aspect could be considered a limitation, but is also inherent in depicting complex human characteristics within the time span of a design video.

	SCENE	MOVING (M) / STATIC (S) / OPTION (O)	LENS	TRIPOD	SOUND	PROPS
	action & post action					
1	dented pillow	S	Canon 28mm f1.8 lens	Manfrotto tripod	x	pillow + pillowcase
2	making the bed	M	Tamron 17-50mm lens	Manfrotto tripod	whoosh	sheets
3	pull up blinds	M	Tamron 17-50mm lens	Manfrotto tripod	blinds	blinds
4	dripping perculator	M	Canon 28mm f1.8 lens	Manfrotto tripod	perculating	perculator
5	coat on chair	M	Tamron 17-50mm lens	Konova slider		coat
						socks
6	condensed bathroom mirror	S	Tamron 17-50mm lens	Manfrotto tripod	running shower	x
7	uncapped toothpaste	S	Canon 28mm f1.8 lens	Handheld	x	toothpaste with twist-cap
8	ringing phone	M	Canon 28mm f1.8 lens	Manfrotto tripod	vibrating phone on nightstand	smart phone
9	flushing toilet	M	Canon 28mm f1.8 lens	Manfrotto tripod	flush	x
10	steps up stairs	M	Tamron 17-50mm lens	Manfrotto tripod	steps	x
	keys on table					
11	closing door	M	Tamron 17-50mm lens	Manfrotto tripod	bang	x
12	burned toast	O	Canon 28mm f1.8 lens	Manfrotto tripod	pop / x	bread
13	unwashed dishes	S	Tamron 17-50mm lens	Konova slider / ⋈		dishes
14	lipstick on cup	S	Canon 28mm f1.8 lens	Manfrotto tripod / Handheld		
15	ticking clock	M	Canon 28mm f1.8 lens	Manfrotto tripod	tick-tack	watch
16	opened book	S	Canon 28mm f1.8 lens	Konova slider / ⋈		book
17	spilled red wine	O	Canon 28mm f1.8 lens	Manfrotto tripod	x	red wine
18	moving TNT	M	Tamron 17-50mm lens	Manfrotto tripod	motors	TNT
	overview shots					
a	bedroom		Tamron 17-50mm lens	Konova slider		
b	kitchen		Tamron 17-50mm lens	Konova slider		
c	living room		Tamron 17-50mm lens	Konova slider		
d	bathroom		Tamron 17-50mm lens	Konova slider		
e	entrance		Tamron 17-50mm lens	Konova slider		
f	view out of windows		Tamron 17-50mm lens	Konova slider		
	CAMERA EQUIPMENT	Henry w/car				
	1x Canon 28mm f1.8 lens					
	1x Tamron 17-50mm lens					
	1x Manfrotto tripod					
	1x Canon T3i camera					
	1x Konova slider					

Figure 4.26. Shotlist for filming 08/08/2016 Vancouver

Lastly, when taking the perspective of nonhumans more explicitly with the strategy of nonhumans and ensembles, there is always a risk of anthropomorphizing. It is tempting to make the video and narrative structure more relatable when focusing on the perspective of a thing. For example, in an earlier version of *08/08/2016, Vancouver*, I added a computer-generated voice that I imagined was the voice of the table-non-table, narrating the story, and carrying the viewer through the morning routine. I quickly decided to leave this voice out of the video, as it made a human character out of a nonhuman table-non-table, which does not have a voice in reality. When taking a thing perspective, there is a need to continuously question human assumptions, and to resist the urge to humanize for the sake of amusement.

4.4 Displacement

I now turn to a concept that emerged from the videos and their making as a possible starting point for repertoires: *displacement*. In the videos, the material speculations are, in many ways, indirectly present. This displacement is a means of decentering the direct use of the artifact to call attention to the many other entities that deserve our attention. The artifacts exist in their video world as one of many actors, portraying adoption into everyday life. In linguistics, displacement refers to the idea of talking about things that are not present in the here and now. For example, when talking about future events (e.g., *"I am going to a concert tomorrow"),* but also when speculating about things and places that we can't be sure of (e.g., *"they will probably play songs from their new album").*

In both the *humanness* strategy, and the *nonhumans and ensembles* strategy, the actual focus of the inquiry is displaced. With the strategy of *humanness*, I attempted to focus on the human, without the designed thing, and with *nonhumans and ensembles*, I gave attention to the world of things, without humans.

Understanding a thing through everything, but that thing could help to expose the importance of the relationships it is part of. This relates to Invisible Design (P. Briggs et al. 2012), videos, in which the design is intentionally left out of the frame. However, while not visually present in these videos, the designs play a significant role in the plot of the stories, for example the characters have dialogues about the invisible things.

In my videos, the thing does not take center stage, but is one of the many actors shaping the world. In that sense, the videos and the way I see displacement more closely relates to design documentaries (Raijmakers, Gaver, and Bishay 2006) in addressing the nuances, contrasts, and variety of elements that make up everyday life.

This notion of displacement in design can help us to see the different roles that one design can adopt. A thing is never just one thing; this way of envisioning can enable computational artifacts to be more flexible and adaptable to everyday life by considering their relationships to other things and people. Secondly, I see displacement as a tool to understand and envision what other things the designed object relates to, and how this accumulates over the long-term within relationships. The concept of displacement has been integrated into further work with the Morse Things, describing it as characteristic of

thing-centeredness, and the quality of our limited understanding (Wakkary, Hauser, and Oogjes 2018).

In the context of this dissertation, the concept of displacement is a way to mobilize the developed narrative strategies, and an idea that will be carried forward in the development of repertoires.

4.5 Reflection on the proposition

This chapter has explored Wakkary's starting point for repertoires as *"new techniques and tools as speech prostheses that account for and realize nonhumans in design"* (Wakkary 2021, 229). In this section, I consider how useful the strategies were in addressing different aspects of the framework of *designing-with.* I reflect on the proposition of developing repertoires through the three sense making terms provided by Wakkary: designer as biography, designer as force, and designer as speaking subject.

Proposition 1: Narrative strategies that counter human-centered strategies can be used to better account for nonhumans in everyday life.

Through the perspective of **design as biography**, Wakkary is clear in stating how biographies are not to be seen as retrospective. The concept of biography asks to account for ongoingness in design. Narrative strategies support three temporalities that I refer to as speculating, synthesizing, and anticipating. These temporalities show how the videos were able to account for relationships with nonhumans in a broad sense, and how this can be helpful in design research.

The Other Half speculates on what a more sustainable relationship with food could be like. The narrative gives room to communicate more details about this preferable future, and the role of technology in it. The work was speculative in that Lyssna was not as fully functional as she could be. The speculative insights of the video allowed me to consider the embedding or mediating aspects of Lyssna, or what something similar to Lyssna might be like. In this sense, the video allowed me to speculate about the material existence of not only Lyssna, but the material relations of daily practices, and other material elements it might be embedded in. The speculation was less a critical account of a possible future as might be expected of a design fiction

video (see for example Corner Convenience by Near Future Laboratory (Near Future Laboratory), and more of a speculative account of the material reality and mediation potential of Lyssna.

In *Vincent & Vincent*, I set out to anticipate everyday experiences, based on the autobiographical experiences of the Tilting Bowl, and past deployments of similar counterfactual artifacts. In the development of the narratives, I used personal anecdotes that I shared with my roommates, and their responses to the Tilting Bowl. The video was developed prior to a multiple-year deployment study with the Tilting Bowl.

The virtue of anticipating lived experiences through video is that it creates awareness of the unique methodological challenges that may be present in the deployment. Typical ethnographic approaches or automated data collection are neither sufficient nor appropriate. The video, and the process of making video, crystallized the effects and experiences that the research team could now set out to support with new methodological approaches. It refined and helped to articulate what type of experiences we were on the lookout for, and also how we might empirically account for them.

Lastly, in *08/08/2016, Vancouver,* I synthesized previously collected observations of technological mediation into a more representative and vivid portrayal. Once the material was represented as a video, it allowed for further reflections and insights in ways that would not have been possible in text and language alone. Through the video, I was able to deepen my understanding of how the table-non-table situated itself among the human and nonhuman ensembles.

These three temporal framings of speculating, anticipating, and synthesizing addressed some parts of the designer as biography. However, in its essence, creating a representational video comes too late in the design process to engage with nonhumans that can actively participate. The ongoingness is emphasized in relationships, but less in the way that the material speculations were open to change, or the participation of nonhumans. As well, while the strategy of patterns in time engaged with, and expanded the way temporality has most often been considered in HCI, the designer as biography urges one to take seriously even wider temporal frames, ones that go beyond human lifetimes, and focus on what is left behind by design practice. The videos do not sufficiently address this part of the theory.

Considering the videos from the perspective of **designer as force**, I reflect here on how the strategies enabled engagement with the agentic capacities of nonhumans. To remind the reader, Wakkary builds on Bennett's understanding of agentic capacities as efficacy — the creative force and trajectory — the direction of this force (Wakkary 2021). In the videos, there were clear moments of efficacy: for example, in how the sound of the Tilting Bowl enabled shared moments between the two Vincents, and how Lyssna prompted preparing a meal with leftovers.

Trajectory is described as the movement of this force, without its purposiveness. In reflecting on the narratives, there is still a clear purposiveness in these videos. The Tilting Bowl supported the conclusion of the video where the two Vincents felt at ease with each other in their new home, and Lyssna was ultimately a pivotal plot moment enabling Anna and Onno to spend an evening together, using up Anna's leftovers – resolving the tension of food waste. Largely, these scripts were written in this way to also be appealing and enjoyable, and while I do see them as different, and more entangled than a common design scenario, there is still a lingering human-centeredness in the importance given to the purpose or role of the material speculations in the story.

This is less present in *08/08/2016, Vancouver*, in which the narrative is driven by a human routine of getting out of the house. The video featured mistakes and errors (such as burning the toast, or a wine stain on the table-non-table), yet these were not featured as tensions or problems to be resolved by the table-non-table, or in general. As such, the video accounted for nonhuman distributed agentic capacities in both efficacy and trajectory.

While these narrative strategies are able to account for distributed agentic capacities, it is important to critically navigate the lingering temptation of returning to purposiveness for entertainment value. I see the concept of *displacement* as one that can go hand in hand with applying the strategies, and speaks to the required attitude of the speaking subject: a reflexive humility that decenters not only the human and oneself, but also the proposed design, in order to bring distributed agentic capacities to the fore.

While the agentic capacities were accounted for in these videos, and through the narrative strategies, the concept of concretization — iterations of nonhumans, was not represented in the videos. The videos featured anecdotes of ensembles, yet these were

mostly retrospective. As Wakkary noted, these concepts are difficult or impossible to represent, and by their nature, are only possible to encounter in real-time (Wakkary 2021). The videos and strategies lack active engagement, and are too retrospective to engage with these aspects of the theory. In order to engage with nonhumans of design more directly, the strategies ought to be located and executed in real-time as well, that is: earlier on in the design process.

Through the understanding of **designer as speaking subject**, these strategies offer ways of speaking on account of the designed thing, which make more nuanced claims of purposefulness. The narrative strategies function as speech prostheses to be used by the speaking subject, in how they were able to account for nonhumans of everyday life. Additionally, video as a medium is well suited to explore forms of speech beyond human language. As an inherently temporal form, I was able to explore more nuanced qualities of representing nonhumans through their entanglement with human and nonhuman temporalities and rhythms. This was further supported by the narrative strategies that challenged my own human-centered framings, and served as a translation into thing worlds. I conclude that there is potential in exploring different narrative strategies and forms as speech prostheses for repertoires.

Lastly, I recognize the **designer as intensities and origins** in the articulation of the concept of displacement. The concepts of intensities and origins in Wakkary's theory refer to the impact of human and nonhumans on a scale of varying presence, and urges to pay attention to the processes and flows (Wakkary 2021). Displacement allows us to not be tempted or distracted by things themselves by pulling focus away from the main character, in our case, the material speculation. However, rather than focusing on the flows and processes of things, displacement redirects our attention to other related nonhumans as they exist in the moment. Another point from understanding the designers as intensities and origins is the role of the speaking subject. While the speaking subject is able to make claims at the moment of origin, these claims are always open to contestation from other members of the constituency. While there was some nonhuman participation in creating the narratives and scripts (their origins stem from my personal experiences with material speculations), this was still mostly human driven, and there was not much room for contestation of nonhumans. The videos and their strategies therefore do not fully support the designer as intensities and origins.

In reflecting on these parts of the designing-with theory, it becomes clear that the potential to employ narrative strategies as speech prostheses should be extended beyond the representation of designed things, to design practice itself, where the human that needs to become decentered is not a general human but the designer herself.

4.6 Concluding remarks

In this chapter I have presented three videos featuring material speculations that I refer to as Videos of Things.

In reporting on these videos, I contribute three narrative strategies that will further enable HCI researchers and designers to move nonhumans of lived-experience to the foreground. These include the strategy of *patterns in time*, which depicts time as a foregrounded element of narrative; *nonhumans and ensembles,* which specifically depicts relationships between humans and nonhumans; and *humanness*, which depicts human qualities from which relationships emerge. These strategies uncovered a concept related to repertoires that I referred to as displacement – the shift of focus from the designed thing to its relationships with other nonhumans.

In summary, the use of narrative strategies that counter human-centeredness were able to account for nonhumans, as demonstrated through the lenses of the designer as biography, designer as force, and designer as speaking subject. Still, while nonhumans were accounted for, the strategies fall short in allowing them to *participate*. The videos were speculative and anticipatory, but from the perspective of designing things, the strategies are too retrospective. In the next case, I explore a different starting point of developing repertoires: *engaging with efficacies and trajectories*. In order to do so, nonhumans need to be accounted for earlier on in the design process. The challenge then becomes not only a matter of decentering the human and countering human-centered narratives in design scenarios, but also a more introspective one, involving the decentering of the human designer, and overcoming deeply ingrained human-centeredness in the practice of design.

Chapter 5. Morse Things[2]

5.1. Introduction

In this chapter, I describe the Morse Things project, in which I explore how to bring attention to the nonhumans of design practice. I propose design journeys to retrace design processes, and to bring attention to the nonhumans of design practice. I aim to bring attention to the nonhumans of design practice such as packaging, UPS, routers, batteries, and ceramics through this case (Morse Things). This case explores the development of repertoires through the reframing of temporal, representational, and organizational design structures.

The work with the Morse Things picks up on Wakkary's call to develop repertoires as *"processes that seriously and deliberately engage efficacies and trajectories"* (Wakkary 2021, 229). This is a way to attend to the *designer as force,* in which agentic capacities are understood as *efficacy* – the creative force – and *trajectory* – the direction of this force.

The Morse Things project is an ongoing design research project from the Everyday Design Studio that centers on sets of internet-connected ceramic cups and bowls that communicate with each other over Twitter. From the start, the project set out to, through design, investigate thing-perspectives, positioning designed things as nonhuman technological entities. The research employs this perspective to the Internet of Things as a way to make space for nonhuman participation, and the design team has continuously challenged its human-centered framings. The project activities include developing a computational logic, language, and virtual world for the Morse Things, preparing for a co-speculative study with designers and design-researchers, iterations to

[2] This chapter is primarily based on a published peer-reviewed pictorial in the full program of ACM DIS 2020, entitled, "Fragile! Handle with Care: The Morse Things" (Oogjes et al. 2020). The chapter elaborates on the text of the published pictorial, and has been edited by adding an introductory section to establish the context within this dissertation. To a lesser extent, the text in this chapter draws from the paper entitled, "Morse Things: A Design Inquiry into the Gap Between Things and Us", which was published in the full program of DIS 2017 (Wakkary et al. 2017).

optimize electronics, and to create a custom PCB, along with collaborating with ceramicists.

I explore the following question in the Morse Things case:

How can designers bring attention to the nonhumans of design research?

This chapter is structured according to three stages of the Morse Things project. I first describe the initial goals and the thing-centeredness of the Morse Things, and provide an overview of their design in section 5.1. In section 5.2, I elaborate on three of the design activities with the Morse Things in preparation for a second deployment study: 1) integrating machine learning, 2) designing packaging for shipping the Morse Things to an extended family of five households for a long-term deployment study, and 3) sending a broken Morse Thing cup to Japan for repair through the traditional kintsugi process. In section 5.3, I describe a turning point in the process that cut the study short, and brought the project to a pause.

In these three sections, I unpack how the design team followed through on thing-centeredness in their design rationale. There is a critical narrative shift in section 5.3, where it becomes clear how the thing-centered approach of the project comes with its own fragilities. I take this opportunity to trace back the agentic capacities of nonhumans that spoke up, and eventually took over in the process. My second proposition towards the development of repertoires is as follows:

Proposition 2: Design journeys can be used to bring attention to the nonhumans of design practice.

I have learned about the Morse Things in surprising and, at times, frustrating turns, exposing the instability of my understanding of what these cups and bowls are. By retracing the events of the Morse Things project, I illustrate how these processes generated and revealed relationships that the Morse Things were a part of that we as a team did not plan for, yet inadvertently helped along, to acquire a better understanding of things and thing-centeredness.

5.2. The Morse Things

This section will elaborate on the design rationale, deployment, and insights from the first version of the Morse Things. The deployment study and its outcomes are discussed briefly. This is intended as a background to frame the design work in section 5.3, which is the core of this chapter.

The Morse Things are sets of ceramic bowls and cups that communicate solely with each other, not in response to human actions. The Morse Things mostly sleep (computationally speaking) and wake at randomized intervals at least once every eight hours. Upon waking, a Morse Thing will send and receive messages to and from other Morse Things in its set. The messages sent by each Morse Thing are in Morse code, and are simultaneously expressed sonically and on Twitter (Figure 5.1). The communication between the Morse Things is purposely limited to communication with each other to bring a thing-centered approach to the foreground. In a sense, the question asked through the Morse Things is: *what is it like to be a thing on a network?*

Figure 5.1. The Morse Things communicate with each other over Twitter as they send messages within each set.

The Morse Things can be used like any other bowl or cup for eating, drinking, and containing items, except that they cannot be put in the dishwasher or microwave. The team designed six sets of Morse Things, each including a cup, a small bowl, and a larger bowl. The Morse Things are made of ceramics that are shaped around electronics. This decision was made to signal the design intention to create a hybrid between an everyday and a computational object.

Each Morse Thing is comprised of a Wi-Fi microcontroller, a sleeping module, an amplifier circuit, a transducer that functions as a speaker, and a battery. When a Morse Thing wakes, it checks an Internet server for messages from other Morse Things in its set. The server coordinates the messages that are sent and received. Each Morse Thing has its name based on its color, size, and set.

The Morse code used for the Morse Things communication combines traditional and adapted Morse abbreviations. Morse code, a character encoding scheme translating human language into dots (.) and dashes (-), is a form of telecommunication used in aviation and at sea, usually sent through light or sound. In designing the Morse Things' virtual world, the team chose to work with Morse code as it is a language that already exists between humans and machines. It is a potentially intelligible language to people, yet it is still very thing-centered.

Figure 5.2. The Morse Things were delivered to the first study participants with a red, blue, and yellow Morse Thing, instruction cards, and a router.

The Morse Things were part of a co-speculation study, an approach in which domain experts are invited to live with material speculations. An MDF laser cut box was designed to host the Morse Things, instruction cards, and a router (Figure 5.2). Six

Vancouver-based designers and design researchers were asked to live with the Morse Things for six weeks, followed by a workshop in which they were asked about their experiences and design things for the Morse Things. The Morse Things fit in with other everyday things in the co-speculators' households, and were used like any other cup or bowl (Figure 5.3).

In the workshop, the co-speculators discussed how they would sometimes compare the Morse Things to pets or teenagers, as partly relatable, but simultaneously inexplicable, or escaping their understanding. Some co-speculators attempted to learn the Morse Things language to understand them better, or to look for patterns or connections between their communication and human practices.

In concluding this study, the Morse Things design team understood these experiences as *tensions in making sense of the gap between things and us*. This is an important insight into thing-centeredness, as it furthers the understanding of the approach's limitations — we can never fully understand, or take a thing perspective. We later elaborated on this insight as ways in which things withdraw from human experience and knowledge (Wakkary, Hauser, and Oogjes 2018; 2020). In other words, the Morse Things — and other nonhumans — are only partially accessible to us.

Figure 5.3. The Morse Things in the co-speculators' households fit in with other dinnerware in a cupboard. They are used to wash some cherry tomatoes, and sit on a cutting board near the sink in an ensemble with other cups and bowls, and a teapot full of loose leaf tea.

To summarize, the first version of the Morse Thing design and study followed through on a thing-centered design approach in terms of how we integrated the electronics in the ceramics, including the logic of using Morse code, and made the choice of letting the Morse Things communicate with each other, independent of humans. However, we felt that there was space to improve on aspects of the Morse Things. This included, for example, the creation of a custom PCB for the Morse Things

circuit, and 3D printed brackets to make assembly more manageable (the electronics were previously attached to the ceramics with elastic bands and Sugru). This involved extensively testing the battery life, and adjusting the sleep circuit code to avoid replacing or recharging the batteries, and creating a more sophisticated packaging design that would support the Morse Things as a research product (W. Odom et al. 2016). As well, there were opportunities to increase the thing-centered and multi-relational approach.

For example, while the Morse Things language was independent of humans, it still felt human-centered in how it was written by the human design team, and was carried out through a script. We also wanted to extend their communication outside of the Morse Things' own sets, and across the entire network of cups and bowls, and started thinking about ways to further study relationality, and the gaps in knowledge through a second deployment.

The next section of this chapter describes the second deployment study and three of the main design activities that were carried out in preparation for it — still detailing the thing-centered design approach.

5.3. Preparing for a new Morse Things study

In line with our research goals of understanding things through broader relationality, we sought to find co-speculators who had an understanding and lived experience of relationality amongst themselves. We saw an opportunity in the parallels between family relations and the Morse Things communication. We were also interested to understand how people of different ages in an intergenerational family dynamic would relate to the Morse Things. We recruited an extended family of six households to get a Morse Things set. This suited our goals of expanding the Morse Things communication across the sets.

Recruiting participants in this way was not effortless, as we could not easily rely on standard recruitment techniques such as flyers, groups on social media, or snowballing. While it is already not without challenges to recruit people for deployment studies with material speculations (as they are admittedly strange things), it was not easy to convince one co-speculator to include four of their other family members. We eventually somewhat serendipitously brought up our deployment plans with a fellow

design and HCI researcher at a conference, and she ended up being our contact point for the study, recruiting her family, and taking on some of the work of explaining the research and its goals. It was beneficial to have a central contact with an interest and experience in similar questions around IoT and relationality to serve as an intermediary between the other households.

Eventually, the deployment study featured five households — leaving us with one spare Morse Things set — across three generations of the family that were centrally connected to our contact point (see Figure 5.4). The participating households were located across the United States in Washington, Texas, and California.

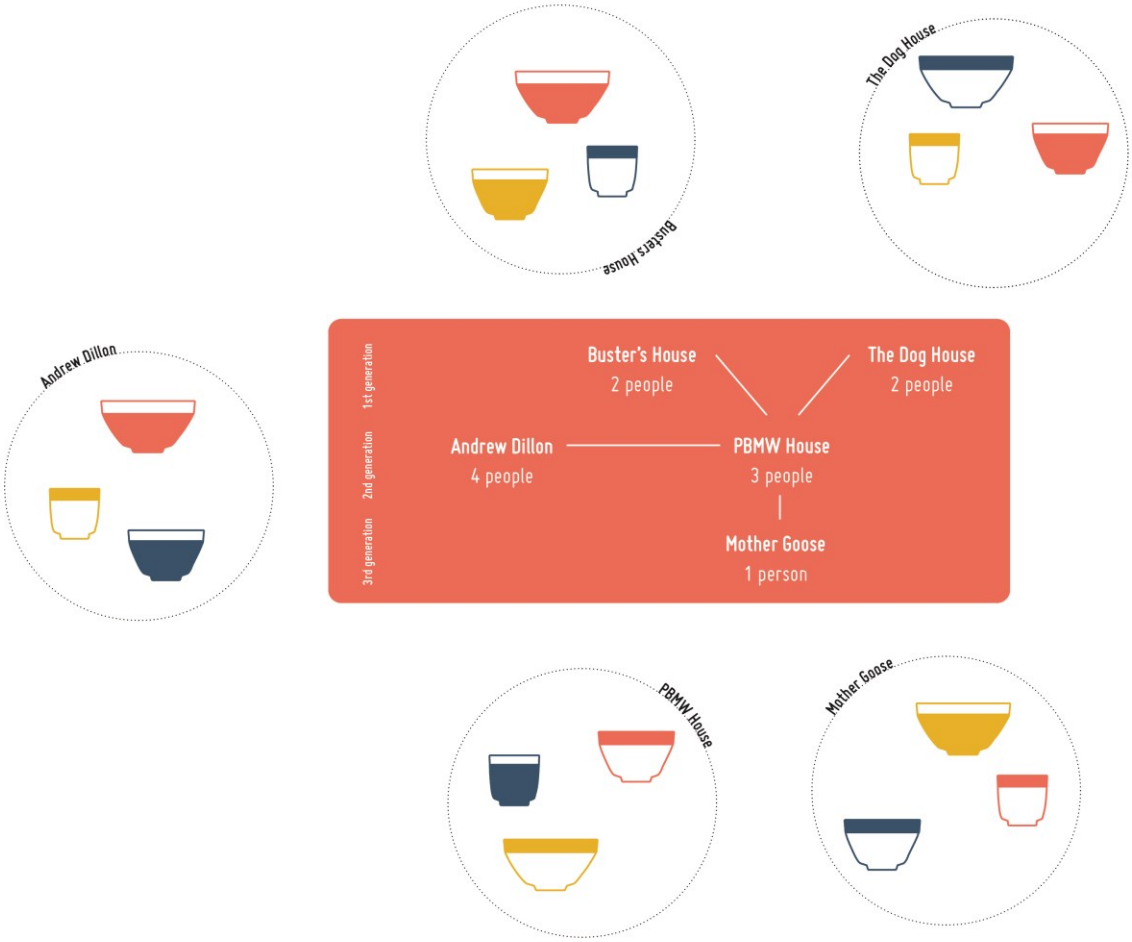

Figure 5.4. Overview of how the Morse Things were distributed to the co-speculators in the study across different generations in the same family.

Each household received a set of Morse Things: a cup, a small bowl, and a bigger bowl in red, yellow, and blue. We asked the co-speculators how they would like

us to refer to their household in the study, resulting in names such as Mother Goose, and the Dog House (see Figure 5.4). The sets were sent to the co-speculators in custom packaging, with an instruction booklet explaining the study, and providing more information on the Morse Things. We also built a custom Morse Things website on which the co-speculators could follow the Morse Things communication of their sets, and those of others. The website featured three videos, one explaining the electronics of the Morse Things, one instruction video on how to set up the Morse Things with the provided router, and one explaining how to package and return the Morse Things after the study was completed (Figure 5.5).

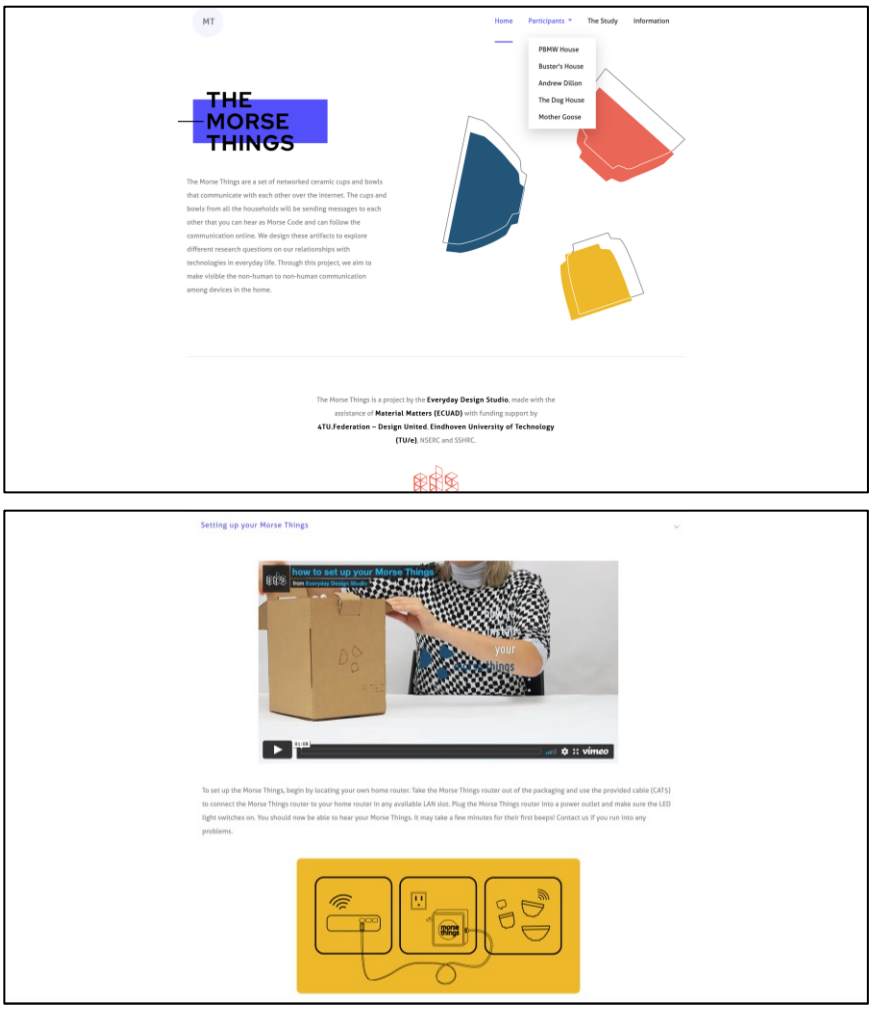

Figure 5.5. Screenshots of the website designed for the participants of the second deployment study with the Morse Things. The website included information on the study, the use and maintenance of the Morse Things, background information on the Morse Things, such as the electronics involved, and instructional videos of how to set up the Morse Things and repackage them for return shipping at the end of the study.

The Morse Things arrived at the co-speculators' houses at the end of August 2019. We did an initial interview with each household over Zoom or on the phone, in which we asked general questions about their homes, and their relationships to things in them. We planned to schedule interviews with the households every 4-8 weeks. Additionally, we asked the households to self-report on experiences with the Morse Things and sent us photos. Similar to the first study, the co-speculators reported on the integration of the Morse Things in their everyday practices as they were used for containing screws, eating ice cream, and placed on a coffee table, amongst other

everyday things such as books, plants, a dog bone, and a newly bought freshly unpacked Apple watch with headphones (Figure 5.6). The following sections of this chapter detail three design processes used in preparing the deployment, and its early ending.

Figure 5.6. In the first few days of the second deployment study at the participants' houses the Morse Things were used to hold screws, ice cream, and food.

5.3.1. Morse Things language

In the initial study, the Morse Things language was thing-centered in its use of Morse code as a form of hybrid language that is only partially accessible to humans. We felt the Morse Things logic and messages were limited, and possibly still too human-centered in their progression. The Morse things followed a logic in which their understanding of their existence grew into the more collective knowledge of the other Morse Things in their set. In practice, this meant that we had a fixed set of messages that were either communicated individually or communally.

For example, a Morse Thing would first say: *calling anyone (CQ)* and move on to saying *calling us (CUS)* to *calling group (CGRP).* The Morse Things would arrive at these messages by reading the messages already on the server. We wanted to extend the communication to cups and bowls in other sets with our new deployment study. We were also interested in creating a less scripted, more complex, and less predictable communication between the Morse Things. We saw an opportunity in machine learning

to decenter further our human assumptions in designing the virtual world and set out to create a learning curve that allowed for the Morse Things to form a temporal and virtual presence.

In our newly conceptualized logic, the Morse Things went through cycles (what humans would call a day). These cycles represented all the available timeslots that the Morse Things could use to plan meetings. Each cycle has 576 Morse Thing units (MTUs), which corresponded to 10 minutes in human time. Over the course of the study, each Morse Thing is looking for a time to meet other cups and bowls from the other households. A Morse Thing wakes up randomly during the day, and when it does, it checks into an online server and chooses a timeslot in the future. If any other cups or bowls have chosen the same time, the Morse Thing is given a reward. Through this process, the Morse Things learn when a good time to meet is, and will adapt their choices to increase the chances of meeting other Morse Things (see Figure 5.7).

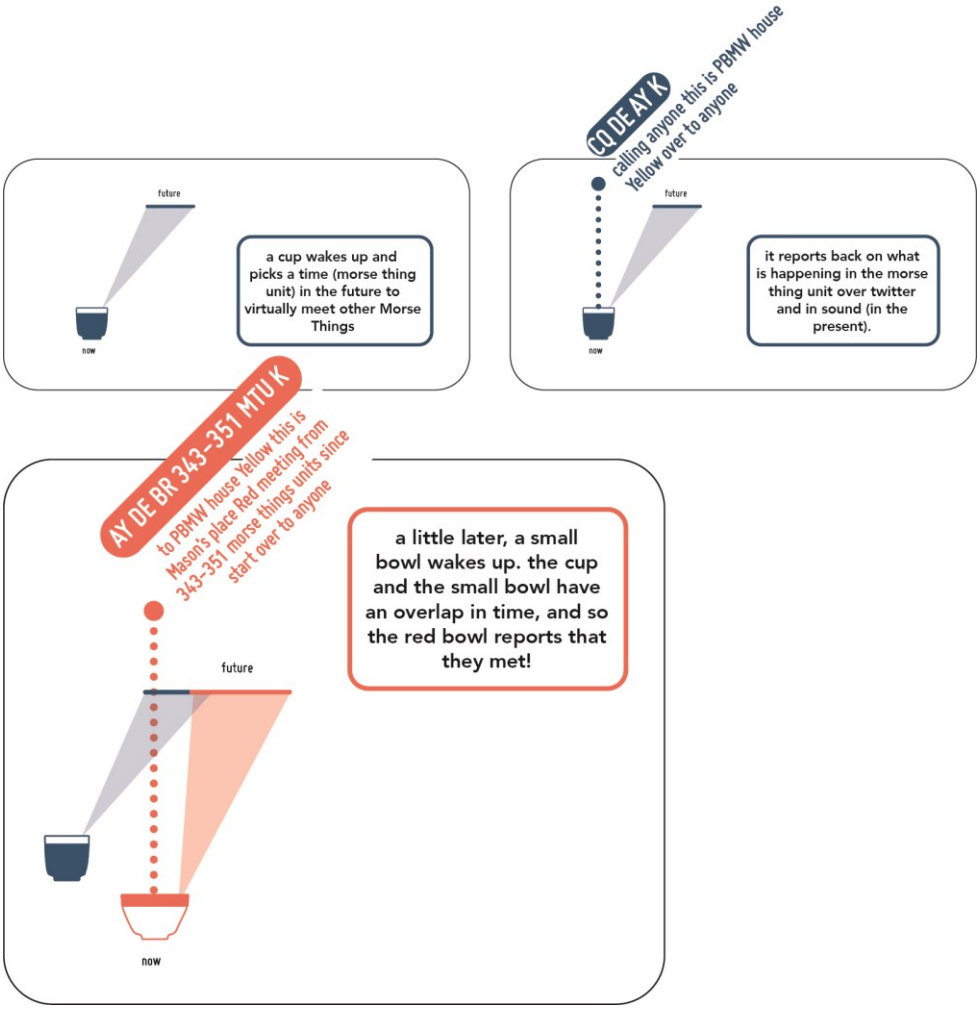

Figure 5.7. An illustrated overview of how the Morse Things messaged each other.

When a Morse Things wakes up in real-time, it will report on the other Morse Things that it has met in the timeslot it has chosen.

A message might look like this:

Figure 5.8. An example of a Twitter message from one of the Morse Things.

In this case, the blue Morse Thing from household 4 (The Dog House) didn't meet any other Morse Things when it checked in to the server.

In another instance, a Morse Thing might tweet the following:

Figure 5.9. Another example of a Twitter message from one Morse Thing to another.

This means that the red Morse Thing from household 4 (The Dog House) met a yellow Morse Thing from household 3 (PBMW House) in the virtual timeslot of 1450 to 1463 Morse Things Units since the router of household A was plugged in.

The conceptualization of Morse Things Units (MTUs) arose from a discussion on how to indicate time in the Morse Things' messages. The team considered these messages (in Morse code, and on Twitter) as not truly thing-centered, but as a necessary part of the Morse Things' existence, to remain intelligible for the participants in the study (after all, the Morse Things don't need to externalize their messages for their own purposes). Using human time (such as hours, days, minutes, and seconds) conceptually did not fit for things that are attempting to meet other things in their shared virtual future, and more practically, the team was also looking for a way to bypass the different time zones that the participants were living in.

Thus, the question emerged: *what is time, for a Morse Thing?* The concept of MTU originated from here. Each Morse Thing starts counting its units from the time it is switched on, and thus, MTUs are a form of time-notation that is relational: 1450 MTUs for the red Morse Thing of household 4 is a different MTU for the yellow Morse Thing of household 3, depending on when it started counting.

5.3.2. Morse Things packaging

As part of the preparation for deploying the Morse Things with an extended family, we collaborated with packaging designer Andrew Zo to create custom packaging for the Morse Things. Our design intentions were to keep the Morse Things safe in shipping, as well as to add to their presentation as a research product (W. Odom et al. 2016; Pierce 2014). We considered three options for the design, including a box that nested the Morse Things similarly as in our MDF packaging of the previous study, as well as separately packaged Morse Things.

We eventually decided on a design in which the Morse Things were vertically stacked. The packaging consisted of a cardboard box with four inserts that contained the large bowl, the smaller bowl, and the router. The cup was stacked separately with a piece of cardboard as padding. To assist participants in shipping the Morse Things back at the end of the study, we created the instruction video that was featured on the website, explaining how to repack them (*How to Repack Your Morse Things* n.d.).

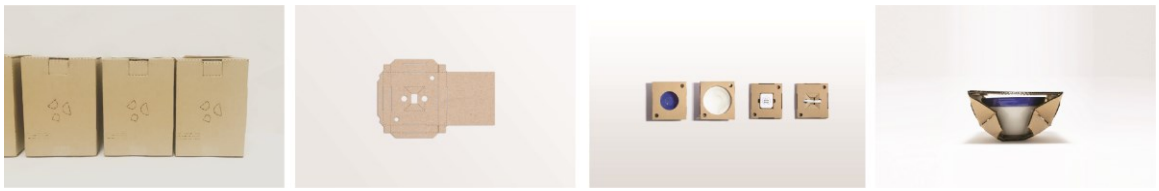

Figure 5.10. Overview of the different parts of the packaging design.

Figure 5.11. Stills from the video explaining how to repack your Morse Things.

5.3.3. One Kintsugi cup

In the process of designing the packaging, one Morse Things cup broke. The team set out to fix the cup through kintsugi: a traditional Japanese method of Wabi-sabi, an aesthetic that values transience and imperfection. We saw this as in line with thing-centeredness through connections with research on material expressions, and as a way to value the cup through maintenance and repair.

Through a local ceramicist, the broken cup was sent to a kintsugi master in Japan. This process included multiple iterations of filling the gaps of the broken cup with mixtures of black lacquer, flour, fine wood particles, fine stone powder, air-drying in a moisture box, painting with black lacquer and polish, and eventually finishing with gold-leaf. The kintsugi repair is a particularly lengthy and challenging process as a proper process is dependent on humidity and weather, the complex shape of the cup, and the severity of the break of the Morse Thing cup.

Figure 5.12. The Kintsugi process of the small broken cup.

5.4. Turning points

In the upcoming sections, I describe turning points in the process that cut the study short, and allowed me to retrace the trajectories and efficacies of the Morse Things.

5.4.1. The Kintsugi cup broke again

The Morse Things are composed of two ceramic parts that house the electronics: a custom PCB, a transducer that functions as a speaker with a neoprene patch to ensure it is pressed against the ceramic surface, and a LiPo-battery. These parts are adhered to the inner ceramic part using 3D printed brackets and Sugru, a silicone-based, mouldable adhesive. The outer ceramic is placed on top, and is adhered with small pieces of Sugru. The Morse Things were then wrapped in rubber bands to ensure that pressure is kept on the neoprene patch, as well as to reduce the gap between the

two parts. The Morse Things are finished with two layers of silicone caulk to seal and waterproof them.

Figure 5.13. Two assembly steps of the Morse Things: the housing of the electronics, and the applied elastic bands to keep pressure on the transducer as the sugru dries.

The assembly process also involved programming the different Morse Things, and making sure that they were named individually in the code (per color, size, and household), and placed in a corresponding ceramic vessel. The assembly was a coming together of many different parts of the design process that needed to align, such as battery testing and charging, finalizing the videos, launching the website, printing the booklets, assembling the packaging design, and including printed return labels from UPS for return shipping, and receiving the signed consent forms from the co-speculators.

In this part of the process, we had set up a separate room with tables to keep the many moving parts of the project organized, and had set a date to assemble the 15 Morse Things (three cups and bowls in five sets), allowing the silicone to dry, and driving them to the UPS store to be mailed out.

Figure 5.14. The assembly process, with a to-do list, and going through the process of fitting the two ceramic parts of the Morse Things together.

Figure 5.15. The outer part of the kintsugi repaired cup broke again during the assembly process.

The pressure applied when placing the outer ceramic part over the electronics of the kintsugi cup released the bond of the kintsugi repair, and the cup broke, again. While we were disappointed by the breakage of the kintsugi cup, we had a spare cup from our sixth set that we were able to use in the study, and so we still sent out the Morse Things to the participants, while we considered how to move forward with the Kintsugi cup.

5.4.2. An early return shipping

Upon the arrival of the Morse Things at the households, one of our participants informed us that the bowls were lighting up frequently. We initially dismissed this as simply part of the Morse Things waking up and checking in to the server, or the randomness that we had desired from the machine learning element. However, as time progressed, we could see on the server that not all the Morse Things had started sending messages, and that the ones that had were slowing down. Something was wrong: either the Morse Things routers were not set up properly, or the batteries were dying.

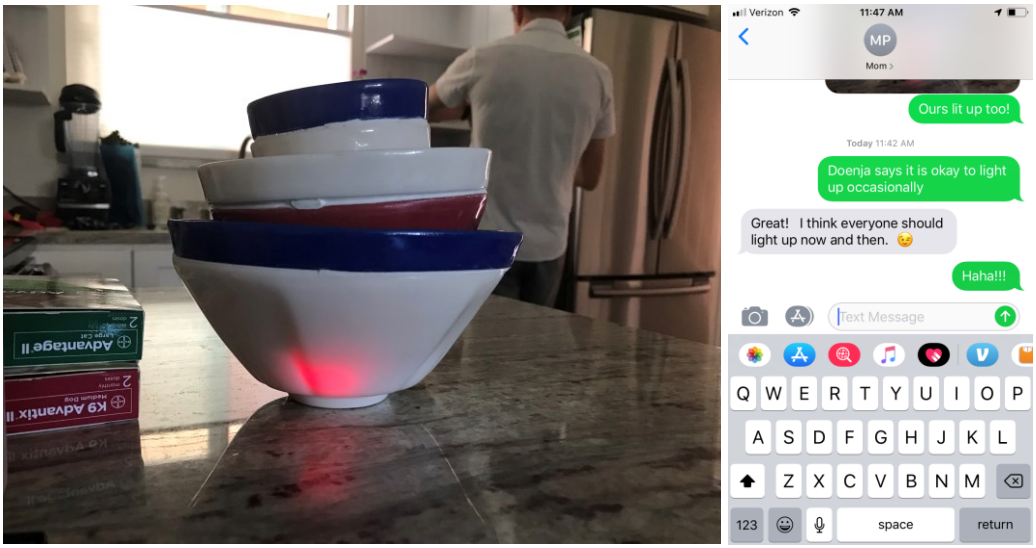

Figure 5.16. An exchange between two households' members of the study, and the Morse Things lighting up.

In preparing for the long-term deployment, we extensively tested the battery life of the LiPo batteries, and Henry had programmed a sleep-loop to save power when the Morse Things were not computationally awake. However, as the Morse Things first wake up, they search for the Morse Things Wi-Fi network. What we had not accounted for in

the tests was the power it would take the Morse Things to continuously search for this network in shipping, when the network was not yet active. This drained the batteries much more quickly than we had anticipated, and, as a result, the Morse Things did not work properly upon arrival at our participants' houses. We asked the households to send the Morse Things back to us to recharge the batteries, and to resolve the issue with the batteries draining over shipment.

However, in returning the Morse Things, we discovered that the designed packaging had failed to protect the Morse Things, and six Morse Things broke in shipping. In unpacking the broken Morse Things, it looked as though the Morse Things cup that had loosely rested on a cardboard piece of padding had smashed into the bowls. The use of cardboard as padding between the vertically stacked Morse Things did not suffice in absorbing the shocks that the packages had encountered along their shipping journey. In the instructions to participants, it was not clearly communicated to pay proper attention to the importance of individually wrapping the Morse Things in bubble-wrap — something we had only realized at the UPS store when we shipped them out, after our final assembly — but did not include in our repackaging video for our participants to ship them back to us.

Figure 5.17. The Morse Things as they arrived from the return shipping.

5.4.3. The different trajectories and efficacies of the Morse Things

I have provided an overview in Figure 5.18 of what, in hindsight, is an obviously fallible process, where I highlight the contrasts between our moments of confidence, and our moments of breakdown.

In the conceptualization of the Morse Things' world, we paid attention to different trajectories and efficacies, including the virtual time in which they plan their meetings, the real-time in which they tweet and beep in Morse code, and the different time zones

of the locations of the participants. This shifted and specified our questions from *what is it like to be a thing on a network?* to *what is time for a thing on a network?* and allowed to conceptualize Morse Things Units – that function independently from human conceptualizations of time.

More practically, we also considered the long-term deployment needs, and the battery power that it would require to run a study for a year or more. However, as became clear in the previous pages, the conceptual considerations overlooked more practical temporalities of the Morse Things network, such as drying time (for the kintsugi cup), and shipping time (for the battery life), as well as important material elements such as bubble wrap and my negligent communication with the participants.

As we made space for certain nonhuman efficacies and trajectories, others became blind spots. We had always considered the Morse Things cups as particularly challenging, as they have limited space to house the electronics and the battery. The focus on circuitry and batteries made us overlook the obvious fragility of ceramics. Even when one broke, we thought this would be a rare occasion that could be celebrated in its uniqueness through kintsugi and its continued use in the study.

In the packaging, the cups were protected with one piece of cardboard padding that separated them from the medium-sized Morse Thing bowl. We were taken by the resourceful use of the cardboard, and how the packaging stacked the Morse Things within each other. This blinded us to the obvious; placing the cup inside the other bowls meant that it became like a small torpedo that broke the other Morse Things as it moved around during the shipping.

These moments in the process revealed actual and temporal worlds of the Morse Things that we were not attuned to, and, eventually, the “thingness” of the Morse Things meant that they did not go along with our plans, timelines, and what we saw as important.

The Morse Things project set out with the intention of inverting human-centered framings of the Internet of Things, and considered instead what it could be like to be a bowl that communicated with other bowls on the internet. This approach opened up ontological surprises, such as the Morse Things being compared categorically to lost socks, pets, and teenagers: things we don’t fully understand or follow, but nevertheless

form attachments to (Wakkary et al. 2017). However, as this chapter illustrates, aspects that were on the periphery, or completely outside of the design research focus, revealed the essential practical, conceptual, and creative relations with the Morse Things. I want to note that it took effort to see these turns as potential learning moments, and I recognize that some of these ‘blind spots’ might just seem rather naïve in hindsight (such as emphasizing the need for bubble wrap in shipping ceramics). However, I also see these more mundane material realities as often being skipped over in human-centered design.

Figure 5.18. In this overview, the white line represents the chronological timeline of the Morse Things project. Blue lines represent the retraced trajectory of the shipping and packaging of the Morse Things. The yellow line follows the trjacetory of the kintsugi cup, and lastly, the red line follows the trajectory of the machine learning and battery life.

5.5. Design Events

A preliminary outcome of the Morse Things case I would like to discuss is the concept of *design events*. In the turning points, our attention shifted to (overlooked) processes, rather than design outcomes. As well, in hindsight the event of the Morse Things assembly encapsulated many starting points for trajectories that eventually led the Morse Things back to us (the batteries, the packaging, and the re-broken kintsugi cup). I propose a framing of design events as a way to engage with nonhumans of design as it allows for understanding them as they are encountered, and as active and ongoing.

This is an ontological shift, with origins in Whitehead's process philosophy (Whitehead 1979) that prioritizes action, or happenings. Latour draws on the notion of events to emphasize the lack of control or mastery in action: *"there is no object or subject (…) but there are events. I never act, I am always slightly surprised by what I do"* (Latour 1999b, 281). Ingold sees the material world as being at a constant boil, in which materials don't *exist,* but rather, *occur,* and emphasizes the need to acknowledge these active states of materials in the way that we account for them: *"to describe properties of materials is to tell the stories of what happens to them as they flow, mix and mutate"* (Ingold 2011, 78).

Within design research, Gatehouse and Chatting (Gatehouse and Chatting 2020) drew from Michael's event thinking (Michael 2012), and, more broadly, concluded that events lend themselves well to calls for attention to the process in design research (Desjardins and Key 2020). Design events have also been positioned in the context of participatory design, where events are seen as non-anthropocentric structures and platforms for engagement (Jönsson 2015).

From the philosophical perspective, it is important to note that objects or things are events as well. This becomes clear in Whitehead's example of Egypt's Great Pyramid in that its relations to its surroundings is different today than it was yesterday — and therefore it does not exist, but is *happening*. Comparably, there is Harman's consideration of Athens, Rome, and Istanbul as the same cities as in ancient times, but are constantly changing in terms of culture and infrastructure (Harman 2016, 9).

What I suggest with the notion of events, based in the work with the Morse Things, is that they can be considered as moments of pause to listen to and understand nonhumans. From this perspective, designers are particularly well-positioned to encounter and participate with nonhumans.

5.6. Reflection on the proposition

At the start of this chapter, I proposed design journeys as ways to retrace these nonhuman agencies within design practice. This process is illustrated in section 5.5, and Figure 5.18. This chapter aimed to develop repertoires as processes that *"seriously and deliberately engage efficacies and trajectories"* to help *"make visible the force of the nonhuman and human designer"* (Wakkary 2021, 229). In this section of the chapter, I will reflect on the proposition through the concept of designer as force.

Proposition 2: Design journeys can be used to bring attention to the nonhumans of design practice.

I see design journeys as successful ways to bring attention to nonhumans. In this section, I will provide additional organizational framing for its use. An important dimension to the use of design journeys is its visual and reflective form of knowledge production. The journey presented in this chapter, the initial design steps, the turning points and the visual overview, was developed by relying heavily on visual content (originally, through a DIS pictorial (Oogjes et al. 2020)) and reflective analysis of design material such as working files, team communication including annotated images, and moments of the process captured in time through Instagram stories. This focus on visuals and active design materials were essential in retracing agencies and forces, and speak to the unique ability of designers to access thing-worlds beyond verbal descriptions. The pictorial format enabled me to explore the force of the designer, and I see this in line with calls for using the format in ways that disclose the situated realities of design research (Sturdee, Robinson, and Linehan 2020).

I have described a turning point in which I started reframing our process through design events to better attend to nonhuman efficacies and trajectories. Firstly, there is a shift in *representation* from a clean, white, studio presentation to a messier reality. I have described three different parts of the process that highlighted the instability of the

physical Morse Things, illustrated by how they materially came apart in shipping, as well as the fragility in my understanding of the Morse Things.

These unexpected moments refined, challenged, and expanded the questions that the team started out with, around how to account for nonhumans in design processes through thing-centeredness. These processes humbled our confident design presentation: the well-intended design decisions, such as creating custom packaging, and making a 'special' cup to appreciate its imperfections, only for it, in retrospect, to actually be an omen for the greater fragility of our research.

Lastly, and as a result of the above discussion, there is an *organizational* shift in design events that reframes design, not as success or failure, or more generally as outcomes, but as ongoing. This is also a *temporal* shift from chronological descriptions to events in which nonhuman agencies were encountered. In concluding this chapter, I see *design events* as a way to structure *design processes* that allow for paying attention to the nonhumans that were encountered along the way. Events — such as the breaking of a cup, and an early return shipping — do not assume relations in the way clear design results within a process do — such as the language of Morse Things, Morse Things packaging, and a kintsugi cup — but are not entirely flat in their ontology either. Structuring design processes around events also opened me up to using team communication, social media, sketches, design materials, and first-person reflections as data, as illustrated in Figure 5.18.

5.7. Concluding remarks

The Morse Things are back in the Everyday Design Studio as the team is considering how to continue the project. Our initial plan was to fix the three broken medium bowls, three broken large bowls, and the one broken kintsugi cup. We considered kintsugi repairing all the broken bowls, and even experimented with performing kintsugi ourselves. However, as we weighed our options, we wondered: is a kintsugi Morse Thing still special if there are seven of them? Our process has since shifted to an approach that sets out to create new cups and bowls that are *in sympathy with* the Morse Things (Behzad et al. 2022).

To conclude, and what I have learned from the Morse Things (so far), is that the conceptual notion of what something is, is quite dynamic and fragile in and of itself — perhaps particularly with internet-connected, or smart things, where parts of the thing's existence are located in more dynamic forms such cloud-based services — see also Wallace and co-authors discussion on being bricked (Wallace et al. 2018) and Wiltse and Redstrom's theory of changing things (Redström and Wiltse 2018). I see this work in line with these investigations that further untangle the impact of networked things in everyday life, and want to emphasize the commitment to staying open to surprising turns and the way they can support decentering the human designer in design processes.

In this chapter, I considered how the relationality of the Morse Things, and our lack of control over it, shaped and re-shaped the project. I contribute the notion of *design events* as a way of structuring design processes, which allows attending to nonhumans of design practice. In the next chapter, I actively apply this notion — rather than in hindsight — and combine it with my insights on narrative strategies from chapter 4.

Chapter 6. Woven Things[3]

6.1 Introduction

The Woven Things case explores what it could mean to develop repertoires unbound from common design structures such as projects, outcomes, failures, and successes by actively working with the notion of design events, as introduced in Chapter 5. This case thereby offers an opportunity to engage with nonhumans during ongoing processes, such as

The guiding research question of this case is:

How might designers actively work with nonhumans?

This case also proposes three anthropological approaches to aid in understanding the events. These approaches were chosen for their shared posthuman theoretical assumptions: 1) *landscape ethnography*, drawing from Laura Watts (Watts 2019), 2) *noticing*, as per Anna Tsing (Anna Lowenhaupt Tsing 2017), and 3) *translations*, building on Bruno Latour's circulating references (Latour 1999b). I explore their potential as a repertoire by guiding my focus in our active reflections on the weaving events. In the findings, I discuss the results of the experimentation with each of these approaches, and the degree to which each accounted for, enabled, or increased the participation of nonhumans.

Proposition 3: Anthropologically-derived writing methods can be used to actively engage with the nonhumans of design practice.

The design work presented in this chapter is from two ongoing projects of the Everyday Design Studio and collaborators briefly described below for context. However, the contribution of this work does not lie in the projects, or their outcomes. I position *design events* as the primary source of the stories: things that happened, or are still

[3] This chapter is largely based on a published peer-reviewed pictorial in the full program of ACM CHI 2022, entitled: Weaving Stories: Towards Repertoires for Designing Things (Oogjes and Wakkary 2022). The text has been edited with the addition of an introductory section to contextualize the work in this dissertation.

happening, during these projects. I use the term *events* to avoid a project- and results-based orientation, which is common in design, but which can detract from the development of repertoires. For example, events may include processes and nonhumans that had no direct role in the outcome, yet are useful for revealing nonhuman agentic capacities.

Wi-Fi-no-Wi-Fi

The Wi-Fi-no-Wi-Fi project investigated relationships between internet-connected things. The project involved making a soft portable/luggable/wearable origami pop-up thing that could sense Wi-Fi networks, and is activated only when no networks are present. The Internet of Things-thing relies on networked connectivity, but only reversely functions when it is not connected. Ron Wakkary, Tiffany Wun, Henry Lin, Mandeep Mangat, and I are involved in this project, along with external collaborator Pauline van Dongen, a fashion designer and postdoctoral researcher at the Technical University of Eindhoven.

My role in this project included the initial conceptualization, and supporting the development of an actuation mechanism. I conducted explorative weaving on a TC2 jacquard loom at TARP, part of Material Matters, at the Emily Carr University of Art and Design, for seven 4-hour sessions in December 2019, and January 2020.

Wi-Fi antenna

This project involved creating a textile Wi-Fi-antenna that could be attached, or become a part of, a home router. The goal was to investigate what type of relationship to the home router, and the home internet, might emerge if the router had a different spatial and material presence. The project team included Ron Wakkary, Henry Lin, myself, and external collaborator Milou Voorwinden, a jacquard designer at EE Labels (a label weaving company based in the Netherlands), and a design researcher at the Technical University of Eindhoven.

My role in this project included project management, conceptualization, material research and acquisition, pattern and weave design, and prototyping. For this project, I also visited the Unstable Design Lab at the University of Boulder, Colorado, for three weeks in February and March, 2020 to weave the first prototype explorations of the

antenna designs. I collaborated with Milou Voorwinden to design the next weaving samples, and the final designs.

Weaving events

The design events in this work included periods in the design projects such as one 4-hour weaving session, creating a particular sample, or shorter moments, and the events leading up to, and following them, such as the breaking of yarn, or the creation of a knot.

Overall, the weaving events spanned between December 2019 and the present, as the projects are still in development. My reasoning for framing the work through events is the desire to keep with design research's ongoing-ness and dynamic nature. I wanted to find a way to talk about the design activities without being bound by the particular project, or to structure them by finished designs, or samples.

Looking at our projects through the events enabled me to pay attention to the relationships and nonhumans at play. Data collection included notes and memories, weaving files created in Photoshop, camera documentation, and scans of finished samples, in-progress photos, Instagram posts and stories, team communication and organization, such as reports, meeting notes, sketches as distributed over email, WhatsApp, Signal, Miro, Slack, Google Drive, reference files such as instruction manuals, books on weaving, and documents provided at workshops.

These data — around 120 images and movie clips, and 28 cells of text reflection — was compiled in an Excel file. The 13 events that structured the weaving stories are outlined below (see Figure 6.1). The events were initially described from a first-person perspective. Next, I highlighted the nonhumans mentioned in the reflections, and followed their trajectories through the other data. While first-person research has inherent limitations in using human memory and retrospective analysis, I acknowledge that there is a particular tension inherent in this work by its attempt to move away from human framings and perspectives. Still, the epistemological commitment of thing-centeredness was present throughout the work.

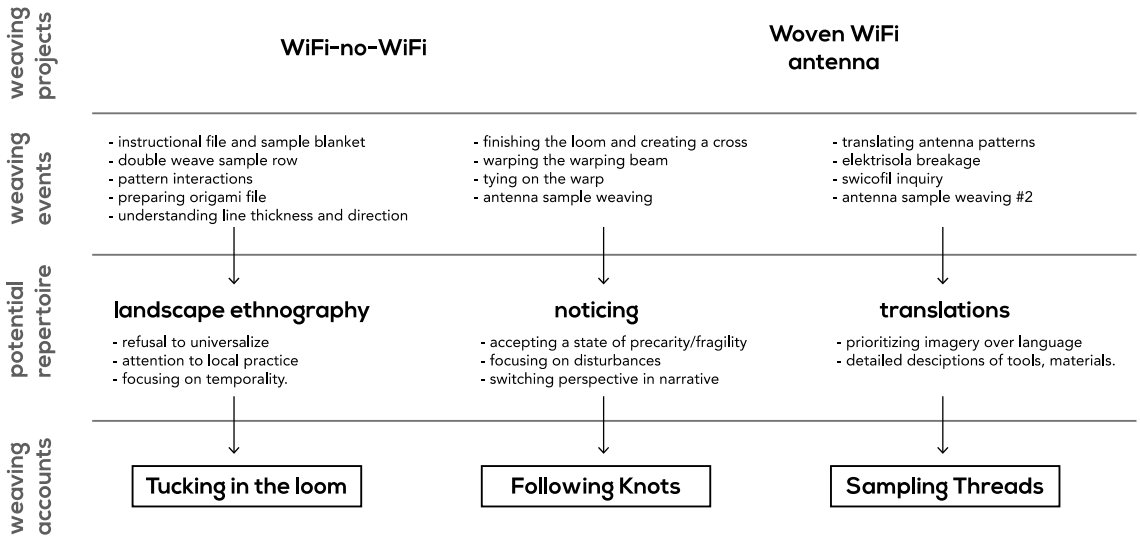

Figure 6.1. An overview of the process to develop the repertoires in the Woven Things case.

6.2. Three Experimental Weaving Stories

In what follows, I drew from three posthumanist/anthropological approaches, in which I saw an opportunity to develop repertoires. I chose to work with two of Wakkary's suggestions: Anna Tsing's noticing (Anna Lowenhaupt Tsing 2017), and Bruno Latour's translations (Latour 1999a), and added Laura Watts' landscape ethnography (Watts 2019), which shares similar critical posthumanist assumptions, but inspired me further in its writing style and use of fiction (which I will elaborate on in the next section). For clarity and reading flow, I refer to these approaches as anthropological, but I recognize that the authors of these approaches are not as easily categorizable, and whose work spans across philosophy, sociology, and anthropology. Next, I briefly outline the concepts behind the approaches and techniques used. In the accounts presented below, I creatively explore the three methods for the speaking subject to later reflect on their potential as a repertoire.

6.2.1. Approach 1: landscape ethnography

Laura Watts' *Energy at the End of the World* presents an ethnography of energy futures in the Orkney Islands (Watts 2019). Her investigation into how futures are made differently in different places is done by describing the landscape in detail, and using

prose that is distinctly different from academic writing, including using fiction, poetry, and ethnographic descriptions.

Watts counters the typical dystopian tone of Anthropocene stories, and positions her ethnographic work as a study of the mundane practices that bring futures into being. She highlights a crucial point in describing the landscape: the refusal to universalize through attention to local practice. Within this, she focuses on the temporalities of the Orkney Islands. Orkney is ahead of the curve in sustainable energy futures; with its electric cars, micro-wind turbines, and extreme climate; it is a temporal present that, for others, could be considered a low-carbon future.

Watts takes advantage of this opportunity, and describes the professional, but also mundane, actions of the inhabitants of Orkney as ways of *making the future*. In our first account, we draw from Laura Watts' writing to understand design research practice through a landscape lens. What does it mean to describe a landscape of design research? How can we represent who and what is actively designing, and within what constituency or gathering? And what else is revealed through describing the landscape?

Why landscape ethnography?

In this story, I describe a series of events that unfolded over my time weaving at TARP at Emily Carr University of Art and Design. This was my first time weaving on a TC2 jacquard loom. The event that led to the development of this story involved a moment when technician and weaver Jen Hiebert showed me a sample cloth, and its corresponding presets in Photoshop. The unintentional contrasts in texture on this sample cloth directly inspired my weaving explorations for the Wi-Fi-no-Wi-Fi project. I saw an opportunity to describe the landscape of this place, including elements such as the sample cloth, and Photoshop environments. With this, I wanted to broaden common descriptions of design projects with landscape elements that also participate in creating. In so doing, I use Laura Watts' landscape ethnography, and the strategies of refusing to universalize, paying attention to local practice, and focusing on temporality.

Tucking in the Loom

TARP is part of Material Matters, a material design research studio led by Hélène Day Fraser at the Emily Carr University of Art and Design in Vancouver, Canada. The school was very close to my residence at the time — within walking distance. I was

scheduled for a series of weaving sessions during a couple of afternoons in December, 2019, from 1-5 pm, and a couple more in January, 2020. I walked from my place down the hill with the ‘EAST VAN’ sign, a few hundred meters over 2nd Avenue, to get to Emily Carr.

Hélène introduced me to Jen Hiebert, who trained me to work on the TC2 loom, and was on campus to assist with any weaving and loom troubles. I had written a short document to communicate the task at hand: I wanted to explore textural weaves, double weaves, pockets, and folding textures for the Wi-Fi-no-Wi-Fi project.

When I arrived, the TC2 loom was under a blanket, tucked away. Jen told me this was to protect it from dust. The space also has a tufting area, s sewing machine, winding tools, and storage. In particular, the tufting gun, a wool shooting carpet maker, produces a lot of fibre dust when in use, which can damage the TC2. Therefore, after every session, we went through a little ritual of unpacking and tucking in the loom. We took two large denim pieces of fabric — leftovers from another project — crossed them over the top of the TC2, and folded in the edges, like wrapping a present, securing the material with binder clips.

To weave on the TC2, one has to prepare the files in Photoshop. As a beginner weaver, I remember feeling intimidated by this at first. The few resources I had found online were hard to follow — they used weaving terms that I was unfamiliar with, and are primarily focused on pictorial weaving: how to replicate an artwork or photograph in cloth.

Jen walked me through the Photoshop process, and quickly alleviated my concerns. She provided me with a library of weaving patterns, including twills, basket weaves, satins, selvedges, and other resources on how to work in Photoshop, such as creating double weaves and working with multiple shuttles and colours (see Figure 6.2). Jen also pulled out a weaving that she had made to accompany these different Photoshop patterns.

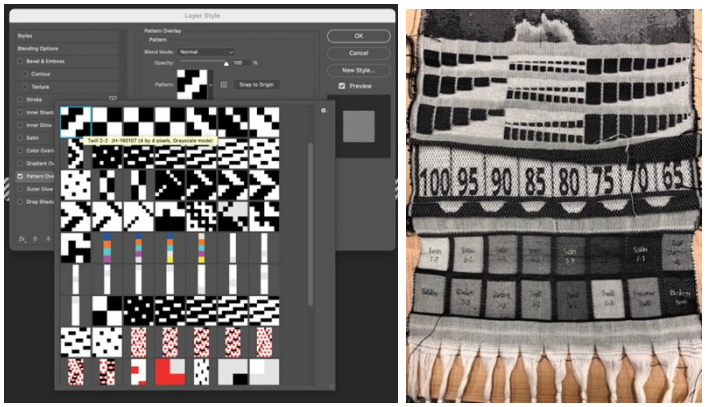

Figure 6.2. The weaving presets in Photoshop, and the sample blanket demonstrating its effects in the woven cloth.

It read almost like a painting swatch: woven with white cotton weft, and black cotton warp, this textile gave an overview of how the thread responded in the actual cloth (see Figure 6.2). There were different sections: one row of blocks of varying weaving patterns labelled with woven-in text. I could feel the different textures, and see the colour of the weaving patterns. An evenly distributed weave is grey, less even like a satin: either more black or white.

The following section featured an alternating twill with visual explorations of half circles and white blocks, with black numbers indicating the pixel count. Next is another graphic exploration of blocks, followed by a larger woven piece that integrated these different weaving patterns, and their colour effects to recreate a photograph.

Jen pointed out to me the sections between the basket weave and the broken twill. The fabric folded over each other, creating a contrasting textural quality. This was precisely what we were looking for in the project, to generate origami textures, and it prompted me to explore contrasting weave patterns. The sample cloth had initiated a direction for my weaving.

The TC2 loom itself was prepared for me. The dense warp was tensioned around the warping beam with looped blue and green elastic (Figure 6.3), and a couple of rows of basket weaves were beaten on the cloth to secure the tension. Jen had also prepared a starting template for the loom.

This file had three main sections pre-set: a black square representing 18 defective threads on the right side of the loom, a pattern-filled square for the right

selvedge, and a similar one for the left selvedge (Figure 6.3). A selvedge is a pattern used at the edge of a fabric to create an even and sturdy finish to ensure equal tension throughout the cloth.

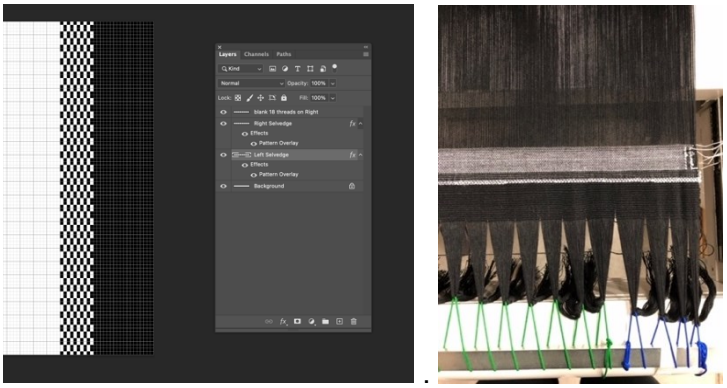

Figure 6.3. The Photoshop template for the TC2 at TARP, including dead pixels at the end of the warp in Photoshop, and on the loom.

The loom itself was adorned with documentation of its module setup and warping logic. TARP's TC2 is two modules wide, and 12 modules deep. These documents were held in place by magnets that said: *keep calm and loom on*. A MacBook Pro sat on top of the loom (Figure 6.4). This is where I opened the Photoshop file — saved as a bitmap (tiff) — in the Loom Driver Software for the TC2. All the files were black and white — corresponding to the lift schedule of the TC2. Each pixel relates to a needle, and black or white tells the loom whether it needs to lift it, or stay put.

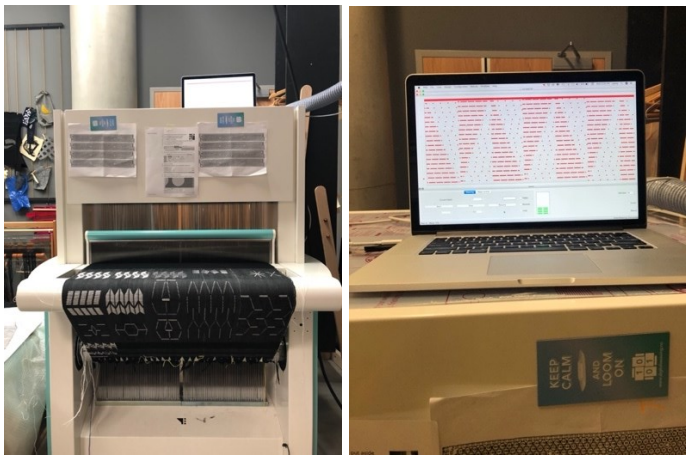

Figure 6.4. The loom with some first weaving samples, and the MacBook pro with the TC2 software.

Jen showed me how to wind the bobbin onto the shuttle that I used for weaving. We clamped the bobbin winder on a stool, and used the handle to spin. We did a couple so that I could keep weaving for a while, but Jen also reminded me that running out of yarn was sometimes a good way to force oneself to take a break. Throwing the shuttle back and forth, and standing over the loom for hours, can get tough on the body.

Jen showed me how to throw — it takes a certain amount of force to get the shuttle across the loom without it flying across the room. I got the hang of it, and soon enough, I was weaving. Throw the shuttle, beat the heddle, and press the foot to go to the next pixel row. Repeat.

Another element of the process enforced taking breaks: the TC2 stops at times. Jen wasn't quite sure why, but it makes a loud puff, kind of like a deep breath, and lowers all its air-suction-controlled needles. This happened a handful of times over the course of my weaving sessions, and Jen disappeared into the room next door, where the vent from the pump of the TC2 went. I'm not sure what happened in that room (part of the landscape, but obscured to me), but the issue is resolved whenever she comes back.

And, every day, as the clock neared 5 PM, I wrapped up my last samples, and called Jen: it was time to tuck in the loom again.

I kept weaving my samples — rows of origami shapes, double weaves, and contrasting patterns. I saw specific weaving structures as soft and others as sturdy — rather than black, white, and grey. I got into a rhythm, adjusting the Photoshop file, weaving again. It is a pretty quick design process, and it was a joy to see the Photoshop files come to life on the loom. I did tests with different thicknesses of lines to understand how the file related to the thickness of the thread I was weaving. And again, at the end of the day, we tucked in the loom.

Whenever I ran into issues, Jen rushed to help me. This was our setup. I am somewhat of a test weaver for TARP, a trial for future students, collaborators, or visiting artists/researchers. Jen noted issues, and jotted down how many rows I'd woven each day to get a sense of my *pixels per minute.* TARP gets to see what weavers might need

help with, where the TC2 has issues, how much training is required, how much assistance is required, and how much time overall it will take Jen. And I get to weave.

During my last day at TARP, Jen and I cut off the final cloth, retied the knots around the elastic, and once again – we tucked in the TC2.

Reflections on landscape ethnography

Key sensitizing concepts applied in our account: refusal to universalize, attention to local practice, focusing on temporality

In writing this account, the sensitizing concept of refusal to universalize was easy to work into the story, as design is already a practice that explicitly deals with the particulars. For example, I was not working with any yarn; I worked with black and white cotton. I was able to explore textural qualities in the way I did because the TC2 that I was working on had multiple modules and a dense warp, enabling the contrast between textures to become tangible. As such, this method felt like an easy one to apply, not too different from other ways of describing design practice from a first-person perspective.

I paid attention to local practice by describing how Jen showed me to wind the spools, and how the warp was wound to the beam with elastic to increase control over the tension distribution of the threads. Here too, the specificity of the TC2 setup at TARP played a part in what I could explore in terms of weavings.

The focus on temporality allowed me to understand better which nonhumans were participating. In describing the landscape of TARP, a nonhuman that I had previously taken for granted — the two pieces of denim fabric we used to cover the loom — exposed a temporal structure of my weaving activities.

The recurring set of actions of tucking in the loom revealed not only the main activities, and obvious nonhumans (the loom, the MacBook, Photoshop, the cotton), but also the things of the landscape that were more tangentially related to my task at hand (the tufting gun, the sewing machine, leftover fabric of an older project). These landscape parts were less accessible to me, but nonetheless actively present. The story of tucking in the loom is one of *maintaining* the constituency of TARP. The cloth draping over the loom, and securing the edges to protect it from dust, is a way of extending the machine's lifetime for future weavers. The ritual also suggested that the participation of

nonhumans (the denim cloth) need not always be toward a goal of production. However, beyond the perspective of caring for the machine, the ritual of tucking in the loom also provided a structure; a rhythm of human to nonhuman relations that was considered so mundane it didn't even cross my mind to document it at the moment — the ritual only became present to me as a speaking subject in constructing the story. In writing the story as I did, structuring the account through the temporal events of tucking in the loom, I attempted to keep this mundanity intact, but simultaneously attuned to the role of the nonhuman. I wanted to maintain this quality so as not to redistribute relations in narrowly human-centered ways, since focusing on one nonhuman is as limiting as focusing on humans only. Describing the landscape, and paying attention to the concerns amongst things in it, allowed me to think multi-relationally.

6.2.2. Approach 2: Noticing

In her book, *The Mushroom at the End of the World*, Anna Tsing tells the story of the Matsutake mushroom (Anna Lowenhaupt Tsing 2017) as a multi-species ethnography. Tsing offers the approach of noticing differently, which has found resonance within more-than-human design research, but remains somewhat challenging to make operational for designers. Another key concept in Tsing's project is that of precarity, as she argues that the world we live in is defined by vulnerability, instability, and the ruins produced by capitalism. Simultaneously, her concept of contaminations highlights how new forms of multispecies relationships can be formed within these ruins. She argues, rather than looking ahead to solutions, futures, or progress, we should look around, and attune our abilities to notice what is newly produced in these ruins.

In her accounts, Tsing makes connections across landscapes (for her work, she followed the Matsutake mushroom through forests in China, Japan, Finland, and the US), reframed disturbances as a matter of perspective, and switched the perspective of narrators to get to know the characters of the landscape. We integrated these strategies in our account of following knots to get to know the nonhuman characters of design. Tsing stated: "*telling stories of the landscape requires getting to know the inhabitants of the landscape, human and nonhuman"* (Anna Lowenhaupt Tsing 2017, 159). To do this, Tsing shifted her perspective of a nematode to a pine tree, back to the Matsutake. Tsing warned us: *"rather than limit our analyses to one creature at a time (including humans), or even one relationship if we want to know what makes places livable, we should be*

studying polyphonic assemblages, gatherings of ways of being" (Anna Lowenhaupt Tsing 2017, 157). Tsing's concepts urge us to embrace heterogeneity and tension, not unified or harmonized nonhumans. Relations can be nonsensical, uninteresting, and disturbing. In drawing from Tsing's concepts and techniques, we ask, what are the inhabitants of design research? How can we notice them differently?

Why noticing?

The events inspiring this story occurred during my visit to the Unstable Design Lab, where I helped to warp the TC2 loom. Warping is a process in weaving practice that prepares a loom with new warp yarn that will be on the loom often for longer periods of time and multiple weavings. It is usually a highly involved and somewhat precarious process that requires attention to keep multiple long strands of yarns in their allocated place while guiding them through different parts of the loom. It is important to note that this is clearly a different type of precarity than those that Tsing articulates, such as economic instability or the migrant life of mushroom foragers. Nonetheless, I saw an opportunity to explore the strategies for noticing and apply them to our account.

The main event that motivated this story was a knot that formed during this process. I recognized this as a moment of nonhuman agency, in which something was created (the knot) that was not according to the plans, or desires, of the humans (us, warping the beam) and still shaped the process. This motivated me to further understand knots in the warping practice, and I saw an opportunity in Anna Tsing's noticing to understand knots differently.

Following knots

I am a Wensleydale sheep. They call me the finest. Sometimes I even get mixed up with a Cashmere goat! I am from the UK, originally, but my kind can be found all over. I am known for my locks, and my cheese. I suspect that is why I was saved from extinction when the humans lobbied for my survival in the 70s. My milk makes for moist, flaky, and slightly sweet cheese, and my sheer don't kemp.

Why do I start this story from the perspective of a sheep? It was my first day at the Unstable Design Lab, and — prompted by a studio member — I took a quiz on a website called Woolery. Based on some questions about my hobbies, favourite colour, and ideal holiday location, it informed me that I am, indeed, a Wensleydale sheep. While

there is some very clear anthropomorphizing going on here, I have also come to understand the possible benefits and unavoidability of this.

So, I am curious to explore its nuances. I want to tell the story of knots, and to do so, I need to tell you about fibre; fabrics and textiles traced all the way back are fibres. Each fibre, whether natural or artificial, has its properties: wool is stretchy, linen dries quickly, cotton is durable. The fact that Wensleydale's sheer doesn't kemp is great: it doesn't get into knots too quickly, it is not brittle, and it can handle a bit of stretch. Fibres also have a texture, making them suitable to weave with. Wool fibres, for example, hook into each other and keep themselves in place. These hooks and angles allow for the interaction between the weft and the warp. Briefly, without overwhelming the reader with too many explanations of weaving terms, the warp is the yarn that is vertically threaded on a loom, the weft is the yarn that is added per row, thrown from one side to the other (or, as it was explained to me: weft = *left* to right). As we will see, there are times weavers want this hook and tangle interaction to happen, and there are times when they don't.

The Unstable Design Lab, led by Laura Devendorf, exists as a communal room with three offices: one for Laura, one for the grad students, and one flex-office for visitors or meetings. The main space has a long table at one end, and two large whiteboards on the wall, as well as a desk with a sewing machine, and a long, narrow, bar height table sits along the window, facing the corridor that houses projects, materials, and samples. The other side of the room is loom-space.

The TC2 stands on the side, with some space behind it. There is a wall filled with yarns in many colours, and in the corner of this wall, there is a section for conductive material. The warping beam stands in the middle of the space, in front of the TC2, and rests on two trestles with custom-made handles to rotate it. The warp on the TC2 is time-consuming, and complicated to replace. It often has over 100 meters of yarn so that the TC2 can be used for a more extended time before it needs to be warped again.

This was the first time the lab was attempting a sectional warp where the beam was warped in thread sections instead of all at once. The warping beam has four wooden rods inserted with little metal dividers to accommodate this. A few other things

are part of our warping setup: a bobbin rack with 24 equally weighted wound bobbins, and a tension box with a counter resting on a stool.

The loom space expands as we start to warp. The communal chairs become barricades to prevent people from walking into the thread that goes from the bobbin rack through the comb of the tension box onto the warping beam. One part of the communal table has become inaccessible. It takes three people at a time to warp the beam: one to rotate the beam itself, one to keep an eye on the threads coming from the spool rack, and one to keep an eye on the counter. As a temporary responsibility, we are assigned to a part of the thread's journey. There is a fragility to the process of warping the loom, one that requires us to pay close attention to detail. At one point, our warping is halted abruptly. I was rotating the warping beam when I suddenly felt resistance, and noticed that the stool that the tension box is clamped onto was slightly tilted under the tension of some threads that had formed a knot. In Figure 6.5, I imagine this situation from the thread's perspective.

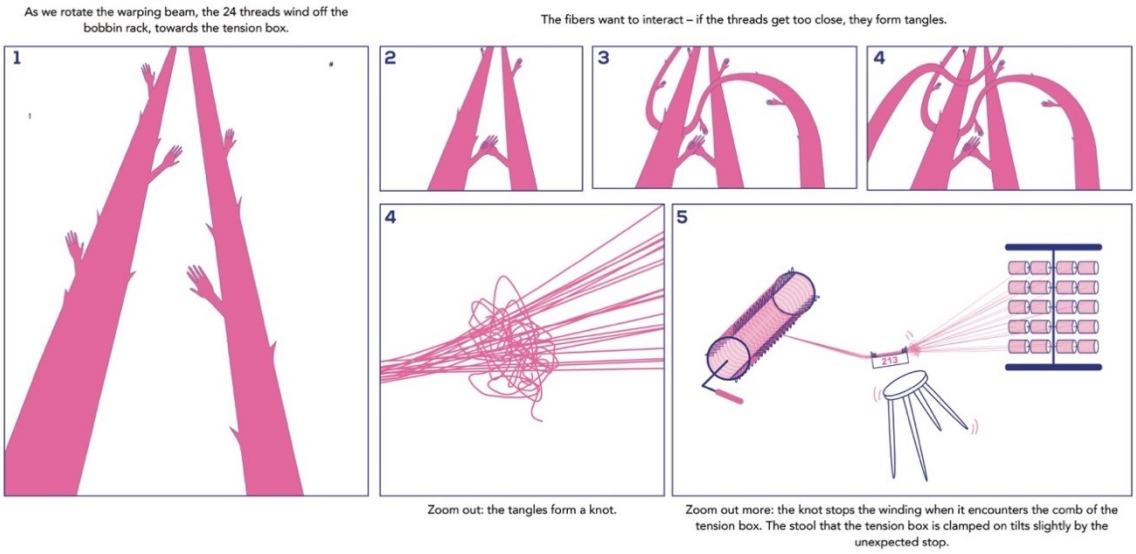

Figure 6.5. Illustration of imagining the thread's journey.

We slowly rolled the warping beam back, releasing some tension on the threads, and allowing the stool to tilt back on all its legs. Pulling back the tangle of threads, we started to pull apart the knots that had appeared — for us seemingly out of nowhere (Figure 6.6). While doing so, we rolled back the bobbins on the bobbin rack to recreate tension on the threads that we managed to free from the tangle, so they wouldn't find their way back in — as well as be able to follow the order of the other threads.

We did this for quite some time until we decided the last few threads would take too long to separate. We cut the tangle out, and bundled each side of the threads. Keeping tension on the threads that were intact through the bobbins, we began retracing the threads that had broken to tie them back in order. These knots will be reencountered when the warp is on the loom: they might cause one of the threads to break again, or they may show up in a weaving.

Figure 6.6. Encountering tangles, and knots during the warping of the TC2.

Knots are often encountered in warping the TC2. We used a human-made knot to undo a fibre-made knot. When the winding of the warping beam was done, we moved on to the next step: tying the warping beam to the existing threads on the TC2. **So. Many. Knots.** The space returned to its original setup. Chairs were back to being things to sit on, the communal table was accessible again, and the walkway was free. This is a one-person job. We are tying each thread from the warping beam onto the existing threads held in order on the loom.

The back of this TC2 holds some documentation: a lifting schedule like the one I saw at TARP, and a very helpful illustration of how to tie a weaver's knot (Figure 6.7): a knot that ties two threads together, and allows you to pull it tight in one direction. There are scissors, a little comb to untangle threads, and tape to hold the threads in place. The warping beam sits below, and I used the loom to tension and tie the existing thread to the new one from the warping beam.

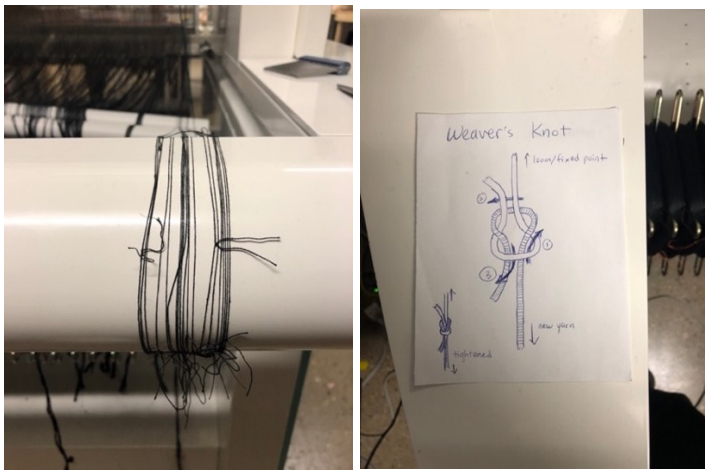

Figure 6.7. Weaver's knots on the back of the TC2.

I was determined to get this done, so I spent the weekend tying knots. I was at about 120 knots an hour. There are threads everywhere. This may be a one-person job, but I would have done better by stepping back. At around knot 800 of 1,320, I messed up, and skipped a warp section. I even documented it in a time-lapse video, but I only really noticed it when I was done, 460 knots later (3 hours and 48 minutes in human time). I confessed to the others on Monday, and we had a lab meeting. The good news was that I tied all the knots, and the bad news was that I missed a section of about 60 threads. Laura decided it was ok — there was no use in retying 520 knots.

I think back to the template at TARP, with the section of dead pixels at the end, and wonder how long my mistake will haunt the weavings of the Unstable Design Lab, or visitors.

So far, I've told you about a knot that occurred while warping, the knots we had to tie to fix those knots, the many knots that were tied to connect the warping beam to the existing threads on the loom, and the missed knots. There are a few more knots in this story. We guided the knots through the needles and heddle slots of the TC2, tied on the warp to the front rod, and adjusted the ties to get equal tension (Figure 6.8). We weaved a few rows to check for missing "pixels" — threads that are doubled up in a slot, or that are loose threads. We used hooks, pins, and magnets to hold the threads in place. Loose threads are either retied, or pinned down (Figure 6.8). Double threads are traced to see if they are doubled in the needle or in the slot. If they are doubled in the slot, we had to unweave and guide the threads again through the heddle. Eventually, we decided it was enough. There were still some errors: the one end of the loom had

threads that didn't lift as we anticipated, and the other side had my 60 missing threads — but it's good enough for now, and we made a Photoshop template to work with these glitches.

Figure 6.8. working through the knots on the front of the TC2.

Reflections on noticing

Key sensitizing concepts used in our account: switching perspective in the narrative, accepting a state of precarity/fragility, focusing on disturbances.

Through this story of knots, I attuned myself to the fibres of the threads. I used the sensitizing concept of switching perspectives in the narrative. For example, I allowed myself to anthropomorphize with the Wensleydale sheep, and the illustration of hands as hooks for fibres. Speculatively tracing the material back to the sheep was an effort to understand better the fibre and its tendencies. It also made me consider how we should do this in future practice, and consider the histories of the materials we choose to work with. The method of noticing allowed me to understand what was gathered, and what *should have* been gathered in the constituency.

While it might be a stretch to call the warping set up precarious in the same sense as experienced by the Matsutake mushroom foragers, it was undoubtedly fragile, and required care and attention throughout. For example, when winding the yarn on the beam, each of the warpers was assigned to a particular part of the journey of the thread. The attention paid to these parts revealed certain relationships of nonhumans, such as thread, tension, and movement, which are essential in weaving, but are more or less

taken for granted when they are all intact on the loom. The moment of fragility in the warping setup allowed me to understand these relationships differently than when I was weaving on the loom at TARP, where the warping was done for me. It gave me insight into the constituency, what happens, and what is gathered in particular ways before weaving.

By following knots, I came to understand disturbances more generously. I began to see knots everywhere. It started feeling almost unreasonable to be annoyed with the accidental knots when I was tying on so many intentional ones only a few hours later. Tsing reminds us*: "whether a disturbance is bearable or unbearable is a question worked out through what follows it: the reformation of assemblages"* (Anna Lowenhaupt Tsing 2017, 160). The retying of the loose threads, as well as the salvaging of loose threads, and the acceptance of an incomplete warp, and a modified Photoshop template, are all ways of embracing these disturbances as both human (the error in missing a section of knots when tying on), and nonhuman (the behaviour of the fibre) — while still making them workable.

Using the sensitizing concepts of fragility, precarity, and disturbances became more intertwined in my descriptions. I now see the incomplete warp with retied knots as a particular fragility. Weaving always requires attention to potentially having to retie knots, again. I came to see disturbances as a way to accept the state of fragility that I was working in, one that allowed me to notice the relationship between the loom, the threads, and my weaving, differently.

6.2.3. Approach 3: Translations

In this last explorative repertoire, we draw from Bruno Latour's account of soil in Boa Vista (Latour 1999a). In his writing, Latour showed the reader the tools that soil scientists used to understand, translate, and document the soil. Through this, he aimed to show us the layers of translation that happen between the soil in Boa Vista, and the scientists' lab.

Through his writing, Latour revealed the networks of humans and nonhumans that collaboratively examine the soil. Latour created a presence for nonhuman participation in his account through detailed writing of tools, materials, and translations.

In the formal approach of Actor-Network Theory, these translations have particular and specified steps that we do not use explicitly, but were certainly guided by. These are *problematization* (the process of a pivotal actor identifying other actors' unmet interests and goals), *interessment* (the key actor utilizing actions to interest actors in the new goal), *enrolment* (onboarding of new actors, which can also involve resistance), *mobilization* (the activation of the network), and *dissidence* (unexpected acts by actors and destabilization or dissolvement of the network) (Callon 1984).

Latour emphasized the humorous shortcomings of language — for example, when the scientists described soil as clay-y sand, or sandy clay. The tools used, Latour argued, express things that language alone cannot, but both are translations/transformations: they attempt to capture the actual thing or phenomenon, but will always simultaneously bring us closer and farther away from it. They are, as he calls them, circulating references. By utilizing Latour's writing as a guide, we explore the questions: what are the circulating references of design research? What do they help us understand, and where might they create blind spots?

Why translations?

In this account, I described the weaving events in the Wi-Fi antenna project, which led us to inquire into new conductive yarn. The main event in the story was the breaking of the yarn we were working with when switching from a prototyping loom (the TC2 jacquard loom) to an industrial loom (the Itema r9500).

I chose to explore Latour's method of translations, as I recognized a moment of dissidence in this event. Latour described the practices of two pedologists, one geographer, and a botanist, on their joint expedition, and the common quest that drives the group of scientists in the Amazon forest to understand the soil. Using their reference systems and tools, the scientists bring back translations of the forest to their laboratories.

In our case, the Everyday Design Studio is collaborating with Milou Voorwinden from EElabels, a weaving company based in the Netherlands. I am also using the visit at the Unstable Design Lab to weave the first samples on the TC2 jacquard loom of the lab. We are similarly making samples, bringing them back to research environments, measuring, and collectively investigating a question that we share: what does a woven

antenna look like? In exploring this method as a potential repertoire, I used the methods of empathizing with the tools we use, describing the translations we make, and focusing on reaching a collaborative understanding across our different locations.

Sampling threads

I was at the Unstable Design Lab, carrying with me — on my laptop — a report made by Henry, with a variety of antenna designs suited for 2.4GHz, the frequency that Wi-Fi operates on. I looked through them to see which ones were suitable for weaving: shapes that allow the thread to travel from left to right, and back again. I wove text into the cloth to label the weaving structures I used, satins, twills, basket weaves (Figure 6.9). I did the same for the antenna types: metal-plated, bipolar (Figure 6.11). I attached paper labels to indicate, and to remind myself of the weft-material I used: Elektrisola, linen, cotton of different thicknesses, polyester (Figure 6.10). While the cloth was still on the loom, I used a multimeter to check for connectivity across patches (Figure 6.9). This quick test gave me enough insight to continue with more complex antenna patterns, as I now knew that even when cut, the conductive thread strands made enough connection across the picks. The real test would come later, when Henry used his setup to test if the antennas would work with a home router.

Latour described how the soil scientists sent the soil back to their labs, used tools to describe the states, and made reports. I, too, wrote a report: which antennas were the easiest to weave? Which strategies worked well, which strategies did not? What were other options we could explore?

Figure 6.9. Weaving with the conductive material on separate bobbins as additional weft, and measuring connectivity with the multimeter.

Figure 6.10. A scan (stitched together in Photoshop) of a woven antenna sample, with labels and woven text indicating the difference between swatches.

Figure 6.11. A photograph of the labelled antenna sample before cutting and scanning (the observant reader may recognize some pins and knots from Figure 6.8).

When I get back to Vancouver with the woven antenna samples, the COVID-19 pandemic has started. The Everyday Design Studio is empty; its parts and machines are distributed between people's homes. We have started relying even more on translations by working from home: using photos, reports, Miro, sound recordings, and video reports of our work with the antennas.

Using a vector antenna analyzer, Henry tested the different woven antennas for their connectivity at his home (Figure 6.12). To our surprise, they worked pretty well. In his video, he showed us how he could connect the woven router in his living room, and load a YouTube video on his phone, connected to the Wi-Fi from his kitchen. Our investigation with these first samples was simple: can we weave antennas? Do they work?

Figure 6.12. Henry's set up to test the antennas, including clippers, a multimeter, and coaxial cables, which needed to be attached to each sample, and testing an antenna sample with a vector antenna analyzer.

We wanted to move to a more refined weaving now that we had some results to work with. Milou from EElabels worked with an industrial loom, an Itema r9500, which is especially designed for weaving labels, like the one in your shirt telling you which brand or size an item of clothing is, or how to wash it (another circulating reference). The loom in question has a much higher density of threads than the TC2 that we had woven on previously, allowing us to create much finer antenna patterns. It was automatic — no more throwing the heddle from left to right and back again.

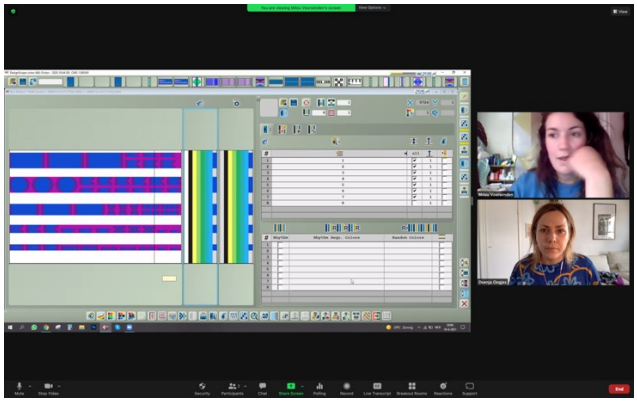

Figure 6.13. A screenshot of a Zoom meeting between FA and Milou Voorwinden, used to translate antenna designs to be woven on the Itema r9500.

As we worked across continents, we could not touch, move, and inspect the materials we worked with directly, so we also had to translate our experiences in some manner. Milou and I met on Zoom (Figure 6.13) to go over the more successful antenna designs. I had worked with Illustrator and Photoshop for weaving on the TC2, but Milou had worked with different software, DesignScope Victor. We worked together to move these designs across the different software platforms. Using Latour's terms, we had a

translation of a translation, as we did this work without an actual thread in sight (or well, maybe a few, in our Zoom-backgrounds). The loom that Milou worked on had some other differences. On the TC2, I could insert conductive yarn as an additional weft in certain sections only, but the Itema r9500 uses the yarns across the whole cloth, and only from left to right (not back and forth). We adjusted our designs to accommodate this. We added floats (longer sections on the cloth where the weft goes over the warp, creating long strands of yarn), rotated designs to waste less of the conductive material, and grouped similar antennas on the same rows.

Milou ran into a problem when she started weaving (Figure 6.14). The Elektrisola, which performed so well in our earlier tests, kept breaking on the Itema loom. Milou has two possible explanations: the Elektrisola is wound on a cone that is incompatible with the Itema r3500, or the Elektrisola yarn itself has no stretch (remember the Wensleydale sheep?).

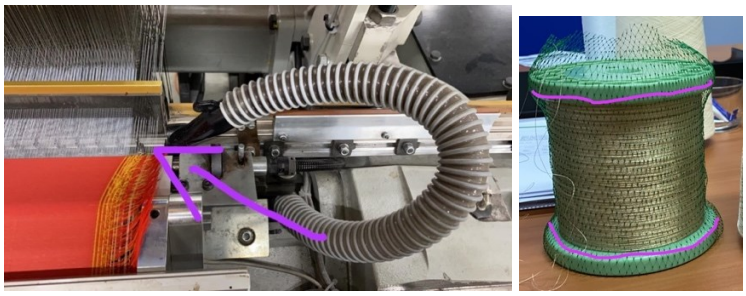

Figure 6.14. Part of the problem: the grabber from the Itema r9500 loom is incompatible with the non-stretch Elektrisola. The edges of the cone (on the right) make for uneven unwinding.

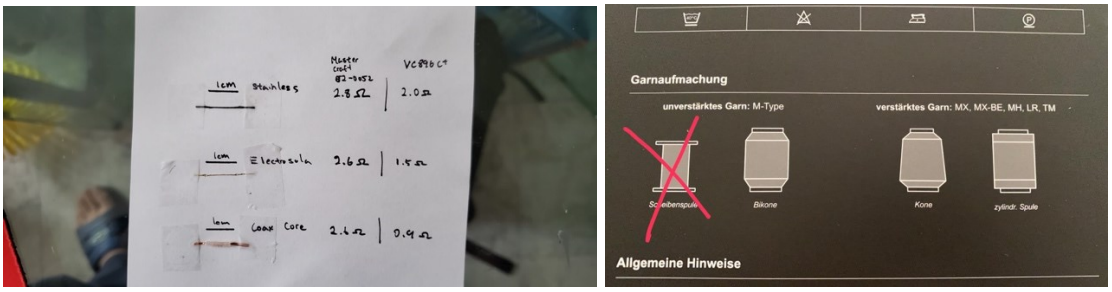

Figure 6.15. An overview of schematics to understand the requirements of the new yarn. On the left, Henry outlined the conductivity range that the new material needed to have, and on the right, Milou annotated a document from Swicofil, about which spool we could not use on the loom at EElabels.

We needed to reconvene, and our questions expanded: is it possible to wind the Elektrisola on another cone? Could we build something to allow it to roll off the cone more easily? Milou was skeptical. The yarn would still not stretch, and risked breaking when the Itema loom grabbed it to weave automatically. I started looking for a new conductive yarn, and considered its specifications. It needed to be wound on a cone compatible with the Itema r9500 loom, it needed to suit our conductivity needs, and we had a few additional requirements for elasticity, twist, and thickness. I consulted with Henry to measure the conductance of stainless-steel yarn, Elektrisola, and a coaxial core with a multimeter to approximate what we were looking for (see Figure 6.15). With the information I gathered, I contacted Swicofil, a Swiss company that Milou had previously worked with to acquire yarn for EElabels. After a consultation, and sending more translations back and forth, I opted for gold, and a silver plasma-coated yarn, and we started our tests again. Milou wove sample cloth with the antennas, sent them to Vancouver, and Henry tested them with his home-router testing set up, and Ron started using them with his home router. We made another report.

Reflections on translations

Key sensitizing concepts applied in our account: prioritizing imagery over language, detailed descriptions of tools, materials, and translations, dissidence of nonhumans.

In exploring Latour's translations, it became clear how the tools of our practice both enabled and limited the team's understanding of the conductive material. While we were not in a forest collecting soil, it was not difficult to spot the circulating references that served to mediate our design research practice: woven text labelling weaving samples, attached labels to separate the material, a vector antenna analyzer, multimeters, weaving drafts. And while we were not collecting soil samples to bring back to a laboratory, still, we were attempting to collect and create knowledge to bring back to the Everyday Design Studio and our collaborators.

The prioritizing of imagery was already present in the teams' communication: annotated imagery of what spools would work, highlighting parts of the Itema r9500 loom, and generally sharing sketches and ideas. It was, therefore, relatively easy to work into the story. On reflection, what I prioritized, more than the imagery in the account, was

the questions that guided our practice, such as: which antennas function on the 2.4Ghz range? How do we translate an antenna design into a weave-able shape (that goes from left to right)? Is it possible to wind the Elektrisola on a different cone?

Through the telling of this story, I also came to see what could, or should, have been part of the biography, such as tools to understand elasticity, other yarn qualities beyond just the conductivity, and other antenna-related qualities that we were focused on.

Lastly, the translation steps were mapped easily to the design process, and could be seen as cycles through which we could better understand the nonhumans that gathered in our research. The dissidence (the breakage of the Elektrisola) followed a process of problematization (the human actors wanting to weave with a higher density), interessment (starting a collaboration with the Itema loom and Milou), and mobilization (the preparatory work of translating weaving files across software). The breakage itself started a new cycle, where the problematization was initiated by the withdrawal of the Elektrisola, leading to the enrollment of Swicofil, and the new material.

6.3. Reflections on the final proposition

At the start of this chapter, I proposed to explore anthropologically-derived writing methods to actively engage with the nonhumans of design practice. This section will describe my use of the methods, and their potential as repertoires.

Proposition 3: Anthropologically-derived writing methods can be used to actively engage with the nonhumans of design practice.

This part of the chapter could be considered the “results” section, and answers my research question: **How can the concept of repertoires be developed in design practice?**

I used the three working definitions of repertoires, as provided by Wakkary:

- Repertoires that provide *“new techniques and tools as speech prostheses that account for and realize nonhumans in design”* (Wakkary 2021, 229)*;*

- Repertoires as *"processes that seriously and deliberately engage efficacies and trajectories" and "make visible the force of designer"* (Wakkary 2021, 229)*;*
- Repertoires as processes for *"convening constituencies that find ways for nonhumans to be more present, more participatory, more cared-with and lively within the constituency"* (Wakkary 2021, 229).

While the weaving stories presented in this chapter were written retrospectively after the events, I argue that they acted as a generative, analytical tool that allowed for understanding the relationships within the events. The stories brought nonhumans, such as Photoshop templates, selvedges, bobbins, denim cloth, 1320 minus 60 Knots, chairs and stools as winding companions, spools in different shapes and their compatibility with different looms, a vector antenna analyzer, Elektrisola, plasma-coated yarn, and more, to the forefront of the research.

An important nuance is that I, as a visitor, arrived as a designer, with nonhuman designers in tow, to an already existing constituency, whether that was TARP, or the Unstable Design Lab. The repertoires were captured, and acted within, the dynamic of those constituencies, yet in relation to the biographies of another constituency, the Everyday Design Studio. Overall, I found the methods used (landscape ethnography, noticing, and translations) mapped easily to the design research events, which further supports the argument of understanding design research practice itself as a more-than-human practice.

6.3.1. Three repertoires

In this section, I summarize the three anthropological approaches used as repertoires. I reflect on their ability to articulate what and who was designing, positioning them as tools for the speaking subject to speak on account of the human/nonhuman designer assembly. I also reflect on how they made visible the force of the designer, and reflect on what was gathered, or what should have been gathered, as a way of convening the constituency.

Repertoire 1: landscape ethnography through temporalities

The repertoire of landscape ethnography describes local practices, and actions undertaken by the people of the place to maintain it. Landscape ethnography also

describes the particulars of design practice, such as specifics on material qualities, software, and tools, revealing the nonhumans that gathered in a broad, generous way. As such, the repertoire of landscape ethnography is very effective in accounting for, and realizing, the nonhumans of design practice. Lastly, landscape ethnography, as a repertoire, pays particular attention to the temporal scales of place. Through this, I found that this repertoire enabled the nonhumans to speak in ways that were *tangentially* related to the task at hand. These nonhumans may initially seem less relevant to design, or to the speaking subject, but were necessary to consider with respect to maintaining the constituency in the longer term. Through landscape ethnography, the speaking subject could pay particular attention to temporalities by asking: what was in the landscape before you? What will come after you? How do the mundane events structure your activities in the landscape?

Structuring the landscape through a temporal lens makes it possible to see the assembly of humans and nonhumans as it is present before the design. Landscape ethnography helped to present nonhumans who spoke, and were present in the events that were initially overseen, such as the two pieces of denim cloth that were used to cover the TC2 at TARP. This was retrospectively helpful, but it fell short in giving insights on which nonhumans *should have* participated. The repertoire of landscape ethnography is successful in accounting for nonhumans, and makes visible longer temporal trajectories, but is less useful in *convening* the constituency or actively working with nonhumans in the moment.

Repertoire 2: noticing through fragility

The repertoire of noticing focuses on precarity and disturbances, to increase attention to perceiving the relationships between humans and nonhumans differently. The method of noticing is different from landscape ethnography and translations in how it utilizes a narrower focus — focusing in on, and following, one kind of nonhuman — rather than focusing on the more equally divided attention of describing a landscape, or attending to translations. I found this useful, as it allowed me to shift from my human-centered assumptions and logic in the most profound way. This is not without risk, as focusing on one nonhuman can similarly create blind spots, yet it also opened me up to a multiplicity within the category of knots.

I found that the concepts of precarity and fragility enabled me to better understand relationships amongst nonhumans in design practice, and I see disturbances as a way to draw attention to this. When applying the repertoire of noticing through fragility, I suggest that design researchers focus on moments in their practice where nonhumans are brought together in an event. Such encounters bring with them a precarity that can be taken as an ontological opportunity. In the weaving stories, I described a warping setup, but I can see similar qualities in assembling research products, soldering electronics, firing clay in a kiln, or setting the intensity of a laser cutter to accommodate different materials. The repertoire of noticing through fragility attunes the speaking subject to precarious events that can reveal nonhuman force. These moments can also serve as checkpoints or possible moments of pause to reconsider what needs to be gathered from within the constituency.

Repertoire 3: translations through questions

The repertoire of translations involves describing design research tools through focusing on the questions asked *through* them. A multimeter *asks* if amperage is flowing through a material, a weaving draft *asks* how a thread will travel. Translations account for nonhumans, in the sense that the tools used can be seen as speech prostheses.

I found that describing tools and materials and the prioritization of images is already fairly common in design. Mobilizing this, in combination with the articulation of the questions that are asked through these actions, is helpful in further articulating the voices of the nonhumans that are being invited to participate. Similar to the repertoire of noticing through fragility, events where tools are invited to participate can be seen as moments of pause for the speaking subject, in which the constituency is consulted. What is being asked through these tools? What is not being asked?

I see similarities between landscape ethnography and translations in terms of what is given attention to through our descriptions: broad, inclusive, and detailed descriptions of tools, and materials used in design research. However, unlike landscape ethnography, I found that the repertoire of translations can also make present the material that *should* have been present, through considering the use of different tools, or by consulting the constituency differently. It is, therefore, also a fruitful repertoire for *convening the constituency*.

6.4. Concluding remarks

This chapter developed three repertoires. It explored anthropological approaches to providing accounts of the weaving events that I was involved in. I contributed three repertoires that could increase nonhuman participation in design practice through the critical reflection of these accounts. In applying the repertoire of *landscape ethnography through temporalities,* designers should allow nonhuman temporalities to guide their practice. In using *noticing through fragility,* designers need to embrace disturbances as moments for listening. And lastly, in *translations through questions,* it is important that the speaking subject assumes a humble position from which it can reconsider what is gathered in the constituency. The next chapter will combine the developed repertoires, with more actionable lessons for the speaking subject.

Chapter 7. How to Design More Things?

This dissertation set out to increase nonhuman participation in design. The work situates design practice itself as more-than-human, as demonstrated through three cases. The main challenge that this work has tackled is understanding the posthuman designer, using Wakkary's term of *repertoires* (Wakkary 2021). The three repertoires are landscape ethnography through temporalities, noticing through fragility and translations through questions. This chapter discusses the implications of the work.

I will discuss three lessons for the speaking subject that enable the repertoires to be mobilized, and used in design. The second section of this chapter reflects Wakkary's designing-with framework, in which I will discuss how it helped to bring nonhuman participation to the foreground, and where it fell short. I will also reflect on my contribution to the theory by discussing connections to narratives and storytelling. In section 7.4, I will draw on the three lessons for the speaking subject, as discussed earlier in the chapter, then I propose possible directions and starting points for designers who want to develop other repertoires. Lastly, I summarize the limitations of this research.

7.1. Lessons for the speaking subject

The following section discusses lessons for the speaking subject on the attitudes that need to go along with the application of the proposed repertoires. The work throughout this dissertation has illustrated how challenging it is to decenter the human *as a human designer.* Even with the intention of increasing nonhuman participation, there is a lingering human-centeredness that proves difficult to escape. For example, in Videos of Things, I realized from the start that focusing too narrowly on the designed things could cause similar blind spots as human-centeredness. Still, the videos used some of the material speculations as a narrative device leading toward a plot twist, or resolution. It took further critical reflection, and articulating the concept of *displacement,* to understand better how the proposed narrative strategies could be applied. As well, in the Morse Things case, the thing-centered approach took multiple iterations to get away from deeply rooted human-centered assumptions that, despite best intentions, found their way into our design decisions. Our commitment to thing-centeredness shifted to

romanticizing in some instances, such as the appreciation of the kintsugi cup, or the enchantment with the packaging design. Applying the repertoires will require an understanding and attitude of what it means to be a human amongst nonhuman designers.

The next section describes lessons learned from developing repertoires in the Woven Things case, and bridges the gap of these approaches to actionable points that can be used in design practice. The three lessons for the speaking subject are structured in relation to the positions or approaches of the speaking subject as proposed by Wakkary (Wakkary 2021): *not-knowing, transmogrification, and horizontality*. In these sections, I also make connections to other works in design and HCI.

Not-knowing: assume a humble position for the speaking subject

Firstly, Wakkary suggests not-knowing as an approach for the speaking subject. Wakkary argues to go beyond common design practice of problem-framing and problem-solving, to stay with the trouble, but even more so to *"act from a position of not-knowing or partial knowing"* (Wakkary 2021, 246). Within a posthuman framing, this relates to the limits of our knowledge, especially when it comes to understanding nonhumans. Wakkary argues that the speaking subject can commit to this partial knowing and still engage in design. I recognized the ability of the designer to act from such a position in two ways in the Woven Things case. Firstly, my limited experience with weaving positioned me as a novice, one that required me to act or learn with a starting position of not-knowing. Secondly, I was a visitor in the places where I practiced weaving, an embodied position of not- or partial-knowing.

In the stories of the Woven Things case, I have described different places that are part of the biography of the projects: TARP, the Unstable Design Lab, and a *space* that existed physically across Vancouver (the Everyday Design Studio and its members' work-from-home spaces), and the Netherlands (EElabels), but was primarily accessed over platforms such as Zoom, Miro, WhatsApp, and Signal. My position in the first two spaces was that of a visitor. I was there with a goal that did not entirely align with the purposes of the space.

Compare, for example, TARP and the Unstable Design Lab. The TC2 at TARP was set up for weaving graphical and photographic cloth. The TC2 at the Unstable

Design Lab was set up for making prototypes, exploring computation, and weaving. These intentions of place materialized in various ways. Compare for example, the yarns used in the TARP and the Unstable Design Lab (black and white, versus many colours, and different materials). The TC2 looms also differed in their width and number of modules that hold the needles to lift the threads of the warp, resulting in a difference in density. These materialized differences speak to the intentions of the constituency and determine what can be created in each space. While the TC2 loom at TARP was set up for detailed graphical work, with a higher density of pixels per row, the TC2 loom in the Unstable Design Lab was meant for prototyping e-textiles and larger cloths, with more space between threads.

These material realities demonstrate the political dimensions of those constituencies. The choices of what kind of loom is needed in each space are value choices that demonstrate matters of concern and matters of care. This also becomes clear in the use of the looms. The TC2 loom at TARP was meant for semi-public use — students, and visiting researchers — and I was there as a test subject. The TC2 at the Unstable Design Lab is there for the lab's students. I earned my weaving time by contributing to the warping process, and accessing these spaces as a visitor meant gaps in my understanding of the relationships amongst the things in them.

When Jen left to fix the loom at TARP, I didn't know where she went, or what she did to recuperate the loom. When I was not working on the loom, others were in the space using the tufting gun, or working at the desk. At the Unstable Design Lab, I was helping with the warping process that was new to me but also to most others in the lab as it was the first time the lab was attempting a sectional warp. This created a space open for questions and contestations, but with a persistency to act.

Through these stories, I have come to understand the position of a *visitor,* and a *novice,* to enable working with *not-knowing,* and *humility*. I see this in line with approaches such as inarticulacy (Gatehouse and Chatting 2020), in which the authors reported on working through their design process with *"a degree of chutzpah"* (Gatehouse and Chatting 2020). Still, this position of productive not-knowing is in stark contrast with common approaches within HCI that invite experts, or domain professionals.

More broadly, and in relation to our theoretical framing, posthumanist, critical race theory, and postcolonial literature have proposed approaches of unlearning (Porter 2016) to overcome deeply rooted humanist framings in knowledge inquiry that I suspect are also present in the conceptual 'expert.' I contribute the position of visitor and novice as a fruitful way to practice humility, unlearn and not-know in design research.

Of course, not-knowing is not without risk. In the Morse Things case, it became clear that committing to positions of not-knowing — such as those that come with thing perspectives, withdrawal, and displacement — can also lead to unanticipated outcomes. While I would not advise anyone to neglect the importance of bubble wrap or proper packaging, I still see value in working through what perhaps feels like naïve pursuits in how they can expand the types of contributions in design and HCI, in line with, for example, calls for reporting on dead ends in research-through-design (Desjardins and Key 2020), unused prototypes (Taylor et al. 2021), and non-contributions (Devendorf et al. 2019).

Transmogrification: allow nonhuman temporalities to guide practice

Wakkary introduces the concept of transmogrification as an often-experienced side-effect of positions of not-knowing: *"a seemingly magical change of who we are in relation to things and nonhumans"* (Wakkary 2021, 248). In the weaving stories, this transmogrification was described explicitly when taking the perspective of a thread, but also, more subtly, in my shifting experiences of time, and material traces.

Throughout the stories, I have woven in nonhuman temporalities such as *rows-per-minute, knots-per-hour, material enforced breaks*, and *rituals that structure practice*, such as tucking in the loom. I see this as an example of transmogrification in how temporal hierarchies are restructured. For example, rows-per-minute, and knots-per-hour prioritize rows and knots over minutes and hours, putting the human weaver in service of the nonhuman designer and the biography.

In describing the forming of knots, I attended to the perspective of the yarn. This allowed me to understand the nuances of the relations between yarn and weaver, or more broadly, material and designer. I wrote: *there are times weavers want this to happen, and there are times when they don't.* I described knots made by the yarn, undesired by the weaver, and many knots tied by her as part of the weaving process.

But what does the yarn want? By zooming in on the perspective of the yarn, it becomes clear that it performs similarly across the warping and weaving process: it is the human weaver imposing on the material that changes the situation. The attention paid to the knots, and errors while warping the beam at the Unstable Design Lab, could also be seen as a material-temporal commitment. The way a loom is warped determines what that loom is for some time. This is clear in the commitment to the material that is warped with, and in the glitches in the Photoshop templates, observed at both TARP, and the Unstable Design Lab, as traces of warping events that continue to be present in weavings. Recruitment of nonhumans therefore has a temporal element. Longer-term commitments to materials are a way to enable nonhuman temporalities to guide practice.

Nonhuman temporalities could be applied in design projects in other ways, by prioritizing materials, and their temporal structures, over other concerns. This connects to works in HCI, such as Odom and co-authors choice to work with wood from a fallen tree (W. Odom et al. 2019), the processes of clay and its drying time, that are prioritized in Liu's work with decomposition (S.-Y. (Cyn) Liu, Bardzell, and Bardzell 2019a), and explorations of material traces by Giaccardi and co-authors (Giaccardi et al. 2014).

There is an opportunity to extend this work, and commit to the temporalities of materials, not just in their recruitment at the start of a project, but to understand it as ongoing, and to integrate rituals to maintain the materials. I see an opportunity here to connect the lens of nonhuman temporalities to design tools that can serve as prompts for noticing during the design process, such as measuring, or recording devices that have a timespan, or end-of-life expression. Enabling nonhuman temporalities also means adjusting our own pace. Nonhumans might take longer to speak, or disclose themselves over different time structures. Allowing nonhuman temporalities to guide practice could look like consciously integrating moments of doing nothing, stepping back, and practicing patience.

Horizontality: embrace disturbances as moments of listening to members of the constituency

Wakkary offers the metaphor of horizontality for a more generous design practice. Horizontality, in contrast to verticality, gives up the powerful position of an all-seeing human, and calls for *"a fall to the ground"* (Wakkary 2021, 251), to be alongside other humans, and nonhumans. Through this, the contact points between humans and

nonhumans are expanded, increasing the multiplicity of relations. In the weaving stories, I recognized this horizontal position when experiencing and reframing moments of disturbance.

In the story of *Following Knots*, I told a story about an event that allowed us to pay attention, to notice the knots that abruptly stopped our warping process. But it is essential to understand that this was a disturbance *for us*, the humans warping the beam, and not necessarily for the thread itself. Anna Tsing proposed disturbances as an analytical tool that required awareness of the observer's perspective (Anna Lowenhaupt Tsing 2017). It was simply an interaction for the fibre, expected, and even desired, by the weaver herself later on in the process. Disturbances have the potential to be seen as generative tools for understanding relationships.

In the third story, I could see disturbances as generative in practice. Our tools, such as the multimeter, and the antenna vector analyzer, provided us with material insights — even in materials that were yet to be acquired. Still, using these tools, and not others, made us oversee other yarn qualities, such as elasticity, and the cone that the material was wound on.

In the story of the conductive yarn, we learned that nonhumans could initiate the process of recruiting for the biography. In our case, the coming together of the Itema r9500, the Elektrisola, and the spool it was wound on, prompted a re-assembly of nonhumans. The recruitment of new material, a new member of the biography, required preparatory work that resulted in requirements such as choice of the spool, and a range of conductivity.

This clarifies the work of the speaking subject as ongoing: recruiting, maintaining, and attending to nonhumans is always open to contestation. The Elektrisola expressed its non-participation, and the speaking subject chose to find a different yarn to work with. Recruitment can also result in excluding nonhumans from the biography, and choosing one nonhuman over another. In this case, the speaking subject prioritized working with the Itema r9500 loom, which excluded the Elektrisola from the biography.

I see the commitment of understanding disturbances within design research more deeply as an ontological opportunity, in line with Leahu's investigation into machine learning glitches. Leahu highlighted not only the chance for approaching such

surprises as ontological opportunities, but also the particular commitments needed to consider thingly expressions (such as glitches, errors, crashes, and breakdowns) as learning moments, or even simply as the revealing of human-centered blind spots.

Other design research has considered such expressions, primarily for its potential for aesthetic interactions, such as breakdown and repair (Jackson and Kang 2014), wabi-sabi (Tsaknaki and Fernaeus 2016), impermanence and patina (Lee, Cha, and Nam 2015; Lee, Son, and Nam 2016; Tsaknaki et al. 2016), traces (Giaccardi et al. 2014; Robbins, Giaccardi, and Karana 2016), decomposition, un-crafting and unmaking (S.-Y. (Cyn) Liu, Bardzell, and Bardzell 2019a; Murer, Fuchsberger, and Tscheligi 2017; Wu and Devendorf 2020), and fragility, or magic (Andersen and Wakkary 2019; Landin 2005). There is also an area of research reporting on mistakes, unintentional aspects, and re-framings in design research practice (W. Gaver et al. 2009; Howell, Desjardins, and Fox 2021; Oogjes et al. 2020; Taylor et al. 2021). The notion of disturbances within designing things is a way of horizontalizing, revealing, and generating aspects of the constituency.

7.2. Reflections on Designing-with

In this section, I reflect on my use of Wakkary's designing-with theory. An important nuance to this discussion is that I did not come to this theory anew. In my contributions to research projects such as the Tilting Bowl (Wakkary et al. 2018), and the Morse Things (Wakkary et al. 2017), I was part of its construction. My work with the theory is an example of how theory is used dynamically in design practice. Particularly, my work with the designing-with theory was a way of working through higher level concepts and understanding them through my own design practice. This example of how theory is used in practice relates to other more dialogical approaches of exploratively and through practice understanding theory and philosophy (Hauser, Wakkary, et al. 2018), but focuses more explicitly on doing design. In these next sections I elaborate on my insights into designing-with that emerged by working towards the development of repertoires. I also describe the lens of narrative and storytelling as an additional interpretation of the theory.

Nonhuman participation, collaboration, and contestation

This research has aimed to increase nonhuman participation in design practice. I have done so through the steps of accounting for, bringing attention to, and finally, actively working with, nonhumans in their respective repertoires. I have come to understand that the question of *participation* is not easily answered. In many ways, the nonhumans that I have brought to the fore in this dissertation were already participating, whether or not I accounted for, or paid attention to them. This work is therefore not about creating a space for nonhumans, or explicitly inviting more nonhumans. I have grown more aware of the nonhumans that are already present in design, which has opened me up to new ways of working with them — for example, by stepping back, by taking pause, and by reorienting myself. This has enabled me to recognize nonhuman participation, and I aim to work towards *collaboration* with nonhumans.

Wakkary aims to increase nonhuman participation with repertoires, but acknowledges that not all nonhumans are equal. He sees the human and the nonhuman designer as present to varying degrees, and drawing from Jane Bennett's political ecologies (J. Bennett 2009), sees different types, and different degrees of power. These power differences were present in the projects. Through the use of the designing-with theory, I heard nonhumans that spoke up loudly; nonhumans that contested. In the case of the broken Morse Things, this led to a humbling of the design team, and a still ongoing search as to how to continue to work with the Morse Things (Behzad et al. 2022). At other times, this led to the nonhuman being excluded from the biography. In the Wi-Fi antenna project, the Elektrisola is no longer part of our active process — but it is part of the constituency in that we have woven samples with the material, and have unfinished cones of Elektrisola that are now dormant in this project.

These two processes of working with nonhumans that spoke up shows how the concepts of biography and constituency overlap. How do we account for the nonhumans of our design practice that are no longer part of the design project, such as the dismissed packaging design for the Morse Things, the broken ceramics, the excluded Elektrisola? The overlap is also present when working with external collaborators that design in their own constituency. For example, when visiting the Unstable Design Lab and TARP, there are moments of maintaining their constituency (such as warping the loom, and covering the loom with cloth to protect it from dust) that overlap with the

biography of the projects of the Everyday Design Studio, an overlap that works in both directions (for example, when missing knots in the warp).

On reflection, the designing-with theory is well suited to understand the type of nonhumans that participated in the biographies. HCI's researchers that draw from posthumanism have often turned outwards, involving nonhumans of agriculture, plants, and animals. The designing-with theory allowed me to focus on the nonhumans of my design practice. My commitment to a first-person perspective situated me to form a deeper understanding of the nonhumans that I encountered – knots, Photoshop templates, and ceramics — as well as some that were encountered indirectly — shipping infrastructures, a kintsugi process in Japan, and future weavings on the TC2 Jacquard loom that I helped to warp. There are, of course, other nonhumans that remained inaccessible through this perspective, that are nonetheless involved and important.

For example, the nonhumans involved in the production of the threads that were woven with, or the infrastructures of digital technologies and their material realities of pipes, cables, and server farms, which enabled the IoT chips of the Morse Things. The strength of the designing-with theory is how it makes posthumanism accessible for designers through its focus on nonhumans that are relevant for design practice. However, nonhumans of design practice are entangled in complex and expansive ways, illustrated, for example, in Tsing's Feral Atlas (Anna L. Tsing et al. 2020). The focus of designing-with is simultaneously its weakness. In prioritizing nonhumans of design practice, other nonhumans that are further removed from the speaking subject remain mute.

This comes along with an open question of how far the responsibility of the speaking subject stretches. For example, in the case of engaging with the situated materialities of internet-connected things — or the internet more broadly (Dye et al. 2018; Bareikytė 2021) – are there soil stories to be told about the cloud? Are these relevant for design practice? Can we draw from other material practices to expand our ways of working with excluded nonhumans or waste (Dew and Rosner 2019)? What happens with samples, prototypes, and products of design research practice after they have served their purpose? The concept of the constituency is complicated by this need to continuously consider what is, and what is not, part of the biography of any given project. Inviting new members into a project might make them part of the constituency if

they continue to be used in other projects, or, like the Elektrisola, if they stick around with an undetermined trajectory. There is a need to develop repertoires to account for a broader set of nonhumans related to the constituency, and to understand how to engage with nonhumans in the aftermath of design decisions by the speaking subject. I see opportunities to develop repertoires to engage with repair, waste, salvage materials, and decomposition (Rosner and Ames 2014; Jackson and Kang 2014; Dew, Shorey, and Rosner 2018; Dew and Rosner 2019; Kim and Paulos 2011; McKinnon, Foth, and Sade 2020; S.-Y. (Cyn) Liu, Bardzell, and Bardzell 2019a; Lindström and Ståhl 2020; Lazaro Vasquez, Wang, and Vega 2020).

Lastly, Wakkary described the Everyday Design Studio as a proto-constituency, one that so far has been concerned with matters of academic research, and argued that the shift towards a constituency happens through *"horizontal and relational expansiveness and inclusion"* (Wakkary 2021, 218). Constituencies are always becoming, an ideal on the horizon that the proto-constituency and speaking subjects work towards but can never fully reach. Repertoires for convening the constituency are therefore not only about gathering, caring for and participating — but also about self-reflection and self-critique. I see the repertoire of landscape ethnography through temporalities as a helpful check point for understanding a constituency at a given time, and here too, consider the perspective of a visitor as helpful. With expanding concerns of material politics, there is a need to develop repertoires that further enable self-critical engagement on the responsibility of the designer in the context of a constituency.

Posthuman design stories

I have provided an additional lens of narrative to the designing-with theory, which I have positioned as a way for the speaking subject to consciously and exploratively consider their narratives. In design, these narratives exist in writing, as demonstrated in the Woven Things case, but also in design documentation, and dissemination, such as in the case of concept videos, and the way in which design work is presented in imagery (Desjardins, Wakkary, and Odom 2016). Narrative is a resonant theme in the relational theories that Wakkary builds on.

For example, Ingold has long argued for writing and storytelling as a unique way for humans to engage with the more-than-human world (Ingold 2011; 2021). He

positions stories as a multi-interpretable, relational form of knowledge that one can grow into, and compares stories to classifications.

In a classification, *"every element is slotted into place on the basis of intrinsic characteristics"* (Ingold 2011, 160). Stories allow for a messier, more connected, and mesh-worked type of knowledge: *"we can understand the nature of things only by attending to their relations, or in other words, by telling their stories"* (Ingold 2011, 160). Ingold further suggested that storytelling is a peculiarly human ability to weave together different temporalities.

Donna Haraway similarly emphasized the temporal opportunities of storytelling when she spoke of *ongoing pasts, thick presents, and still possible futures* (Haraway 2016). She presented the Camille stories: vignettes of living on earth as 'syms and critters', where human newborns are assigned to a species on earth (in Camille's case, a butterfly) to live in explicit symbioses. The story is told over five generations, starting in 2020, and particularly emphasized the decreasing human population — reduced reproduction is proposed as a form of climate reconciliation.

Haraway wrote the stories, along with filmmaker Fabrizio Terranova, as well as Vinciane Despret, and she urged the collaborative aspect of the stories, as well as their openness: *"they long for a fuller weave that still keeps the patterns open, with ramifying attachments yet to come"* (Haraway 2016, 144). Donna Haraway further elaborated on speculative fabulations as one of her SFs, and drew from Ursula Le Guin and Bruno Latour to emphasize the need to not only tell untold stories, but to change the stories.

To think outside of the dominant tale of humans, Haraway urged: *"we **must** change the story; the story **must** change"* (Haraway 2016, 40 original emphasis). Natalie Loveless (Loveless 2019) built on Donna Haraway and Thomas King (King 2005) to position stories as powerful, not only for their content, but for their form: *"both authors implicitly insist that to do research – of any kind – is not simply to ask questions; it is to let our curiosities drive us and allow them to ethically bind us; it is to tell stories and to pay attention not only to which stories we are telling and **how** we are telling them, but how they, through **their very forms,** are **telling us.**"* (Loveless 2019, 24 original emphasis).

This suggests not only the broader potential of storytelling, but also that exploring multiple **forms of storytelling** and language is a worthy pursuit. This resonates, for example, with Ingold's call to investigate naming as storytelling (Ingold 2011), and Robin Kimmerer's suggestion to look to the animacy of grammar (Kimmerer 2013) to better represent the vibrancy of nonhumans. Both of these authors point to the power and importance of language when speaking of nonhumans, such as plants and animals, and argue that naming them with verbs instead of nouns would better represent their agentic capacities.

In another exploration of form, authors in this range of work have explored story structures such as sagas (Watts 2019), interludes (Anna Lowenhaupt Tsing 2017), lists, prologues (Wakkary 2021), and an abecedary (Despret 2016). These forms of storytelling can be used as resources for design researchers that have looked for new forms of dissemination of information, such as design memoirs, podcasting, collage, poetry, and video work.

Collectively, these works invite designers to be much more experimental in the ways they are documenting and presenting their work, in line with works of critical tactics for research dissemination (Jungnickel 2020). In relation to the designing-with framework, storytelling can be experimentally used as a repertoire to account for nonhumans. It also offers opportunities to better understand the designer as biography, by inviting a more open, multi-interpretable, and ongoing form of communicating design work.

7.3. Designing more things

I now turn to potential starting points for more repertoires, and elaborate on how other researchers can develop them. For this, I turn back to my lessons for the speaking subject, and structure the potential repertoires along the lines of not knowing, horizontalizing, and transmogrification.

Repertoires for elastic relations to the truth

To begin with, in expanding positions of not knowing, and working from a humble position for the speaking subject, I see opportunities in developing repertoires by continuing to work with seemingly pointless, useless, and naïve pursuits (Treusch,

Berger, and Rosner 2020; Sicart and Shklovski 2020; Rosenbak 2015; 2018b), engaging with the false, fabricated, myths and magic (Rosenbak 2018a; Andersen and Wakkary 2019; Sultana and Ahmed 2019), speculating with the incomplete (Feinberg, Carter, and Bullard 2014; Albaugh et al. 2020), and expanding modes of drifting (Goveia da Rocha and Andersen 2020). I have particularly pointed to the practice of unlearning as a way of actively working with problematic histories, including actions of refusal, rebuilding, and repairing (Azoulay 2019; C. L. Briggs 2021; Honig 2021; Ann Light 2022). I envision ways of developing repertoires that similarly work through the unlearning of design methods or assumptions.

Repertoires for disorientation

In the earlier discussion on lessons for the speaking subject, I also outlined the embracing of disturbances as a form of horizontalizing, to listen to the constituency. I see horizontalizing as one of many possible re-orientations for the speaking subject. For example, multi-stability, a concept from postphenomenology, draws from an optical illusion that allows one to see an object anew, to illustrate how one thing can be many things at once depending on one's position (Rosenberger and Verbeek 2015). This example illustrates a change in the object as much as in the viewer.

Sarah Ahmed speaks of *disorientation,* and *becoming oblique,* and emphasizes the process of orientation as starting from a point of being lost. Ahmed draws on queer and migrant orientation(s) and argues for a queer phenomenology that *"would involve an orientation toward queer, as a way of inhabiting the world by giving support to those whose lives and loves make them appear oblique, strange, and out of place"* (S. Ahmed 2006, 179).

Repertoires for dis- or re-orientation could include involving such perspectives either in collaboration, or from a first-person perspective, to open up to different understandings of nonhumans — for example, based on Bennett's study on hoarders (J. Bennett 2012), there is an opportunity to develop repertoires from these theoretical positions that resonated with speculative approaches of de-familiarization, and embodied speculation (Dörrenbächer, Löffler, and Hassenzahl 2020; Lindström and Ståhl 2017; Devendorf and Ryokai 2015a), to further reposition the human designer as not being above, but being horizontal to, being alongside (Latimer 2013), or being

disoriented whilst gaining a better understanding of what becomes visible and invisible through each position.

Repertoires for nonhuman temporalities

Building on my discussion of transmogrification through nonhuman temporalities, I see opportunities for designers to develop repertoires that engage deeply with time. Design and HCI have strong research agendas, exploring longer-term, or slower temporalities (Hallnäs and Redström 2001; W. T. Odom et al. 2014; W. Odom et al. 2019; Friedman, Nathan, and Yoo 2017; Mary Costello 2020). These works can be built upon to develop repertoires that engage more explicitly with nonhuman temporalities, going beyond human experiences and lifetimes. For example, Rahm-Skageby and Rahm argued for further engagement with geological tempo-materialities through *deep time* (Rahm-Skågeby and Rahm 2021). Deep time sees materiality and temporality as intertwined and *"illustrates how time can be seen as vertical (structured as sediments and layers) rather than horizontal (structured as teleological progression)"* (Rahm-Skågeby and Rahm 2021, 11). For researchers interested in developing repertoires that engage with nonhuman temporalities, I suggest archeology studies, or collaborations with archeologists as possible starting points (Bergmann 2016; Roberts 2017). Archeologists share similarities with designers in understanding materiality and translating object language and possess techniques and skills that can help design to expand its understandings of nonhuman timescales, slow material processes of decomposition and end of life of designed things (Lechelt et al. 2020; Farmer 2020; Rahm-Skågeby and Rahm 2022). I can see this becoming part of design projects in considering longitudinal relations with nonhumans and design materials (Moradi et al. 2022) and developing tools and processes to keep track of changes over time as a continuous engagement with the biography. This perspective also challenges design ideals of durability and permanency and could prompt repertoires for shorter lifetimes or the breakdown of designed things, as well as expand current discussions on nonhuman care (Key et al. 2021) when thinking of reuse, repair, decomposition, or archiving.

As a last note here, my approach to developing repertoires is characterized by its engagement with theory, especially in the Woven Things case. While I have pointed to theories in my suggested starting points above, I also see it as fruitful, and possible, to work through these questions with design, and focus on methods as more accessible

repertoires. For example, I can see how the Morse Things case could have been developed into a kintsugi repertoire, or how the Videos of Things case could have expanded to represent the designer as biography, focusing on the processes of design, and the life of materials left behind. I see the work of developing repertoires as an interplay between theory and method, but this work can lean more toward either direction.

7.4. Limitations of the research

The first limitation of this work comes from the structure of the thesis that developed repertoires through propositions. While all the core chapters (chapters 4, 5, and 6) supported this development, and have outcomes of their own, chapter 6 is the only one that presents full repertoires and answers the research question concretely.

While aimed at designers in a broad sense, this work was developed in a design research setting. My approach of developing repertoires involved thorough engagement with theoretical works. I recognize that this way of working, as well as certain elements of the repertoires that I proposed are not as easily translatable in a higher-paced environment. In future research, it would be valuable to put these repertoires to use in different projects to understand their applicability better, and to present a range of design contexts.

The work presented in this dissertation took a first-person approach. The work is not able to fully generalize on the usefulness of the repertoires for other designers. There are further ongoing tensions of first-person approaches in exploring research questions that focus on the nonhuman. These limitations could be overcome by exploring the repertoires through other approaches, such as duo-ethnography, or tri-ethnography.

Nonhumans are nothing new, and have been accounted for, attended to and engaged with for much longer from non-western perspectives. A limitation of this work is that it builds on largely western philosophies and does not engage with other perspectives of nonhuman agencies, such as indigenous knowledges and eastern philosophies of animism. These discussions are arising in posthuman discourse but there is an open need to bring these concerns into the fields of HCI and design as well.

Another limitation of this work is the idealization of nonhuman participation. Nonhuman participation is not always necessarily *good*, and not all nonhumans are, or should be, equal. I described earlier how I aimed to find ways to develop design that went beyond human control; however, this is certainly not always desirable: consider garbage patches in the ocean, and other processes that have grown outside of/beyond our control, challenging the habitability of the earth. However, by better understanding nonhuman participation, designers can start to work towards nonhuman collaborations. This will enable designers to be better equipped to understand longer term and multi-relational effects of design.

Speculative design has been critiqued for its limited and Eurocentric perspective (Tonkinwise 2014; Oliveira 2015). While the approach presented in this dissertation does not necessarily align with the speculative approaches in the critiques cited, I do see a privilege in the ability to commit to a thing-perspective and continuously change my orientation. I relate this particularly to discussions on horizontalizing, and other forms of dis- or re-orientation. Choosing to be horizontal is something I can do from a position of power and freedom, and this should be acknowledged. Further, as part of the nature of the speculative design work that I have been engaged in, from an academic context, there are deeper politics of nonhumans that I have not encountered. The work can be expanded to engage more deeply with entanglements between humans and nonhumans. I see this challenge in connection with work on infrastructural studies (Wong et al. 2020; Steinhardt 2016).

Lastly, this work took on the challenge of better understanding the position of the speaking subject and enabling nonhuman participation. An inherent challenge of this lies in the use of human language. There is a tension in the work of committing to mystery or not-knowing of nonhuman worlds whilst simultaneously asking nonhumans to speak or translate in a language that is comprehensible for me. This is further complicated by the common forms of knowledge distribution in academic contexts that rely heavily on language and formats such as papers, articles and dissertations. There are parts of the design work that were challenging to communicate in text and would benefit from multi-sensory channels.

Chapter 8. Concluding remarks and future work

This chapter will conclude the dissertation by summarizing the development of three repertoires. It will also outline directions for future research, and summarize my contributions.

8.1. Revisiting the research questions and propositions

This research has positioned design practice itself as more-than-human and aimed to investigate ways for designers to increase the participation of nonhumans, by developing Wakkary's concept of repertoires through design projects. The dissertation engaged with several nonhumans in the following ways:

- Accounted for nonhumans that may be encountered in everyday life, such as furniture, food, pots and pans, laundry detergent, a set of keys, ventilators, houseplants, and headphones (chapter 4, Videos of Things);
- Attended to nonhumans of design practice such as packaging, UPS, routers, batteries, and ceramics (chapter 5, Morse Things);
- Actively engaged with nonhumans of design practice such as a TC2 loom, Photoshop presets, a vector antenna analyzer, cotton threads, gold plated yarn, knots (chapter 6, Woven Things).

Throughout this dissertation, I worked with three propositions that each answered a research sub question, and collectively answer my research question:

How can the concept of repertoires be developed in design practice?

In the next sections, I will revisit the propositions and sub questions, and summarize the repertoires.

Proposition 1: Narrative strategies that counter human-centered strategies can be used to better account for nonhumans in everyday life.

In the first proposition, narrative strategies were considered as *speech prostheses* to account for nonhumans in everyday life. The chapter also articulated the

concepts of displacement in answering the sub-question: *how can designers better account for nonhumans in everyday life?*

Chapter 4 details the development of three design videos. In reporting on these videos, I contribute three narrative strategies that will further enable HCI researchers and designers to move nonhumans to the foreground. The first strategy is *patterns in time*, which depicts time as a foregrounded element of narrative by exploring different structures such as one day or a few months and highlighting nonhuman temporalities and rhythms. This strategy counters common human-centered approach to structure design videos by situations of use and problem solving. The second strategy is *nonhumans and ensembles,* which aims to get away from a singular focus on the proposed technology as a main character, and depicts a plurality of relationships between humans and nonhumans. Finally, *humanness* aims to expand often limited characteristics of personas and human actors that in traditional, human-centered design narratives are often at the service of the technology. The strategy of *humanness* depicts more rounded characters that say and do things that are not necessarily in direct relation to the proposed technology, allowing for other situations to emerge.

These strategies uncovered a concept related to repertoires that I referred to as displacement, the shift of focus from the designed thing to its relationships with other nonhumans. This notion of displacement in design can help us to see the multistability of design artefacts and allows to speculate on a multitude of relations that might develop. The concept of displacement has been integrated into further work with the Morse Things, describing it as characteristic quality of our limited understanding in thing-centeredness (Wakkary, Hauser, and Oogjes 2018).

In summary, the use of narrative strategies that counter human-centeredness were able to account for nonhumans, but they fall short in allowing them to *participate*. The videos were speculative and anticipatory, but from the perspective of posthuman design, the strategies are too retrospective. In proposition 2, I explored a different starting point for developing repertoires that accounts for nonhumans earlier on in the design process. The challenge then becomes not only a matter of decentering the human and countering human-centered narratives in design scenarios, but a more introspective challenge involving the decentering of the human designer and overcoming deeply ingrained human-centeredness in the practice of design.

Proposition 2: Design journeys can be used to bring attention to the nonhumans of design practice.

In the second proposition, the tracing of design processes through *events* allowed to make visible the force of the designer. The concept of Design Events answers the sub-question: *how can designers bring attention to nonhumans in their processes?*

I retraced events of the Morse Things project in chapter 5, where an in hindsight fallible process revealed agencies and forces of involved nonhumans such as the UPS shipping system, bubble wrap, LiPo batteries and a kintsugi cup. In the coming together of several of these events and through our commitment to thing-centeredness, we lost control of the project. This taught us that the conceptual notion of what something is, is quite dynamic and fragile in and of itself. The loss of control and the actual and conceptual breakdown allowed us to better understand relations within the project and was generative in initiating an approach that sets out to create new cups and bowls that are *in sympathy with* the Morse Things (Behzad et al. 2022). I see this work in line with these investigations that further untangle the impact of networked things in everyday life, and want to emphasize the commitment, as well as the risk, to staying open to surprising turns and the way they can support decentering the human designer in design processes.

I contribute the notion of *Design Events* to structure design processes in a way that engages with nonhumans of design as they are encountered, and as active and ongoing. Events do not assume relations in the way design results within a process do but are not entirely flat in their ontology either. What I suggest with the notion of events, based in the work with the Morse Things, is that they can be considered as moments of pause to listen to and understand nonhumans. In the next proposition, I actively applied the notion of Design Events.

Proposition 3: Anthropologically-derived writing methods can be used to actively engage with the nonhumans of design practice.

In the third proposition, nonhumans were actively engaged. From this last proposition, three repertoires emerged that were formulated in chapter 6. The developed

repertoires answer the third and final sub-question*: how might designers actively work with nonhumans?*

The cases in this research most clearly built on each other through the propositions that shift from accounting for, to attending to, to actively engaging with nonhumans. In the following sections, I summarize the repertoires and describe how there are threads that lead towards their development in the preceding cases.

Landscape ethnography through temporalities

The repertoire of landscape ethnography through temporalities utilizes the key sensitizing concepts of refusal to universalize, attention to local practice, and a focus on temporality. Landscape ethnography through temporalities as a repertoire asks designers to generously consider their environments, describe them in detail and with particulars, and to understand them as continuously in flux.

In the Woven Things case and the final repertoire, the importance of paying attention to things that may initially not seem relevant to the task at hand, such as the tucking in of the loom, are given importance through landscape ethnography and bring to the fore broader and longer-term concerns of the constituency. The relevance of this for design becomes clear in the expanding landscape of the Morse Things, where the team lost track of parts of the landscape such as battery life and shipment time.

In my findings, I elaborated on how landscape ethnography was helpful in accounting for nonhumans, but fell short in actively working with them. I proposed that landscape ethnography works best for earlier, or orientating stages in a design process, such as when the human designer finds themselves in a new environment. Landscape ethnography provides a generous overview of the constituency, which can be helpful when it is not yet clear which nonhumans will be of importance in the design process. It can also be of interest to researchers who are engaged with longitudinal projects as a way to identify, and attune to temporal rhythms of the nonhumans involved.

Noticing through fragility

The repertoire of noticing through fragility utilizes the sensitizing concepts of switching perspective in the narrative, accepting a state of precarity or fragility, and focusing on

disturbances. Noticing through fragility enables the exposing of relationships through more precarious circumstances.

The switching of perspective in the narrative resonates strongly with the epistemological commitment of this research to follow through on thing perspectives. In the Videos of Things case, the switch of perspective was most explicit in taking the point of view of the Tilting Bowl in the video. There are moments of accepting a state of fragility or focusing on disturbances in the videos as well, bringing into view flaws that do not need to be fixed or resolved.

In the Morse Things case, there is an obvious fragility to the ceramics yet in this case the greater fragility was in a coming together of factors of battery life, packaging and our design communication through video. Noticing through fragility enables exposing relations through more precarious circumstances.

In the findings, I stated that these precarious circumstances could be identified in events in which multiple nonhumans newly encounter each other. From this perspective, the repertoire of noticing through fragility can work throughout a design process, and things need not necessarily break, fail, or fall apart as a result. I see this repertoire as especially useful for listening to nonhumans, and consulting the constituency.

Translations through questions

Lastly, the repertoire of translations through questions prioritizes imagery over language, uses detailed descriptions of tools and materials, and accounts for translations of nonhumans. In bringing tools and materials to the foreground, this repertoire most firmly backs the claim of design as a more-than-human practice. The repertoire of translations suggests an increased focus on another type of design event in which I ask the speaking subject to pause.

This repertoire connects to the previous cases mostly in the emphasis on imagery over language. This is present in the Videos of Things case through video and in the Morse Things case by tracing the design journey through visual sensemaking. The repertoire of translations through questions is already present in design but offers opportunities in focusing more on the mediating qualities of tools and materials.

In applying this repertoire, I ask designers to reflect on their tools to better understand what they are asking of nonhumans, and perhaps more importantly, what is not being asked. This repertoire can also be used throughout the process, but as I elaborated on in the discussion, these moments of pause require a slower pace of design. This repertoire is well suited for assessing the biography at a moment in time, and understanding what should or should not be involved.

The three repertoires answer my main research questions:

How might designers increase the participation of nonhumans?

I invite designers and design research to apply the repertoires. In the previous chapter, I discuss three lessons based in my own experiences that I see as helpful for doing so. Firstly, I propose to assume a humble position, for example through engaging in design through a position of not-knowing. Secondly, I suggest to create space for nonhuman temporalities to guide practice. And lastly, I encourage to embrace disturbances as moments of pause and listening to nonhumans. The proposed repertoires, along with these three lessons will allow designers to increase participation of nonhumans.

8.2. What's next?

In the next section, I outline three opportunities for future work. I first outline design as autotheory, in which I see an opportunity of expanding the approach used in this dissertation. Next, I outline the ways in which I intend to continue work with narrative and storytelling in HCI. Lastly, I see opportunities to deepen material engagements through a posthuman lens.

8.2.1. Design as autotheory

In this dissertation, I positioned design as a first-person practice that allowed me to be reflective in regards to my own positionality, bias and decisions in the design process. This contributes to posthumanist design and theory through material engagement and reflection to overcome deeply rooted human assumptions. I aim to further develop this approach *as auto-theory*.

My research has engaged with Wakkary's designing-with theory and particularly addressed the open call for the development of concrete examples of repertoires. I contributed a process of developing repertoires and understanding them in relation to other activities such as design narratives, personas and design journeys. As the same time, this was a way of working through the theory in the book through particular and specific design projects. This enabled me to explore the stability and applicability of the various concepts, and highlighted points where they may need to be more open and malleable. In developing the repertoires, I also worked exploratively with theory in understanding how anthropological approaches fit and could be expanded on through design. These endeavors open up theory as a more active form to work with in design research.

There are important discussions on the role of theory in design research (Redström 2017; Wakkary 2020; Hauser, Wakkary, et al. 2018), yet there simultaneously are many open questions on how it is enacted and produced through practice. I see opportunities to extend this work and further interweave theory, design practice and personal experiences (Devendorf, Andersen, and Kelliher 2020; Chen and Odom 2021).

Lauren Fournier investigates emerging and historical practices in art and literature of autotheory as a coming together of autobiography and theory or philosophy (Fournier 2021). The book includes examples of artistic works of expressing experiences of consuming theory, narratives of lived experiences with references to theory in the margins, art performances of theoretical groundings or visualizing references in paintings or illustrations. These practices demonstrate that there are many ways to engage with theory that are multi-interpretable, can be based or connect to first-person lived experiences, and that don't need to be aimed towards mastering the matter or becoming theorists. For example, Fournier quotes an interview with novelist and autotheorist Maggie Nelson who in her writing annotates her lived experiences with extracts and examples from theory in the margins (Nelson 2016). Nelson describes her engagement with theory as *"swimming in waters that are way, way over your head"* (Fournier 2021, 131), not dissimilar from Laura Devendorf reflecting on succumbing to complexities of weaving: "*I can't wait to swim in the ocean/where I can feel small and insignificant."* (Andersen et al. 2019, 33). I see opportunities to extend first-person research and material conversations (Goveia da Rocha and Andersen 2020; A. Mackey et al. 2019) to include theoretical considerations in an accessible, designerly way.

In continuing my work in the context of posthumanism I will expand ways of engaging with theory, by enabling theoretical drifts, speculative proposals that work through theory or probe studies aimed at materializing concepts. These scaffolding practices are moreover a way to address the limitation of the theoretical load of developing repertoires, or in general the accessibility of engaging with theory in design. My longer-term goal for my research is to seek further engagement with philosophy and theory in a co-constitutive matter, to promote the unique knowledge that design practice can generate and expand the audience for this work to include anthropology, philosophy and critical theory.

8.2.2. Expanding narrative practices in HCI

There is work underway in HCI and design further exploring the potential of knowledge production through stories (Desjardins and R. Biggs 2021; Heshmat et al. 2020; Friske, Wirfs-Brock, and Devendorf 2020). This research has prompted speculations and imaginaries of design to be more inclusive (Bray and Harrington 2021), to re-engage with histories (H. R. Ekbia and Nardi 2017; Rosner et al. 2018), and there is also emerging research on storytelling and more-than-human design (Turner and Morrison 2021; Galloway 2012). I see an opportunity to expand these directions and to commit further to leaps of imagination. There are starting points for this in the anthropomorphic accounts of knots, or taking the perspective of a sheep. I intend to engage with the false, fabricated or partially true and see this as a way to engage with the limits of human knowledge.

Storytelling is a relational and co-constitutive type of knowledge in which form matters. In this pursuit of my research, I also intend to expand modes of dissemination for design research in which I will continue to work with storytelling. I aim to explore new forms of dissemination such as design memoirs, podcasting, collage, poetry, and video work. As well, I see opportunities for further examining tools such as Instagram, TikTok and other forms of modern media to understand their potential use in design for documentation and dissemination. This is a way to take up calls for stories that are more open for others to contribute to or participate in, for example through the use of hashtags or creatively repurposing short sound recordings.

8.2.3. Deepening material engagements

Lastly, my future research will continue to engage with materials as nonhumans of design research. I envision connections of my work to material research on bio-materials and living materials to explore longer term biographies (Dew and Rosner 2018; Ofer, Bell, and Alistar 2021; Zhou et al. 2021; Bell et al. 2022).

My interest in textiles as a material is appropriate for this pursuit as fabrication steps, such as growing flax, spinning wool, and dyeing yarn are relatively accessible and traceable. The textile and fashion industry are known to be polluting but have also brought forward novel approaches and models for circularity, such as slow, circular or local initiatives (Jia et al. 2020; Phelan 2017; “Regional Textile Economies” n.d.). In line with approaches such as unfabricating (Wu and Devendorf 2020), how might we approach a project with a limited lifetime, intended to break down? Is it possible to create and unmake an e-textile from the very beginning of fabrication steps to its final decomposition? What can a first-person account of such a process reveal? And what are previously unencountered nonhumans that may be relevant for design practice?

I see opportunities for HCI to learn from such approaches and to apply them in the field of smart textiles as well as more broadly for the design of interactive systems. There are opportunities to understand fabrication processes and make them accessible and material for designers to work with. Specifically, I want to expand on approaches to work with local materials and see connection to recent discussions on connections to the land and infrastructures of digital technology (J. Liu 2022; Steinhardt 2016).

8.3. Summary of contributions

This dissertation presents four contributions. Firstly, the work provides an account of the designing-with theory in practice. In chapter 4, chapter 5 and chapter 6, I provide rich and detailed descriptions of design research. This clarifies and nuances concepts of the designing-with theory through examples. These descriptive accounts also strengthen the positioning of design as a more-than-human practice.

The second contribution is conceptual. The dissertation contributes three repertoires (in chapter 6) that can be applied in design. Additionally, it contributed the narrative strategies and the concepts of displacement (in chapter 4) and a restructuring

of design journeys through design events (in chapter 5). These concepts provide new perspectives and starting points for designers that work within a posthuman framing or are interested in better understanding and working with the nonhumans of design.

The third contribution is reflective and offers lessons for the speaking subject. This responds to the research problem of decentering the human designer. This expands previous work on decentering the human to include the speaking subject of design practice. I also suggest possible next steps to critically engage and further understand the responsibility of the speaking subject. These reflections are of importance for design and HCI as they can provide humble, disorienting and responsible positions for designers.

Finally, there is a methodological contribution. The work presented a way of developing repertoires through propositions. It is an open-ended and cumulative form of working through theory in design. The work also exemplifies approaching design research as first-person research. First-person approaches are gaining traction in design and HCI (Desjardins et al. 2021), where they have been applied within posthuman framings (H. R. Biggs, Bardzell, and Bardzell 2021) and to design processes (A. Mackey et al. 2020). This dissertation provides an example of combining approaches and mobilizes design as more-than-human. I invite other researchers to continue working with this perspective and finding new ways of relating to design.

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