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Productive Oscillation as a strategy for doing more-than-human design research

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1. Introduction

A key tenet to this paper's contribution is the assertion that while there are many specialized terminologies relating to more-than-human design – terms including but not limited to posthumanism, new materialism, and postphenomenology – in some circumstances it may be strategic to deliberately not worry about the nitty-gritty details of the differences between them, and perhaps draw upon concepts from several different theoretical canons. We will offer some short notes on our interpretation of some of these related terminologies, but it is important to note that, within reason, the thesis we present in this paper is agnostic toward these theories, approaches, perspectives, and terms. Similarly, we don't aspire to advance, critique, or contribute to these areas directly. Rather, our intention with this paper is to describe a strategy for applying some of these ideas within the context of doing more-than-human design. Hence, where we refer to more-than-human design in the paper unless otherwise clarified, we are referring to this "family" or "college" of approaches. Our aspiration is to describe Productive Oscillation as an organizing principle for putting more-than-human design into action in the context of Human-Computer Interaction (HCI) oriented design research. In turn, this may mean being applied in education, in academic research, or in an industry or practice setting.

The factors driving the increasing interest in more-than-human design are multiple and complex, for example, the climate crisis, decolonization agendas, and the Anthropocene. From the perspective of HCI and design, however, the role of more-than-human discourse can be cast with a tighter focus. Taking steps toward clarity of focus, we must consider the ways in which design has had transformative consequences. From dishwashing machines to deep learning, design changes society, society changes the world, and the world changes design.

Through the 20th century designers developed sophisticated means to accelerate this cycle by understanding what human factors that would support the development of products and services that were desirable to have, gratifying to use, and profitable to sell. In a capitalist world, among a society built on unrestricted growth and consumption, such gratifying-and-desirable products and services are an essential cog in the economic gearbox, generating wealth, representing progress, and amplifying demand. The practices, methods, and techniques that make up human-centered design are, unavoidably, complicit in this cycle of design-driven transformation of society and the world (see Forlano, 2017; Giaccardi & Redström, 2020).

In the last two decades, the clamoring to address problems arising from the era dominated by human-centered design has become increasingly audible. Part of this is the realization that whilst

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growth and consumption have traditionally represented progress, they also directly contribute to some of the biggest existential threats to our civilization. While human-centered design is not culpable for all the world's problems, it is the case that the products of human-centered design have contributed, in a myriad of ways, to many of the wicked global challenges we currently face.

During the same period, many other aspects of our social fabric have shifted too. Long-held inequalities – for example, gender, race, and sexuality – are increasingly taboo, and recognition that it is essential to right the wrongs of their hangovers is growing. Accepting and responding to the unquantifiable harms of the colonial era, which is inseparable from the disproportionate wealth of some parts of the world, is galvanizing a growing decolonization agenda. Whilst our contemporary 21st-century societies are far from perfect, arguably we live in a world that is more equal, more progressive and has a broader appreciation of universal human rights than it ever has done before.

The considerable breadth of practices, theories, and motivations that make up more-than-human design is representative of the vast scope of the types of problems it seeks to address. This includes consideration of overarching high-level discussions but also at the level of fine-grained detail relating to specific challenges. With such broad more-than-human horizons, an educator, researcher, or designer interested in doing more-than-human design might struggle to know where to start. Hence, our aspiration with this paper is to describe a strategy for more-than-human design that is decoupled from the specificities of any given theory. As we describe Productive Oscillation, we hope it provides a useful framing for embracing the meta concerns of more-than-human views and putting them into practice while also allowing for the adoption of some of the very specific ideologies or approaches that some more-than-human variants promote. We also note that this "pick-and-mix-ism" (as one of the reviewers of this paper termed it) that Productive Oscillation represents should not be confused with a reason to neglect one's own understanding, but rather can be seen as a discerning choice to allow the more-than-human practitioner to leverage increased agility and flexibility, and bring that to bear on navigating the rich theoretical landscape.

The remainder of the paper is structured as follows:

In section 2, we note the growing lexicon of terms relevant to the more-than-human space. Although we adopt the shorthand "more-than-human" for most of the paper, this section is included to enhance the readability of the paper for someone unfamiliar with the diverse terminology of the more-than-human movement and to provide reference points for further reading. Moreover, this section serves as an opportunity to indicate our interpretations and some of the popular constituents of the more-than-human landscape (accepting that there are likely to be other interpretations). This section is intended to make our lenses explicit and to provide entry points into the discourse. We acknowledge that this is an incomplete and brief introduction to the landscape. As eloquently suggested by one of the reviewers of the paper, it is not possible to capture the nuance of these points of view with such brevity, moreover, in the context of a special issue about more-than-human matters, including such a lexicon may seem misplaced or patronizing. Accepting these shortcomings, we have elected to maintain the lexicon based on the aforementioned logic; to enhance readability for newcomers and to give some insight into our particular interpretation of the theories. Toward the end of the paper, we will provide some practical examples of how one might harness Productive Oscillation to move between the positions described in the lexicon.

In section 3, we describe the Shape of Trust, a research project that was integral in the development of this paper's thesis. Notably, however, the Shape of Trust is *not* a project directly leveraging more-than-human theory. Hence, the Shape of Trust project's relationship to the paper is not (as one might usually expect) an example of more-than-human Productive Oscillation *happening*. Instead, reflecting on how the Shape of Trust project played out was the *inspiration* for developing this rhetorical argument for Productive Oscillation. Although it is not a "live" example of the paper's thesis being deployed in action, given the centrality of the Shape of Trust project to the formation of the Productive Oscillation idea, including an account of the project in the paper is necessary to properly articulate the case for Productive Oscillation. To reiterate, this paper is somewhat unusual, in contrast to more commonly seen paper structures where included project examples would tend to

demonstrate the core idea in action, in this paper the project example is what *inspired* the idea, but does not, in its own right, demonstrate Productive Oscillation. The pathway and journey that the Shape of Trust project took exhibited a structure which is reminiscent of what we now proffer as Productive Oscillation. At its core, the Shape of Trust was a Research through Design (RtD) project (Gaver, 2012). In common with many RtD projects, it had no clearly defined hypothesis to test or research question to answer. Instead, the point of the project was to engage with the complexity of a multifaceted problem space. What became evident through the course of the project was the value of oscillating between elements of empirical research with people, elements of exploratory practice, and elements of theory. Reviewers of this paper asked and wondered whether the *only* link between the Shape of Trust project and more-than-human concerns is that both touch upon and try to unify disparate ideas. In the Shape of Trust project, the ideas are the myriad of facets of trust, while for Productive Oscillation are the facets of the myriad of more-than-human theories. Hence, the Shape of Trust and Productive Oscillation have disparate ideas in common. However, this is just one such link between the two and there is more nuance to consider. First, as we have already asserted, the Shape of Trust – mediated via the murky mechanics of abductive reasoning – inspired Productive Oscillation. Second, we note that some findings of the Shape of Trust project are related to the more-than-human landscape – namely, the nascent concept of Trust as a Distributed Concern (Lindley et al., 2023) which aims to provide strategies for discussing and designing for trust in the context of complex socio-technological systems aligns to the more-than-human movement. Third, and perhaps most significantly, is the way that the Shape of Trust – framed as an RtD or design research project in methodological terms – necessarily moved or oscillated between aspects of design practice, empiricism, and theory. As we begin to discuss in this section, couched in the concepts of intermediate-level knowledge and emergence, the synergy between design research and more-than-human inquiry is a crucial part of how we present our argumentation for the benefits of Productive Oscillation.

In section 4, we discuss and elaborate on the "crucible" or "melting pot" that may emerge when one's perspective or stance is deliberately shifted from one place to another and back again. We term this notion Productive Oscillation. This discussion includes an exploration of why one might want to frame more-than-human design research practice in terms of Productive Oscillation; it unpacks specific contexts that seem appropriate (and those that do not seem appropriate); and offers notes on how you put Productive Oscillation into action in your own project. We also cast a critical eye back over our argument and discuss the limitations of the concept.

The paper aligns and identifies with the more-than-human turn. We describe Productive Oscillation as inspiration and an organizing principle for how to go about *doing* more-than-human work in the context of HCI and design research.

2. The more-than-human lexicon

It is difficult to know where to begin with a more-than-human lexicon as the skeleton of terms is sprawling. There is certainly nuance among the diversity, and that nuance is almost certainly useful when it comes to being able to communicate specific points with utmost clarity. A challenge, however, comes when it is only possible to utilize that clarity when the person being communicated to has the same reference points as the person doing the communication. Offering a potential alleviation to this issue is one reason to include the lexicon, although there are several others. First, we wish to provide some reference points to enter deeper into the literature for a reader unfamiliar with more-than-human texts. Second, whilst we anticipate that more detailed accounts of some of these topics will appear elsewhere in this issue of the journal, this first section aspires to ensure that if this article were to be read in isolation by a newcomer to the territory, the core conceit of Productive Oscillation would be comprehensible and coherent. Third, we seek to underscore the sense of change, difference, and forward movement that many of the more-than-human terminologies evoke, this is a quality that ultimately contributes to our framing of Productive Oscillation within

the broader HCI and research landscape. We will preface the lexicon by pointing to some of the other more comprehensive reviews of the more-than-human space.

Frauenberger's (2020) frames the rise of the more-than-human perspective in terms of HCI. The notion of *waves* in HCI refers to how the field's interest has necessarily changed as the role computers play in our lives has changed. First-wave HCI was mainly concerned with the mechanics of how we interact with computers (screens, keyboards, etc); second-wave HCI began to appreciate the broader impact of computing on organizations and work and explored these spaces using a range of empirical research methods often based on cognitive psychology; third-wave HCI is characterized by more critical, progressive, and reflective approaches to the study of technology and its impact work, culture and society. The thesis of Entanglement HCI extends the third wave and embraces the notion of "entanglement" in two ways. First, Frauenberger notes that we, technology, and the world are intertwined, twisted together, knotted, and coiled. Hence, trying to conceptually separate these ideas is folly. Second, several theories and perspectives – which broadly fit within the more-than-human landscape we are concerned with – are united by their shared interest in describing and understanding how this entanglement manifests in HCI contexts. Frauenberger writes "this article has aimed to make a humble start to sketching Entanglement HCI, on the basis of a collection of related philosophical stances, that I called entanglement theories" (2020). Some of the specific terms that are addressed in Entanglement HCI are Actor-Network Theory, Post-Phenomenology, Object-Oriented Ontology, Agential Realism, and New Materialism.[1] These are terms we will provide some commentary on in our lexicon below.

Forlano's *Posthumanism and Design* is less colored by HCI and provides a wider-angle lens on the landscape (Forlano, 2017). Forlano notes that global challenges such as inequality and environmental sustainability present challenges which demand new ways of thinking. The more-than-human (and/or posthuman) movement is a response to this. Forlano discusses multiple perspectives from philosophy, sociology, geography, and history. Several terms that we highlighted from Entanglement HCI are discussed (Actor-Network Theory, Object-Oriented Ontology, New Materialism), and in addition, Forlano pays attention to several new ideas: Non-Representational theory, Transhumanism, Anthropocentrism, and notably, the keyword in the article's title Posthumanism (Forlano, 2017). We will add these to the list of terms to be described in our lexicon.

In addition to the two examples above, some additional and noteworthy reference points include Giaccardi and Redström's exploration of the broader context that more-than-human design seeks to work within, including key challenges that arise in trying to establish the fundamentals of the practice and the need for a holistic rethink of what it means to make ethical design assessments (2020). Lindley and Coulton present a view which builds an argument explicitly based on the shortcomings of Human-Centred Design in the context of networked technologies, and in doing so propose the metaphor of constellations as a productive way to enact more-than-human design (Coulton & Lindley, 2019). Wakkary's book *Things We Could Design* explores many of the themes we've already identified but annotates them with numerous design-oriented examples to argue for a type of design that can be expansive and pluralistic (Wakkary, 2021). Braidotti's *The Posthuman* offers a more expansive, philosophical, and feminist view – representing a position in its ascendency in the HCI context – but, once again, we have similar themes. She notes that nature and culture have collapsed into one another, largely catalyzed by the adoption of science and technology, and as such we must reconsider many assumptions and rebuild everything from social theory upwards (Braidotti, 2013).

As well as elaborating on the underlying factors that motivate this paper, the texts referenced above are offered to support newcomers to the landscape of more-than-human scholarship providing useful entry points. Moreover, we have compiled a shortlist of related terms to elaborate on in our lexicon. These elaborations are concise, and as such, they are imperfect. They do however serve

[1]We note an array of other terms that we do not have scope to elaborate on also appear in the paper including materiality, hybridity, critical fabulations, fluid assemblages, and material speculations.

roles for the overall line of argumentation and rhetoric of this paper. First, the lexicon makes explicit (albeit briefly) our own alignment with these terms. Second, the lexicon provides an aid or crib sheet for newcomers trying to navigate the depths of the terminology and understand how to *apply* more-than-human logic to a specific problem. Third, we seek to highlight resemblances and correspondences between the ideas, which ultimately will help to punctuate our presentation of Productive Oscillation.

2.1. *Actor-network theory*

Actor-network theory (ANT) is a sociological theory that explores the social world by studying the interactions and relationships between human and non-human actors, such as individuals, organizations, technologies, and other entities. ANT became popular in the 1980s and, as such predates several of the other terms in this lexicon. The theory contends that all actors (which could be human or non-human entities) actively participate in shaping social reality and that they are interdependent and equally important in creating social order. ANT emphasizes that networks of relationships are the fundamental unit of analysis, where actors are seen as nodes within the network, and the relationships between them are the key determinants of social action and change. For further reading, see *Reassembling the Social: An Introduction to Actor-network-theory* (Latour, 2005).

2.2. *Agential realism*

Agential Realism pulls together several lines of reasoning to arrive at a philosophical framework that includes elements of epistemology, ontology, and ethics. It says that agency is not an inherent property of things but arises from how things interface with each other (sometimes called *intra-action*) and that what things mean and what they are physically made of are unavoidably linked (sometimes called *mattering*). See *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning* (Barad, 2007).

2.3. *Anthropocentrism*

Anthropocentrism simply means "*humans at the centre*". Human-centric, human supremacy and human exceptionalism – terms which crop up in more-than-human discussions – mean the same thing. More-than-human stances are often referred to as *post-anthropocentric*, but the term doesn't align inherently align to any specific theory or point of view.

2.4. *New materialism*

New Materialism represents the recapitulation of materialism that began to take hold around the year 2000. Materialism is an ontological view (i.e., a theory that describes what it means to exist) that argues that physical matter is the fundamental substance in nature. Although the name is similar, some New Materialists see their way of thinking as separate from "old" Materialism. The reason for this is mainly that New Materialism is not *only* concerned with physical things but also the "materiality" (in a metaphorical sense, as opposed to literal) of natural, social, and technological matters, as well as how they interact with each other. Most New Materialist perspectives may be described as posthumanist and post-anthropocentric. New Materialism is not a specific theory or perspective but represents a broad movement that spans art, the humanities, social science, and aspects of the natural sciences. For a more detailed introduction see *What is New Materialism?* (Gamble et al., 2019).

2.5. *Non-representational theory*

The Non-representational Theory we describe here is that which is commonly attributed to Nigel Thrift (although has been extended by many others), however, there are other viewpoints which may share the same name. Thrift's Non-Representational Theory is grounded in geography rather than philosophy but ultimately offers a philosophical viewpoint. The theory says that the rapidly changing technological age we live in means that we have new experiences quicker than we develop a full understanding of what those experiences really mean. To help deal with this challenge Non-Representational Theory suggests paying closer attention to our embodied experience of the events we take part in, realizing that they play an active role in making the world around us and how we make sense of it. For further reading see Thrift's article *Lifeworld Inc – And What to Do about It* (Thrift, 2011).

2.6. *Object-oriented ontology*

Object-Oriented Ontology (OOO) is a philosophical movement and is not to be confused with Object-Oriented programming (although the term was knowingly borrowed from programming[2]). It proposes that when seen as "objects" the significance of anything in the world – no matter what it is – is, arguably, equal. Everything that can exist is imagined as part of a "flat ontology" (as opposed to a hierarchical ontology, which for example might put humans at the top or center – see anthropocentrism). To make sense of this, OOO suggests that we can and should take efforts to understand the perspectives of the other things that are part of the flat ontology. For an accessible introduction that cites much of the foundational literature, consider *Alien Phenomenology, or What It's Like to Be a Thing* (Bogost, 2012).

2.7. *Posthumanism*

Taken literally posthumanism means *after humanism*. The term humanism is not straightforward and can refer to lots of things. For example, a humanist perspective often promotes compassion and welfare, but humanism is also often used to refer to secular and non-religious viewpoints. Posthumanism, which doesn't necessarily reject some humanist qualities, is equally hard to define and has related terms that are sometimes used interchangeably (e.g., *transhumanism*). In the context of more-than-human perspectives, posthumanism is a philosophical and cultural movement that emphasizes the fluidity and interconnectedness of humans, animals, machines, and the environment. Laura Forlano's article *Posthumanism and Design* provides an excellent discussion of the challenge of defining posthumanism (Forlano, 2017).

2.8. *Postphenomenology*

Once again, the literal meaning of postphenomenology would be *after phenomenology*. Phenomenology is the philosophical discipline that is concerned with human experience and consciousness, it is distinct but related to other key disciplines such as ontology and epistemology. Postphenomenology is usually concerned with how humans and technology interact and takes a close look at how the way we experience the world is impacted by technology, this is sometimes called *mediation theory*. Postphenomenology tends to be explored in a "hands-on" way and looks to use real-world examples rather than purely theoretical analyses. Robert Rosenberger and Peter-Paul Verbeek's *Field Guide to Postphenomenology* is a useful starting point (Rosenberger & Verbeek, 2015).

[2]See Ian Bogost's comment on May 19th 2012 on this page, https://bogost.com/writing/blog/what_is_objectoriented_ontolog/

2.9. *Reflecting on the lexicon and imagining oscillation*

There are multiple reasons to include the lexicon in the paper. One is to provide a starting point or user guide for newcomers (but we encourage anyone new to this arena to read more extensively; there is much nuance). Beyond that very practical purpose, collating these terms together plays a rhetorical role in the objectives of the paper too. The full contextualization of that role will be unpacked in the subsequent sections, but the crux of the matter is that we think it plausible that, in the context of *practising* a more-than-human approach, "oscillating" between different aspects of some of these positions may be a productive strategy. Put differently – given the shared ground – there is no need to align, steadfast, to a single more-than-human theory. However, executing such a maneuver with finesse requires that the terminologies be used and navigated with clarity and confidence. Achieving such clarity and confidence can be challenging with such an esoteric lexicon, which is confounded when we consider that each term in that lexicon has a huge amount of depth and contested space.

To alleviate the complexity of the terms, we one strategy might be to consider what the ideas each term represents *do* in practice. New materialism, agential realism, posthumanism, and nonrepresentational theory are oriented toward framing; they describe how and why to look at the world in a particular way. Actor-network theory, postphenomenology, and object-oriented ontology are subtly different, and orient slightly more toward taking a theory and using that theory empirically as part of a methodology. We do not mean to suggest that any of these ideas can *only* be used as a frame or *only* be used as a method, but, if we are picking and choosing elements of each theory then it can be useful to consider what aspect of what theory is informing our reasoning or framing and what aspect is informing our method and the actions we take. A practical implication of this for somebody practicing Productive Oscillation would simply be to commit to using one framing to inform motivation, another to construct a method, and even possibly a third, fourth or fifth to articulate analysis or consequences. We will elaborate on this further in the subsequent sections.

We also draw attention to the prefixes utilized by some of these terms. For example, *post*phenomenology, *post*humanism and *new* materialism. For that matter *more-than*-human itself. We argue that encoded within the way we describe these ideas is a suggestion of change, of difference, of augmentation, of forward momentum. The ideas that come under the more-than-human umbrella are, to some extent, unified by an aspiration toward being different or beyond to the status quo. If these points are taken together, then it seems that rather than committing to a specific stance, we might aspire to describe how facets of different perspectives are relevant in specific circumstances. Considering the lexicon in this way, we argue, opens the possibility to move from one theory to another, without feeling trapped by either the language or the contrasting theoretical roots. Putting it crudely, one could legitimately say "a new materialist text inspired the project, the methodology was based on postphenomenology, and the analysis used actor-network theory." Of course, in reality, things are often more complex and contradictory positions may need to be reconciled, however, the swathes of common ground in the lexicon suggest that this "pick-and-mix" approach could work. With that said, and as will be discussed in the final section of the paper, such "pick-and-mix-ism" is not a panacea and should be treated as a strategy to augment and reconcile the elements in the more-than-human landscape rather than a rationale to ignore the detail or avoid the in-depth comprehension.

Returning to the lexicon, in this work we adopt *more-than-human* as the overarching way of describing alignment to all the ideas in the lexicon. Somebody else may choose posthuman, non-anthropocentric, or another term. In our view, the Productive Oscillation thesis that we offer in this paper is necessarily agnostic to those choices, so it is not critical to our argument. However, generally, we suggest it is useful to tell your audience about your chosen nomenclature. This is another reason to have included the brief lexicon and to qualify that when we refer to more-than-human theories we could be including of the discussed terms and that it would not be consequential (in our view) if our uses of more-than-human were transposed to posthuman or non-

anthropocentric. Sign-posted by a reviewer of the paper, we take this opportunity to draw attention to the close attention paid to some of these terms in Ferrando's *Philosophical Posthumanism*. The text, which happily complements this section of the paper, includes a discussion of how Continental Philosophers (e.g., Nietzsche, Heidegger, and Deleuze) challenge human-centrism, provides a feminist technoscience lens (e.g., that of Donna Haraway), and reflects on the role of postmodernism (e.g., Lyotard and Derrida). Part and parcel of the discussion is the observation that even something as initially innocuous as the use of hyphens in the construction of these terms can have quite a significant impact on their meaning (Ferrando, 2019). While, for the most part, we will continue to use the catch-all term more-than-human, we accept and celebrate that the frequently hyphenated glossary of terms adjacent and central to the more-than-post-human dictionary *is complicated*.

In the subsequent section, the paper takes a turn to describe and reflect on a design research project, *the Shape of Trust*. As discussed in the introduction, the account of the project is not included in the paper as an example of more-than-human Productive Oscillation. Instead, we include the account of the project because it was the catalyst for coming together of Productive Oscillation as we present it in this paper. Whilst the discussion of the Shape of Trust project does not exemplify Productive Oscillation, it *is* crucial to our articulation of how one might practice it, why it is a useful strategy, and its relevance to the broader HCI research agenda.

3. The shape of trust and shaping productive oscillation

The Shape of Trust project was funded by a UK-based research organization that was set up to help enable the development of socially beneficial autonomous systems that are trustworthy in principle and trusted in practice by the public, government, and industry. The specific aspect of this challenge that Shape of Trust sought to address was to use a Design-led approach to understanding the nature of the gap between expert interpretations and public interpretations (or narratives) of how to interpret trust in the context of autonomous systems (e.g., self-driving cars). The overall objective was to create a *master narrative* for trust in the context of autonomous systems.

As discussed in the earlier sections of the paper, the relationship between the Shape of Trust project and this article is not exactly as one might expect. Productive Oscillation – an approach to helping manage design-oriented, more-than-human HCI research – is the core contribution of this paper. The Shape of Trust project *does not* directly demonstrate this Productive Oscillation, however. Instead, the relevance of the Shape of Trust is that reflection on that project inspired the Productive Oscillation concept. Underlying this relationship are some fundamental sympathies between how design-oriented or RtD-type research works and how more-than-human perspectives can integrate with HCI research. In this section, we seek to use our account of the Shape of Trust project to demonstrate those sympathies and to articulate the value of adopting Productive Oscillation. Because of this rather unique relevance between the Shape of Trust project and the Productive Oscillation thesis, it is not essential that full details of the Shape of Trust project's findings relating to trust itself are shared. However, it is *undoubtedly* necessary that we explain the structure of the project. The following passages provide an illustrated and high-level narrative of what form the project took.

The Shape of Trust project plan was for three distinct phases. The first phase centered on an exploratory workshop. At the workshop, a diverse group of 22 autonomous systems experts – including a chief technology officer, policy researcher, backend engineer, data scientist, marketing professional and a range of others (see Lindley et al., 2023) – shared their perspectives on what the key challenge, issues, theories, and approaches relating to trust and autonomous systems. The data captured at the workshop were analyzed with an ethnographically informed method (McGarry et al., 2022). The workshop was conducted during a COVID-19 related "lockdown" and hence had to be conducted remotely. A custom-made interactive whiteboard helped to facilitate this (see Figure 1). The workshop was intentionally divergent and sought to capture the spectrum of possible expert

perspectives on trust. A sketch note artist was also present during the workshop and assisted in capturing the diversity of the topics discussed (see Figures 2 and 3).

The second phase of the project took the findings from the workshop, a study of related literature, and inspiration from 19th Century polymath John Ruskin and funneled them through a Research through Design (RtD) style process (Gaver, 2012). This design process aimed to create a conceptual framing, with a graphical or physical aspect, that could meaningfully represent the broad spectrum of expert perspectives and narratives relating to trust in an accessible manner. In other words, conceptually, how can the almost infinite array of situated contexts where we might need to consider trust be represented? The outcome of that process was the notion of *Trust as a Distributed Concern* (Lindley et al., 2023), which provides a conceptual framing for how to conceive of the multiple dimensions of trust in complex systems. We sought to take inspiration from John Ruskin because of a parallel between his writing about the wider societal impact of the Industrial Revolution and the equivalent impact of the digital revolution that we are currently living through. While the intention was never to directly translate Ruskin's work to the 21st century, we were inspired to consider his

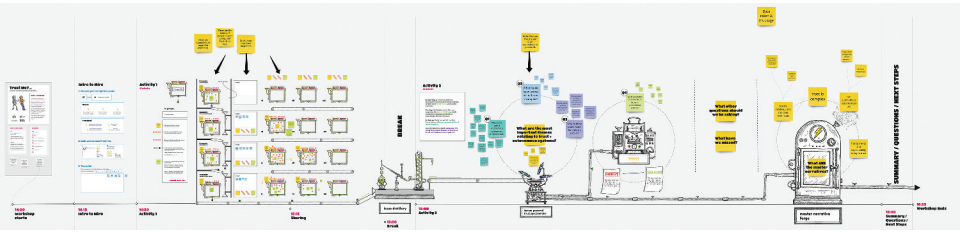


Figure 1. Screenshot from custom-made workshop facilitation tool. The detail is not relevant to this paper, but a full analysis is available in McGarry et al. (2022).

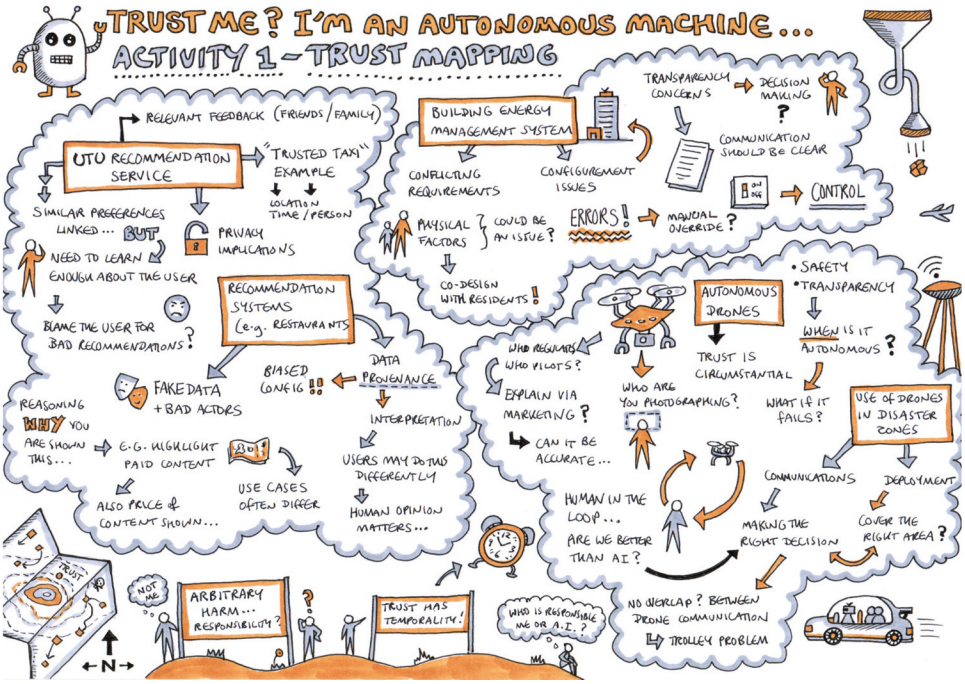


Figure 2. Sketch note account of the workshop's first activity highlighting the complexity of possible contexts for assessing Trust.

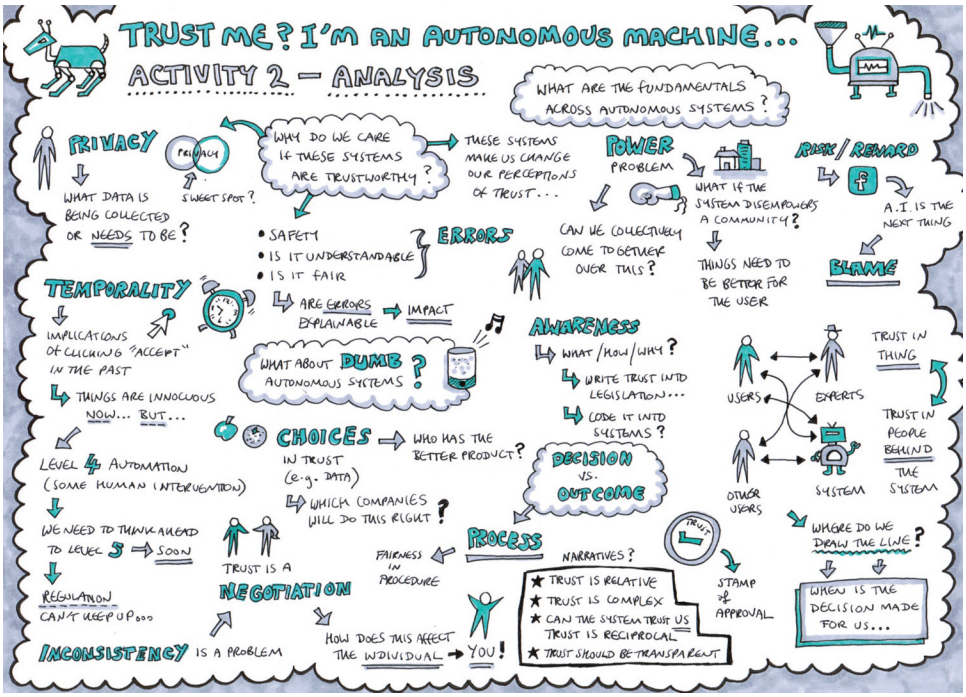


Figure 3. Sketch note account of the workshop's second activity highlighting the array of abstract concepts (choice, temporality, privacy, negotiation, power, blame, etc) that our experts saw as crucial elements of Trust.

diverse interests to, first metaphorically and then later practically, design things that could meaningfully respond to the inherent complexity of understanding trust in the context of autonomous systems.

The foundation of Trust as a Distributed Concern is the understanding that – based on the diversity of expert perspectives we gathered in the workshop – we might imagine there are countless different ways to theorize or articulate trust. These aspects may be ethical, phenomenological, legal, moral, philosophical, technical, temporal, mathematical, etc. Within any given framing, there is also likely to be a spectrum, rather than a fundamental or binary answer to whether trust is present or not. For example, we might trust that an aeroplane is relatively safe if it has been through all its maintenance checks, is regulated effectively, has the correct insurance, and is flown by a qualified pilot. However, each of those dimensions also has a potential variance, e.g., a pilot with a lifetime's experience might be more trustworthy than a newly qualified one. We termed this conceptualization Trust as a Distributed Concern because the relevant dimensions of trust in any given context are necessarily distributed, either by how those dimensions are constructed for an individual (e.g., my point of view is different than yours), how the dimensions change over time (e.g., I may trust a brand new product to not fail, but an older one is more likely to), through the actual dimensions that are relevant in a given situation (e.g., legal aspects of trust are irrelevant if there is no way to enforce them). Through experimentation with form, a constant revisiting of Ruskin's work, and a close study of a range of trust frameworks, we began to conceptualize this as a multi-dimensional form that could be imagined as a "gamut of spectra". In other words, potentially endless "layers" are stacked on top of each other. Each layer is made up of several related dimensions, and each dimension is represented on a variable scale (see Lindley et al., 2023).

The third phase of the Shape of Trust involved translating the concept of Trust as a Distributed Concern (as represented visually in Figures 4–6) and integrating it into an interactive prototype. Creating the prototype was another aspect of the RtD process. By integrating the Trust as

a Distributed Concern idea into a functional prototype, we sought to assess the viability and usability of Trust as a Distributed Concern and to elaborate on the underlying concept. The prototype was demonstrated as part of the Mozilla Festival 2022, and as part of London Digital Design Week at the Victoria and Albert Museum.

The prototype embedded the geometric forms into a story (see Figures 8 and 9). In the story, participants were invited to imagine their journey in an autonomous vehicle. A series of different situations arose during the journey, and after key moments participants were invited to answer various questions (see Figure 10) relating to dimensions of trust. Over the multiple chapters of the story each participant built their own unique trust fingerprint that was represented as a series of layered geometric shapes (see Figure 11, 12).

As we have explained, the actual content of the Shape of Trust project is, for the most part, not relevant for the purposes of this paper. What is crucial is to recognize that RtD was the crucial organizing principle. We also note that, although RtD is *our* chosen terminology, related approaches may be referred to as Practice-based Research or Practice-based Design Research, "alternative design" (Pierce, 2021), or simply Design Research (Lindley & Green, 2021). The key factor uniting these approaches is that the design process is used to generate research insights. RtD can be particularly useful in contexts where there is no specific research question or hypothesis, but instead, there is a broad area of inquiry or problem space to be explored. Often, such problem spaces arise around emerging technologies because those technologies tend to change the context within which they act meaning that there is no practicable precedent that can be applied to a situation. This ability to contend with the future and changing contexts is part of the logic for why design research (and the cornucopia of its related terminology) has become popular and essential parts of the HCI research landscape – they have a unique ability to engage with alternative possibilities (Pierce, 2021). Being able to tactfully react to the rapidly changing and entangled 3rd and 4th wave contexts that HCI often addresses is hugely valuable. It was these factors that led us to adopt RtD in the Shape of Trust project's inquiry relating to autonomous systems and trust. The account provided up until this point distilled the Shape of Trust project into three chronological phases, with outcomes from each phase leading into the next. The account is not disingenuous. However, as we will explore in the following, there is a viable alternative framing, and it is that alternate framing that directly inspired our proposal for Productive Oscillation as an actionable approach to more-than-human design.

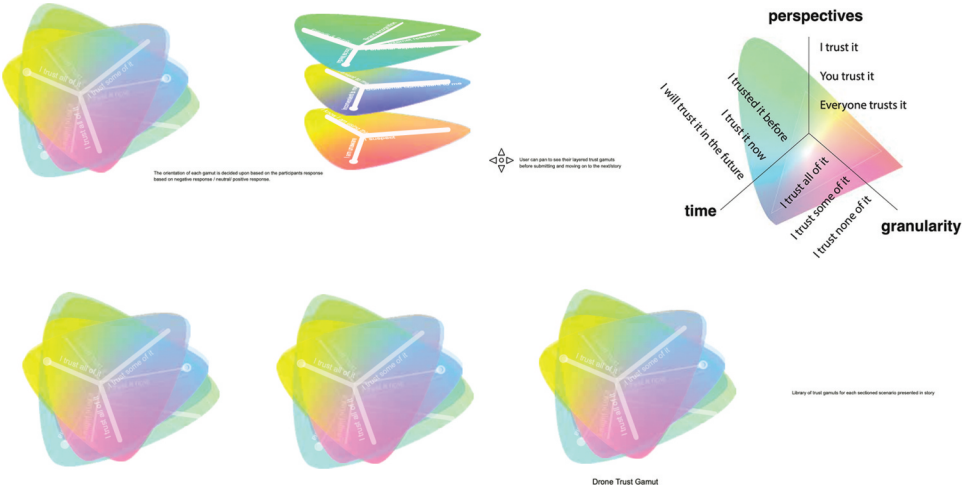


Figure 4. To the top right is an initial sketch of what a 'trust spectrum' might look like. The other sketches began to explore how to layer multiple spectra together to form a more comprehensive gamut.

3.1. *An alternative story*

The three-phase account of the Shape of Trust above roughly follows the project's planned trajectory, and it's certainly true that those phases happened. The illustration below shows an elaborated version of the project moving from the workshop, through an analysis stage, to the design, deployment, and assessment of the prototype.

While the linear representation is straightforward to articulate, and does a suitable job of explaining what happened, there is some merit in recognizing that a more complex, less linear process was also unfolding. For example, right at the start of this project, it was necessary to imagine several steps ahead (from the workshop) to think through what the output of the entire project would be. This was partly to consider what resources and skills we had in the team but also to think through who we might engage with that output and in what context. Looking back now the project has finished, it is clear that by thinking ahead both the facilitation plan for the initial workshop and the outputs we ultimately produced were impacted.

It's also true that once the workshop was complete and we began to analyze what had happened, we were constantly trying to imagine ways to take the abstract ideas we were developing relating to trust and think through how to make them physical, graphical, or tangible in some other way. Sometimes, those thought experiments were imaginary and only existed in our minds and through dialogue. At different points, however, it was necessary to practically test them in prototypical designs or forms (see Figures 4–6). With those experimental designs realized, we would cross-reference them with our interpretation of the workshop data and research in the related literature. Simultaneously, we would have to conceptually jump forward to imagine deployment and assessment, establishing if the idea we were currently considering was feasible. The same non-linear pattern was, in fact, at play throughout the entirety of the project, right through to the latter stages. Things that happened whilst building the final prototype that we deployed (Figures 10–12) consistently shed new light on the analysis of the workshop data. Illustrating and creating the story, to which we invited reactions from our participants (Figures 8, 9), lent the otherwise abstract dimensions of trust we had tried to capture in the prototype design a new tangibility, causing us to reconsider and amend which dimensions of trust we used incorporated into the prototype (Figure 10).

In the case of the Shape of Trust, some logistical challenges amplified these effects. The project place while under COVID-19 lockdown restrictions, team members had to change during the project, and due to unforeseen circumstances partner organizations withdrew their support. Together, these factors necessitated more frequent and more intense traversal between the project phases. When visualized graphically this rapid and constant change of focus takes the shape of *oscillations* (Figure 13).

The phenomenon we are describing – oscillating between different foci in the context of a design research or RtD project – is not unique or even unusual. This kind of oscillation is arguably a desirable attribute of most design research. RtD practitioners will recognize the interplay between research, creativity, action, and reflection. Many other practitioners for whom reflection is a core part of their practice will also find this description familiar – popular reference points for the importance of these action/reflection cycles in the context of HCI and design research are Donald Schön (1983), and by extension John Dewey's pragmatic theory of inquiry (see Dewey, 1908; Dixon, 2020). The oscillation of focus, which was enabled by reflective practice, was notable to the research team in this project because, compared to our prior experiences working in related fields, it had to happen more frequently, more deliberately, and with more intensity. Unpacking and describing the resonance and interplay between this aspect of RtD practice and more-than-human practice is the kernel of our presentation of Productive Oscillation.

In the next section of the paper, we wish to frame the Shape of Trust project in terms of two perspectives that relate to the reality of doing RtD in the context of HCI. The first of these perspectives – articulated in *Emergence as a Feature of Practice-based Design Research* (Gaver

et al., 2022) – discusses how emergence (often inseparable from accounts of RtD) can lead to tensions in reporting that research. The authors offer some strategies for dealing with that emergence based on their experiences and observations working with Design in an HCI context. The second perspective we draw on – presented in *Strong Concepts: Intermediate-Level K|nowledge in Interaction Design Research* (Höök & Löwgren, 2012) – explains an attribute of RtD-derived knowledge called *strong concepts*. These concepts, an extremely common outcome of Design-led inquiries, are neither so particular that they can only ever apply to one specific context nor are they so generalizable that they might be called a theory. Instead, such concepts occupy an intermediate space that can infer valuable insights from a specific example and convey those insights so that they can be helpful or generative in some other context.

By discussing our experience with the Shape of Trust project in terms of these two positions, we hope to demonstrate how the qualities of RtD-type approaches can be harnessed as a vehicle for practicing more-than-human HCI research that draws upon multiple theoretical perspectives and traditions. These ideas can be organized around what we term Productive Oscillation. The objective of Productive Oscillation is to aid RtD practitioners who are working with more-than-human positions in an HCI context, by providing an emancipatory strategy that allows them to negotiate the richness and complexity of the more-than-human landscape.

3.2. *Staying with the emergence*

Framing what they mean by emergence Gaver et al. (2022) evoke the feeling of unplanned events that are acted out as part of an activity. In making their case they cite Françoise Jacob's juxtaposition of what is referred to as *day science* (that which is based on reasoning, logic, and predetermined plans) and *night science* (more instinctive, intuitive, creative, and exploratory acts). Gaver *et al.* also explore design theory and the history of design research, while there are many nuances, they conclude that among all the different schools of thought "virtually all admit to at least a degree of emergence in actual practice" (ibid). This quality of emergence is not unique to RtD, but when doing RtD emergence is unavoidable but also desirable as a constructive strategy. Of course, being partly defined by unplanned circumstances means that attempting to define the kind of things that emergence might look like might seem oxymoronic. However, Gaver *et al.* offer an array of tactics that could be put into practice for helping to manage some archetypal examples of emergence that they have encountered in their considerable experience working with RtD in an HCI context. In the following, we recount some of the examples of emergence we also had to contend with during the Shape of Trust project and pair them with the relevant strategies as explained by Gaver *et al.*

3.2.1. *Happy endings belies the fullness of the journey*

Gaver *et al.* discuss the virtues of "telling the full backstory" (strategy 8 in the paper). This means representing the full design process, including failures and unexpected turns, and not just the "bubble" of findings, finished designs, and other endpoints. If we refer back to the Shape of Trust project, the idea of telling the full backstory of how we arrived at the various outputs – including the concept of Trust as a Distributed Concern, the associated prototype designs (Figures 4–6), the story (Figures 8, 9), the usable version of the prototype (Figures 10, 11)—is a more helpful account in terms of being generative for other designers or researchers. Our articulation of oscillation in the context of the Shape of Trust project (Figure 14), as opposed to the linear telling of the story (Figure 12), seems entirely consonant with the idea of telling the full backstory. We also note emergence strategy number 7, "present design research as a journey, not a quest" (Gaver et al., 2022). Part of the significance of this strategy is to allow the team engaged in a design research project to temper and reduce any dogmatic assumptions about what the endpoint should be. This strategy seems sympathetic and complementary to telling the full backstory. In our case, the original goal was to make the space between expert narratives and everyday peoples' narratives about trust, arriving at a so-called master narrative. This constraint was akin to a quest, and in the face of unplanned

challenges, it became an unachievable quest. Until we reframed the project as a journey, the quest-like quality completely stifled our progress, and it limited our ability to oscillate because each time we encountered this unachievable aspect, the oscillation was paused. Hence, based on this experience, we assert that casting this type of design research as a journey and not a quest will help foster a healthy oscillation between different parts of the project.

3.2.2. *Context and concreteness*

The contention that design usually resolves to "encounters with settings and situations" is at the heart of Gaver *et al.*'s emergence strategy number 5 (ibid). Focusing on this allows practitioners' skills to flourish and the concerns at the core of an inquiry to evolve, resolve and for solutions or insights to solidify organically. For the Shape of Trust, this meant rather than attempting to design around trust in an entirely abstract manner, applying the context of autonomous vehicles. Moreover, we used a specific journey in a specific car, where an imaginary protagonist encountered a series of specific events. In the sense of our foci oscillating between different aspects of the project, the concreteness of the setting and context was useful to solidify aspects of the design work, but it was also useful for sense-checking and vetting whether the conceptual and theoretical aspects of the ideas we were developing made any sense. The slow accretion of setting and situation meant, even in this quite speculative and exploratory project, our oscillations became increasingly focused.

3.2.3. *Getting with the program*

Design research *programs*, as opposed to *projects*, are a different type of "unit" for narrating or conceiving of research that works at a slightly different scale. While projects – such as the Shape of Trust – tend to be explained in terms of objectives, problem spaces, and methods, contrastingly, programs are more akin to broader schools of thought. While projects are where the work happens, programs are where larger, overarching conceptual structures take shape (see Redström, 2017). In strategy number 4, Gaver *et al.* note "rather than seeing changes as a deviation from project objectives, they can be viewed as expanding and enriching the encompassing research programme" (Gaver et al., 2022). We endorse this quality of design research projects and note that research programs are likely a key means by which the wider world will ultimately benefit from design-based contributions to HCI knowledge.

However, for the purposes of this paper, we are interested in also applying the logic of research programs and projects to our oscillation metaphor. If we do this then it seems helpful to consider that oscillation may occur at different scales (just as projects/programs represent different scales). We have used oscillation to describe moving between different project phases (e.g., workshop, analysis, and design phases), but our experience is that oscillation invariably happens *within* some of those phases, too. For example, with the Shape of Trust project, we frequently would "bounce around" inside the design phase to arrive at a new concept before moving back to a more "zoomed out" scale and oscillating between project phases again.

In the above, we sought to overlay our after-the-fact view of the Shape of Trust project, including how description of oscillations between project phases, similarities between the practicalities of those oscillations, and the strategies laid out by Gaver et al. (2022) when discussing design research and emergence. The main takeaway of that discussion is to consider that several of these strategies to manage and promote emergence are similar to, compatible with, and suited to viewing design research projects in terms of oscillation. This applies, in our view, to providing the full details of what occurs within projects when they are written about afterward (as opposed to massaging the story to fit the outcome), consciously increasing the relevance of setting and situation (as opposed to allowing projects to remain entirely abstract), and, at any given moment purposefully taking note of whether one's purview is at the level of a specific part of a project, a project, or a program.

So far, the discussion does not directly address findings that are unique and specific to the more-than-human design-oriented HCI landscape. Rest assured, that element of our argument will be

presented in section 4 of the paper. In the following, we provide the final component of this paper's rhetorical foundations, the idea of *strong concepts* also known as *intermediate knowledge*.

3.3. *Aspiring for strong concepts and intermediate knowledge*

Strong Concepts or Intermediate Knowledge are a type of knowing that frequently emerges from design research conducted in the context of HCI. These concepts are neither so particular that they only apply to one individual setting, nor are they so generalizable that they might be called a theory. Instead, such strong occupy an intermediate space that can infer valuable insights from a specific example and convey those insights so that they might be useful or generative in some other context (Höök & Löwgren, 2012). Several strong concepts together (arising from multiple projects) may form the basis for a wider and longer-term research program. Many examples of design research produce strong concepts or intermediate knowledge in one way or another. We note that the term "design research" may describe several types of situations. For example, it may be where research where a design is assessed using some other research method (e.g., a user study). The specific type of design research (or RtD) we are referring to is where the knowledge outcome was the direct result of a design process. In those circumstances, the quality of the knowledge outcome is what we would describe as a strong concept or intermediate knowledge. The Shape of Trust fits this pattern; the concept of Trust as a Distributed Concern that emerged from the project (Lindley et al., 2023) is an example of a strong concept.

To further explain the type of understanding strong concepts represent Höök and Löwgren use the analogy of the Angry Birds video game to help explain (Höök & Löwgren, 2012). When considered as a whole the game—i.e., that specific design – has no abstraction. It is entirely concrete and only applies to the setting in which it is used. In other words, Angry Birds only applies to situations where people want to play Angry Birds. However, *aspects* of the design – for example, the "slingshot" interaction that allows players to control the game – can be isolated from the game itself, can abstracted, and its relevance and usefulness are no longer concrete. Abstracting the slingshot interaction in this way means that this component of the overall design could (and, in fact, has) be used generatively in other contexts. Putting this plainly, the slingshot interaction that was pioneered in Angry Birds inspired other similar interactions elsewhere. Importantly, although abstracted elements of design instances can be helpful elsewhere, the slingshot interaction does not represent a *universal* theory of interaction. This liminal area between the non-abstract specificity of an instance and the universal generality of theory is the space that strong concepts and intermediate knowledge occupy.

Reconsidering our Shape of Trust project, we note that some of the terms might get a little confusing. That is because, in our case, the "instance" (i.e., the design), which was a product of the various aspects of emergence described above, is itself an *abstraction* of multiple issues relating to Trust. Hence, in the language of strong concepts, the concreteness of the design that is at the core of our project—i.e., the part that is supposed to be not at all abstract – that part is, in fact, inherently abstract. Putting this slight quirk aside, the project's knowledge does seem to make sense within the framework of strong concepts. The prototype we demonstrated at the Mozilla Festival and the Victoria and Albert Museum (see Figure 15) carried our design concept and put it into an exceptionally focused instance – being used to capture feedback on perceptions of trust around autonomous vehicles in response to specific events and scenarios (see Figures 8–10). Our prototype was hyper-specific, and its specifics would make little sense in any other setting. However, the idea that emerged to help inform the design of the prototype, the geometric visualizations of Trust as Distributed Concern (Figures 5, 6)—is a strong concept, occupying that part of the spectrum between specific-instance/generalizable-theory. We have published about Trust as a Distributed Concern elsewhere, and in that work, we describe the idea as a model, abstraction, and a proxy for the complexity of changing trust relationships (Lindley et al., 2023) that, in the context of design or socio-technological research may be used generatively to produce better outcomes. This demonstrates an

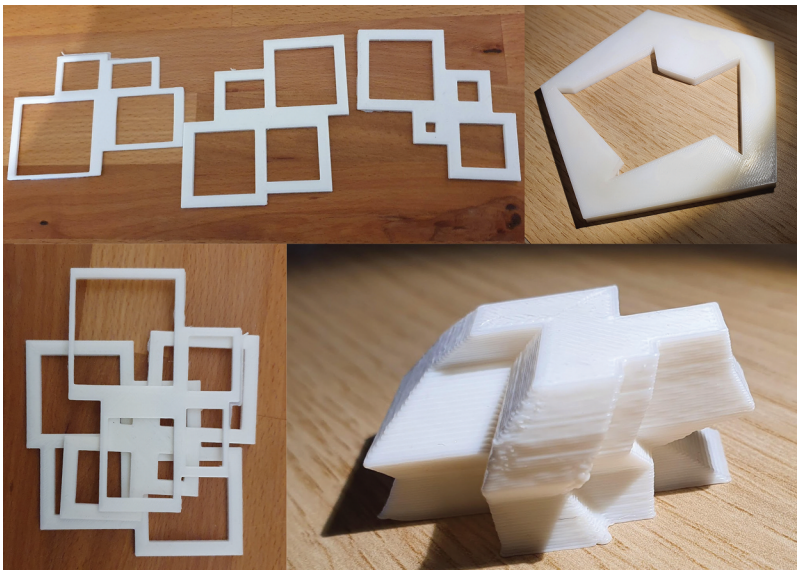


Figure 5. Taking direct inspiration from Ruskin's geometric and geological forms (see Figure 7), we explored ways to represent spectra and gamuts using 3D prints to visualise the forms and understand how layering could be used to arbitrarily add new sets of dimensions as required.

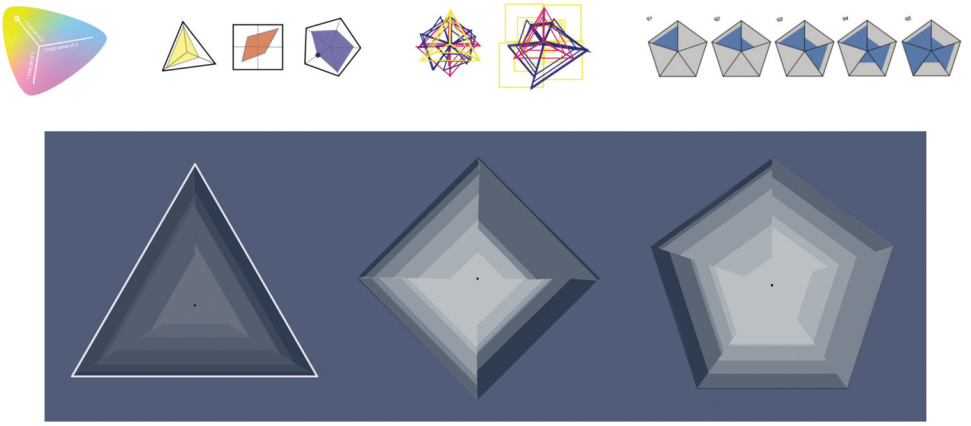
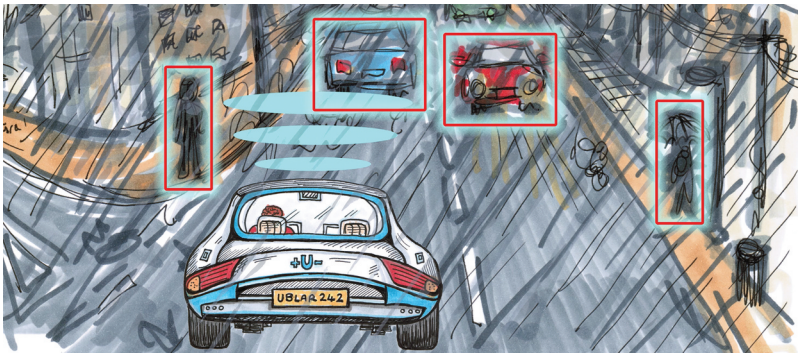


Figure 6. This displays the evolution of various forms into what became the basis for our prototype. The final form (the bottom three shapes) shows three gamuts: one with three dimensions (the triangle), one with four dimensions (the square), and one with five dimensions (the pentagon). The 'layers' within each shape show how those dimensions of trust change depending on the position within the distribution.

interesting quirk of how design research and strong concepts intersect: frequently, strong concepts *inform* design processes, and when that process is part of a research project, it often *produces* strong concepts as well. Hence, strong concepts are frequently both input and output of design research processes.

While a valuable framing for design research, strong concepts have no specific or special alignment to more-than-human theories. However, in the final section of the paper, we will put together our thesis. The discussion in section 4 leverages the various ideas we have

Figure 7. We took several research field trips to John Ruskin's former house and the Ruskin Museum in the English Lake District. Ruskin's interests were incredibly diverse and included using the organic and geometrical forms of nature as metaphors for human issues. This became the basis for giving a physical and graphical form to the concept of Trust as a Distributed Concern.



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discussed thus far. Within the context of design research projects, it frames the more-than-human positions as a type of strong concept that we might expect such positions to be used generatively to support a design process. During that process, oscillations such as those we have described are likely to occur and be a valuable knowledge-producing feature. As we have articulated, the Shape of Trust project's role in this has been inspirational (as opposed to demonstrative). Reflecting on that project has helped us reframe our understanding of the role that more-than-human positions and piece together the thesis for *Productive Oscillation as a Strategy for Doing More-Than-Human Design Research*. As well as explaining how these pieces come together rhetorically, we will cite some examples of prior projects where something akin to Productive Oscillation appears to have been at play in a more-than-human design research context and explore some limitations of this point of view.

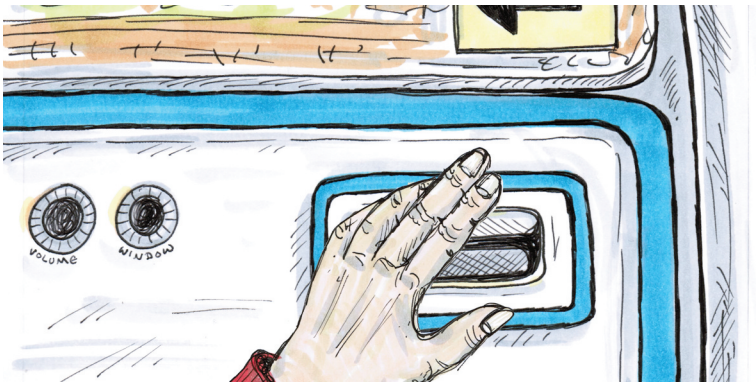

Figure 9. In this illustration, the autonomous vehicle is held up in a severe traffic jam because of an accident. The person riding in the vehicle wishes to go outside, but for safety reasons the door will not open.

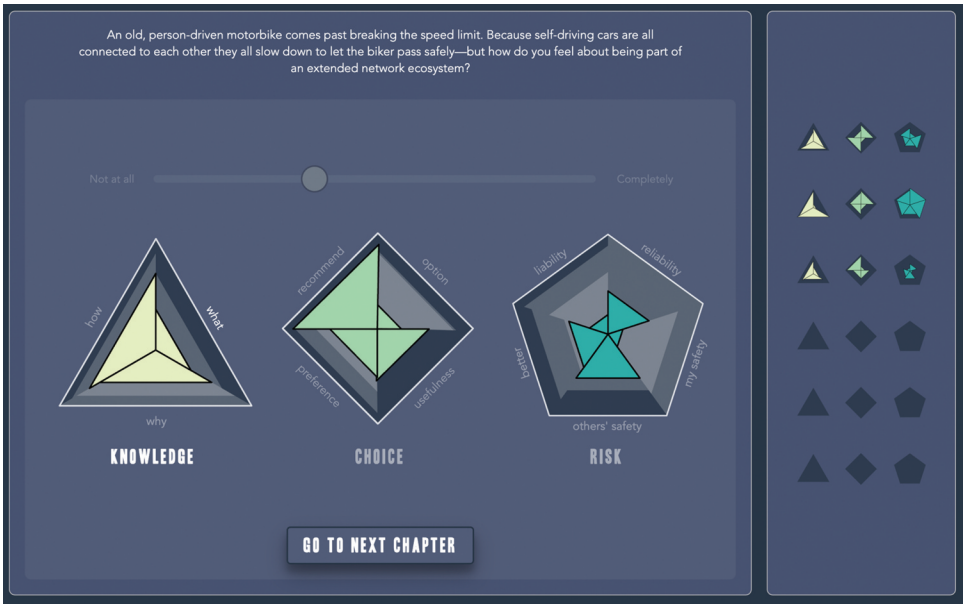

Figure 10. This screen is shown to participants after each chapter of the story. The slider is used to assign a to each dimension of trust. Those values are captured in the geometric shapes. As the story progresses the shapes form layers creating a unique fingerprint or 'shape of trust' for each participant.

4. Productive oscillation

In section 2 we offered an overview and introduction to several more-than-human perspectives. Section 3 focused on the Shape of Trust project to interrogate and exemplify the emergent qualities of design research and how that emergence can produce strong concepts or intermediate knowledge. We characterize the process by which emergence manifests as strong concepts in terms of *oscillation*; by this, we mean a regular and repeated movement around a central point, a fluctuation between different foci, or cyclical consideration of contrasting but related elements. In this third section, we aim to cohere and connect all these ideas to explain how, in the context of HCI-oriented design research with a more-than-human element, the metaphor of oscillation may be deployed as a helpful or productive strategy. The aim of the article is not to revolutionize any aspect of more-than-human

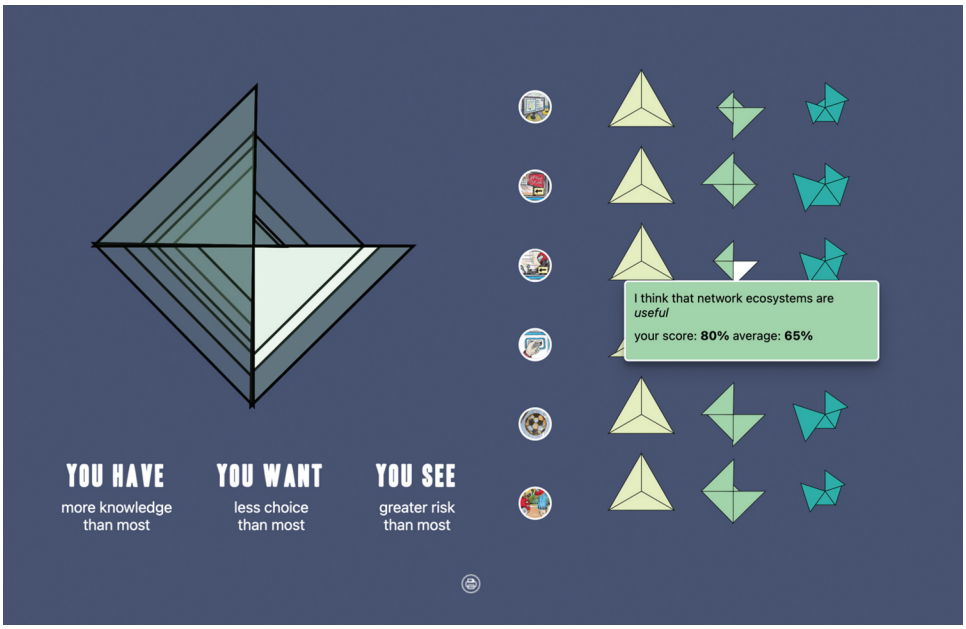

Figure 11. This screen is shown to participants after each chapter of the story. The slider is used to assign a to each dimension of trust. Those values are captured in the geometric shapes. As the story progresses the shapes form layers creating a unique fingerprint or 'shape of trust' for each participant.

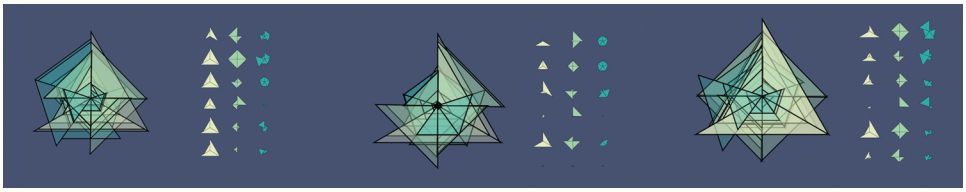

Figure 12. Multiple examples of the 'shapes of trust' generated by different participants.

thinking with a new grand theory. Instead, we hope to offer some practical steps for *doing* more-than -human design research.

4.1. *Who is productive oscillation for?*

This question is helpful both practically – to make it clear who the intended audience for this work is – but also to help clarify the article's contribution to more-than-human HCI research. The motivation for this work is the realization that although the rationale for adopting a more-than-human approach to HCI is relatively straightforward to advocate for given the enormous global challenges we face at this moment in history (see the first paragraphs of the introduction), *applying* that rationale and turning it into practice is not straightforward. This is because of the multiplicity of theoretical positions that can be adopted; this is because many more-than-human positions are outside of the anthropocentric status quo; and this is because many of the theories can be somewhat enigmatic (i.e., challenging to get one's head around). With these factors in mind, our primary audience is teams or individuals who understand design research in an HCI context but have not previously engaged in more-than-human research endeavors. Our aspiration is that for those groups, this paper will provide a framing that can act as a license to "dive in" and experiment with more-

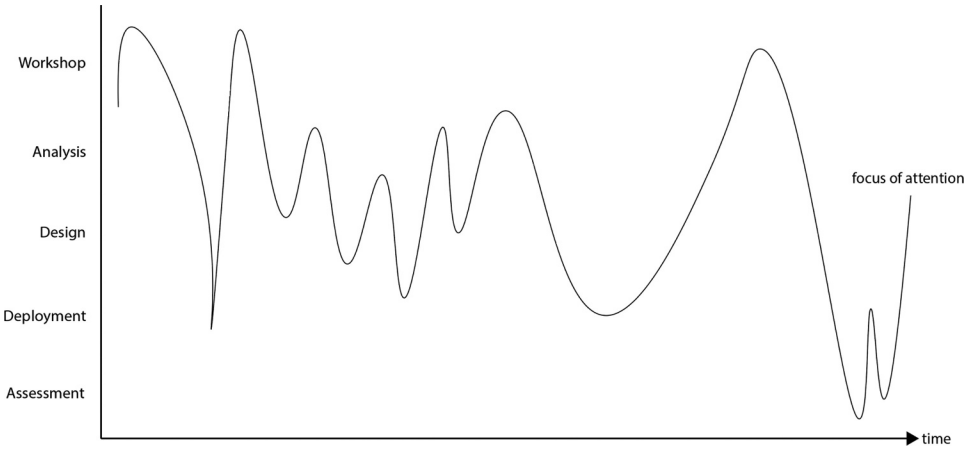

Figure 13. Non-linear representation of the Shape of Trust project's trajectory showing how the 'focus of attention' fluidly moves back and forth between different aspects.

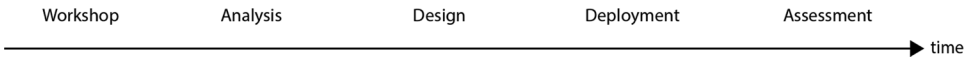

Figure 14. A linear representation of the Shape of Trust project's trajectory.

Figure 15. Participants are shown experimenting with the Shape of Trust prototype at the Victoria and Albert Museum in 2022. Photo credit Hydar Dewachi.

than-human perspectives and means to mitigate inertia that could result from trying to enter the rich and diverse onto-epistemological landscape.

Relative newcomers are not, however, our *only* intended audience. We hope that the paper will also be of use to more experienced, more-than-human design research practitioners. Elements of our argument (e.g., the role of emergence and the quality of strong concepts) will likely be familiar to such individuals. However, in constructing this treatise, we hope to arrange the ideas in such a form that they may become a useful shorthand for referring to the interplay between them, particularly in

the context of more-than-human research. Such metaphors and abbreviations can become practical conventions in establishing cohesive communities of practice.

Finally, we also hope to stimulate debate about the more-than-human landscape in general. We hope our provocation will be of use for specialists who align with a particular more-than-human position as well as for generalists who subscribe to the overarching motivations but don't have a specific theoretical allegiance. The foundation of our thesis is that having the license to embrace multiple more-than-human perspectives concurrently is practical and valuable. However, we offer that conceit in the spirit of debate and provocation and hope that this work might stimulate continuing consideration of whether this point of view has merit or not.

4.2. *What is meant by oscillation?*

For the purposes of this article, we use the term oscillation as a metaphor. In section 3 we gave some concrete examples of what this meant in the context of the Shape of Trust project. We identified several resonances and similarities between Gaver *et al.*'s characterization of design research as something that relies upon and leverages emergence (Gaver et al., 2022). In plain language, what we mean by oscillation is the tendency to freely, frequently, and without prejudice consider other points of view. In our example this meant conceptually jumping between design concepts, analysis of workshop data, and the practical constraints of what we had the expertise to create. Oscillation may also mean considering a theory, building a prototype, reflecting on the prototype, and returning to the theory. The acknowledgment of these cycles of action and reflection is not, in its own right, a novel contribution and in fact has been reproduced innumerable times in design research texts, often – but not always – resolving back to the influence of Donald Schön's framing of the reflective practitioner (1983) and before that, arguably John Dewey's pragmatic theory of inquiry (see Dewey, 1908; Dixon, 2020).

The infamous "double diamond" can be seen as an instantiation of this idea, however, if we consider the emergent qualities of design-oriented research and combine that with the interplay between instance-specific knowledge, program-level knowledge, and strong concepts – the actual paths that form these relationships are rarely cyclical or structured but are much likely to involve frequently revisiting different perspectives, constraints, or ideas. The oscillation metaphor helps to accommodate this.

Referring to the Shape of Trust project, one way this played out was through the interdisciplinary, disparate, and rarely compatible perspectives on trust that we were trying to meaningfully represent in the single design concept that became part of the prototype. These ideas came from our workshop, from our own desk-based research, and as it evolved from our design practice. At one moment we might need to consider a social theory of trust, how formal mathematical methods can guarantee an algorithm's output, how John Ruskin's interest in rocks might be relevant, and how that could be represented in a two-dimensional design. We proffer the metaphor *oscillation* to explain the act of willfully moving between multiple points of view in the context of a Design-oriented Research endeavor. As with many metaphorical explanations, we do hope that some element of interpretation remains. The way we use the term oscillation is not intended to be used dogmatically or strictly – for example, we noted in section 3 how oscillation may happen within one phase of a project, within a project, or even within a research program – but rather as a flexible interpretive frame to help describe a phenomenon that frequently arises in the context of design research.

4.3. *Why are strong concepts important?*

Strong concepts (or intermediate knowledge) are important to almost all practice-based design research, regardless of whether it has a more-than-human element or not. That is because, for that type of research, strong concepts are almost inevitably going to be one of the key outcomes. Hence, being cognizant of how to capture, communicate, and foster that kind of knowledge production is important.

However, strong concepts play another *crucial* role in framing this paper's contribution to the more-than-human HCI research landscape. Perhaps the most important conceptual maneuver in this paper's internal rhetoric is captured in the following: *In the context of applied HCI-oriented design research, we can consider all more-than-human positions as strong concepts*. This conceit is central to our formulation of Productive Oscillation as a structure for conceptualizing more-than-human HCI research.

If we cast our mind back to some of the definitional features of strong concepts, they are ideas that *inform* design processes – they provide inspiration. By design and to its advantage, intermediate knowledge is partial, contingent, open for appropriation, and generative (Höök & Löwgren, 2012). Strong concepts are ideas that emerge from extremely specific situations (e.g., the Angry Birds app) but, without needing to be interpreted or proven as an overarching or generalizable theory would be, can be extremely useful when applied elsewhere. Simply reframing any more-than-human perspective – Object-Oriented Ontology, Postphenomenology, Agential Realism, et cetera – as a strong concept, can emancipate practitioners from feeling obliged to subscribe to a specific point of view to the exclusion of others. This conceptual move, positioning more-than-human theories, methods, and perspectives as strong concepts, gives practitioners a license to consider multiple more-than-human points of view, and to oscillate between them generatively.

Arguing the value of design-based examples Gaver puts it thus, "the role of theory should be to annotate those examples rather than replace them" (Gaver, 2012). In the context of this paper what Gaver refers to as "annotations" may be seen as individual cycles of an oscillation. For example, in one cycle, I may consider how to analyze a design from the lens of Actor-network theory, whilst in the next I may use Non-Representational Theory to inspire the next design iteration. If we want to take ideas from the more-than-human lexicon and understand how to use them to *do* more-than-human design, we should consider the theories as strong concepts that help annotate our work. Considering more-than-human theories as strong concepts, rather than universal theories, as practitioners we have the freedom to use these ideas generatively (to inform our designs and insights derived from the designs) rather than prescriptively (to attempt to rationalize design decisions or explain their impacts). In turn, this shift in framing increases one's ability to engage with and promote the emergence which is extremely likely – or even necessary – within the context of a practice-based design research project.

4.4. *What is productive oscillation?*

At this point, we have discussed and unpacked all the elements of our position. Here, we offer a short recap of our Productive Oscillation thesis.

Design Research projects exhibit a feature that we term oscillation. Oscillation refers to constantly shifting focus (e.g., between theories, methods, or other priorities) and is a necessary element of successfully doing design research. Oscillation is a way of articulating some of what Gaver *et al.* term emergence (Gaver et al., 2022).

Design Research projects also rely upon strong concepts or intermediate knowledge (Höök & Löwgren, 2012). Such knowledge usually comes from a particular example or use case and is not seen as a universal theory but rather as a contingent, inspirational, or generative influence. In the context of HCI-focused design research, we can electively consider each of the varied theories within the more-than-human spectrum as a strong concept or type of intermediate knowledge.

If we consider more-than-human theories as strong concepts as opposed to generalizable overarching theories, then multiple theories can be incorporated into the emergence or oscillation of any given design research project. This approach has productive potential because it lowers the barrier to entry (because a practitioner need not be an expert to engage with a theory as a strong concept) and allows for elements of multiple theories to be incorporated into a single project.

4.5. *Putting productive oscillation into practice (and teaching grandmother to suck eggs)*

To "teach grandmother to suck eggs" is an English phrase that refers to giving advice to somebody who is already familiar with the topic (the likely root of the idiom is that in times of poor dental care, older people had bad teeth and would sometimes "suck eggs" as a way of getting protein into their diet when they could not chew other foods). So the phrase is used to acknowledge it is folly to try and instruct people how to do things they know perfectly well how to do already. The relevance here is that we do not think it appropriate or useful to attempt to explain, as one would with a method or research protocol, in concrete terms *how* one would put this idea into practice (we do accept that exploring how to put the idea into practice might be an interesting future contribution, however). Instead, in this paper, our contribution is an *organising principle* for engaging with the gamut of more-than-human theory in the context of HCI-oriented design research. As discussed in the section *Who is Productive Oscillation for?* our primary audience is experienced HCI/Design Researchers who may not be familiar with the more-than-human landscape. For that audience, we hope that Productive Oscillation will provide a basis to get on with what should be a familiar design/research process and to begin to organically integrate more-than-human concepts as one would any other design consideration. For our secondary audience, those already versed in more-than-human perspectives, we hope that in situations where multiple theories come into play, Productive Oscillation may be used as shorthand to articulate the nuance and complexity of how that plays out in design processes. With these factors in mind, we do not attempt to teach grandmother to suck eggs but instead encourage the broader community to embrace, interrogate, and define what the term means by examples.

Instead, we provide some examples of where something akin to Productive Oscillation appears to have occurred. In *Morse Things* Wakkary *et al.* refer to multiple perspectives that fall within the more-than-human canon, touching upon actor-network theory, Postphenomenology and Object-Oriented Ontology. Reflecting on their epistemological commitments they note that while their designs engage with and reflect several such positions *through design* there was no need to delve deeper (Wakkary et al., 2017). In their project exploring the agency of things, Cila *et al.* touch upon Agential Realism and several other post-anthropocentric positions, but purposefully acknowledge "we do not adopt the arguments of any of these approaches directly [...] but rather aim to appropriate their main message" (Cila et al., 2017). In *Networking with Ghosts in the Machine*, Lindley, Coulton and Alter identify "much shared ground" across a wide variety of more-than-human perspectives before explicitly committing to Object-Oriented Ontology as a theoretical framework supplemented by ideas appropriated from Animism (see Lindley et al., 2019; Marenko, 2014).

We would not be so bold as to appropriate these examples without conferring with the practitioners individually (i.e., checking if they agree). However, in each case, what we have described as Productive Oscillation has arguably occurred. In the context of a design process, a non-linear event punctuated by emergence, the design researchers appear to have oscillated between multiple more-than-human theories.

4.6. *Risks and limitations*

In developing this thesis, we have noted some clear risks and limitations to what we propose. The first of these is best exemplified in the logic of the previous sub-section and the notion that we do not wish to teach grandmothers to suck eggs. There is a paradoxical situation where it seems counter-intuitive to *tell* practitioners how to manage their creative process (they know how to suck eggs) but meanwhile, without some clear instruction how can anyone try this idea out? (do they know how to suck *this* egg?) We have attempted to allay this concern in the paper somewhat by providing three examples of similar practice in the preceding paragraph, and we hope this limitation

will be addressed over time as evidence develops to demonstrate the virtues or problems associated with applying the lens of Productive Oscillation.

Another risk relates to the "pick and mixism" that this paper overtly endorses. It is central to the rhetorical argument that there is value in considering multiple perspectives, and the examples in the previous subsection also endorse this point of view. However, by advocating for this, and providing a strategy that deliberately lowers the bar to entry and suggests that you needn't be an expert on *all* the more-than-human perspectives to use *some* of those perspectives, there is a risk that newcomers might use Productive Oscillation as an excuse or justification for superficial engagement with the underlying theories. We hope that with responsible scholarship, honest accounts of projects, and tactful peer review, this risk can be sensibly managed. We also note that the lens of Productive Oscillation may provide practitioners with a legitimate explanation for superficial engagement with theory, where, without such a lens, they would be more motivated to masquerade as an expert, even if that were not the case.

Finally, we note that there are likely to be some situations where the kind of oscillation we are, for the most part endorsing, could become a distraction and a hindrance. For example, in the convergent phases of design processes, it is often necessary to reject the plethora of options and focus on refining specificity rather than increasing potentiality. An idea like Productive Oscillation is explicitly focused on increasing potentiality. Hence, at times the temptation to shift focus should probably be tempered or even rejected. Managing such a phenomenon is undoubtedly tricky, and we suggest is most likely to be achieved through experience.

5. In conclusion, "the difficulty in life is the choice" (George A. Moore)

In conclusion, this work identifies with the more-than-human turn that we are amid, and its relevance to both HCI and design research. We believe that there is a need to embrace more-than-human issues and approaches. The context for this contribution is to streamline and promote the process of more-than-human stances becoming more commonplace and increasingly accessible to HCI scholars and design researchers in general.

In the lexicon we provide in section 2 of the article, we acknowledge the breadth of related but nuanced perspectives in this arena. We also acknowledge that the lexicon we provide is a superficial introduction and remind any newcomers wishing to deploy any of those ideas that it would be prudent to further research the concepts before assuming that our precis introductions are sufficient.

The Shape of Trust is a design research project that is detailed in the second section of the article. The purpose of this explanation is *not* to exemplify the core thesis, but to articulate how the ideas we present here were inspired. Specifically, we use the reflection on the project to frame the emergent qualities of design research in terms of "oscillation" between different concepts and highlight the role and key qualities of strong concepts.

In this, the final section of the paper, we make explicit what we mean by Productive Oscillation and explain how it may be used as a strategy for *doing* more-than-human HCI-oriented design research. The main constituents of Productive Oscillation are to imagine more-than-human theories qualitatively as strong concepts. Positioned this way, they can be incorporated as generative elements within the non-linear structure of a design research project, and by extension, a practitioner can oscillate between multiple more-than-human theories productively.

Our aspiration is that this contribution has different value propositions for different audiences. For the primary audience – newcomers to the more-than-human landscape who have some experience in HCI or design research – our aspiration is that this Productive Oscillation can increase accessibility and help drive the adoption of more-than-human principles into a broad array of projects. For the secondary audience – experienced more-than-human design research practitioners – we hope that this terminology may provide a convenient means to articulate a process that although commonplace, is hard to define and explain. Such a provision, we hope, may help galvanize the more-than-human HCI research community and further its impact. Finally, as a general

provocation, we seek to stimulate debate around the value of combining and merging ideas from different more-than-human perspectives as compared to the idea of firmly aligning to a single perspective. As the more-than-human turn matures into a diverse community of practitioners, we hope to encourage debate about how to organize and articulate the similarities and differences among this diverse landscape.

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References

Barad, K. (2007). *Meeting the universe halfway: Quantum physics and the Entanglement of matter and meaning*. Duke University Press Books.
Bogost, I. (2012). *Alien phenomenology, or, what it's like to be a thing*. U of Minnesota Press.
Braidotti, R. (2013). *The posthuman*. Polity.
Cila, N., Smit, I., Giaccardi, E., & Kröse, B., 2017. Products as agents. *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems - CHI*, Denver, CO, USA (Vol.'17, pp. 448–459).
Coulton, P., & Lindley, J. G. (2019). More-than human centred design: Considering other things. *Design Journal*, *22*(4), 463–481. https://doi.org/10.1080/14606925.2019.1614320
Dewey, J. (1908). What does pragmatism mean by practical? *The Journal of Philosophy, Psychology and Scientific Methods*, *5*(4), 85. https://doi.org/10.2307/2011894
Dixon, B. S. (2020). *Dewey and design*. Springer International Publishing.
Ferrando, F. (2019). *Philosophical Posthumanism*. Bloomsbury.
Forlano, L. (2017). Posthumanism and Design. *The Journal of Design Economics and Innovation*, *3*(1), 16–29. https://doi.org/10.1016/j.sheji.2017.08.001
Frauenberger, C. (2020). Entanglement HCI the next wave? *ACM Transactions on Computer-Human Interaction*, *27* (1), 1–27. https://doi.org/10.1145/3364998
Gamble, C. N., Hanan, J. S., & Nail, T. (2019). What is New Materialism? *Angelaki - Journal of the Theoretical Humanities*, *24*(6), 111–134. https://doi.org/10.1080/0969725X.2019.1684704
Gaver, W., 2012. What should we expect from research through design? *In*: *Proceedings of the 2012 ACM annual conference on Human Factors in Computing Systems - CHI '12*. New York, New York, USA: ACM Press, 937–946.
Gaver, W., Krogh, P. G., Boucher, A., & Chatting, D., 2022. Emergence as a feature of practice-based design research. *In*: *Designing Interactive Systems Conference*. New York, NY, USA: ACM, 517–526.
Giaccardi, E., & Redström, J. (2020). Technology and more-than-human design. *Design Issues*, *36*(4), 33–44. https://doi.org/10.1162/desi_a_00612
Höök, K., & Löwgren, J. (2012). Strong concepts. *ACM Transactions on Computer-Human Interaction*, *19*(3), 1–18. https://doi.org/10.1145/2362364.2362371
Latour, B. (2005). *Reassembling the social: An introduction to Actor-network-theory*. Oxford University Press.
Lindley, J., Coulton, P., & Alter, H. (2019). Networking with ghosts in the machine. Speaking to the internet of things. *Design Journal*, *22*(sup1), 1187–1199. https://doi.org/10.1080/14606925.2019.1594984
Lindley, J., & Green, D. P. (2021). The ultimate measure of success for speculative design is to disappear completely. *Interaction Design and Architecture(s)*, *51*(51), 32–51. https://doi.org/10.55612/s-5002-051-002
Lindley, J., Green, D. P., McGarry, G., Pilling, F., Coulton, P., & Crabtree, A. (2023). Towards a master narrative for trust in autonomous systems: Trust as a distributed concern. *Journal of Responsible Technology*, *13*, 100057. https://doi.org/10.1016/j.jrt.2022.100057
Marenko, B. (2014). Neo-Animism and Design. *Design and Culture*, *6*(2), 219–241. https://doi.org/10.2752/175470814X14031924627185
McGarry, G., Lindley, J., Green, D. P., & Mason, Z., 2022. *Workshop report: Trust me? I'm an autonomous system*.
Pierce, J., 2021. In tension with progression: Grasping the frictional tendencies of speculative, critical, and other alternative designs. *In*: *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*. New York, NY, USA: ACM, 1–19.
Redström, J. (2017). *Making design theory*. MIT Press.
Rosenberger, R., & Verbeek, P. P. C. C. (Eds.). (2015). A Field Guide to Postphenomenology. In *Postphenomenological Investigations: Essays on Human-Technology Relations Lexington Books* (pp. 9–41). Lexington Books.
Schön, D. (1983). *The reflective practitioner: How professionals think in action*. Basic Books.
Thrift, N. (2011). Lifeworld Inc—and what to do about it. *Environment and Planning D: Society and Space*, *29*(1), 5–26. https://doi.org/10.1068/d0310
Wakkary, R. (2021). *Things we could design for more than human-centered worlds*. The MIT Press.
Wakkary, R., Oogjes, D., Hauser, S., Lin, H., Cao, C., Ma, L., & Duel, T., 2017. Morse Things. *In*: *Proceedings of the 2017 Conference on Designing Interactive Systems - DIS '17*. New York, USA: ACM Press, 503–514.