



Delft University of Technology

Designing-with AI More-than-human Design in/through Practice

Nicenboim, I.

DOI

[10.4233/uuid:e741163d-0334-4f06-826f-3b9836b21a86](https://doi.org/10.4233/uuid:e741163d-0334-4f06-826f-3b9836b21a86)

Publication date

2024

Document Version

Final published version

Citation (APA)

Nicenboim, I. (2024). *Designing-with AI: More-than-human Design in/through Practice*. [Dissertation (TU Delft), Delft University of Technology]. <https://doi.org/10.4233/uuid:e741163d-0334-4f06-826f-3b9836b21a86>

Important note

To cite this publication, please use the final published version (if applicable).
Please check the document version above.

Copyright

Other than for strictly personal use, it is not permitted to download, forward or distribute the text or part of it, without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license such as Creative Commons.

Takedown policy

Please contact us and provide details if you believe this document breaches copyrights.
We will remove access to the work immediately and investigate your claim.

Designing-with AI

More-than-human Design in/through Practice

Iohanna Nicenboim

Designing-with AI

More-than-human Design in/through Practice

Dissertation
for the purpose of obtaining the degree of doctor
at Delft University of Technology

by the authority of the Rector Magnificus Prof.dr.ir. T.H.J.J. van der Hagen,
Chair of the Board for Doctorates
to be defended publicly on November 18th 2024

by
Iohanna NICENBOIM
Master of Arts in Visual Communication, University of the Arts Berlin (UDK), Germany
Born in Buenos Aires, Argentina

This dissertation has been approved by the promotor.

Composition of the doctoral committee:

Rector Magnificus Delft University of Technology, the Netherlands, chairperson

Prof. dr. Elisa Giaccardi, Delft University of Technology, the Netherlands/Politecnico Milano, Italy, promotor

Prof. dr. Johan Redström, Umeå University, Sweden, promotor

Independent members:

Prof.dr. R. Braidotti, Utrecht University, the Netherlands

Prof.dr. B.F. van Eekelen, Delft University of Technology, the Netherlands

Prof.dr. L. Forlano, Northeastern University, USA

Prof.dr. R. Wakkary, Simon Fraser University, Canada

Reserve member:

Prof.dr. ir. A. Bozzon, Delft University of Technology, the Netherlands

Non-independent member:

Dr. R. Banks, Microsoft Research Cambridge, UK

The research was funded by Microsoft Research through its Ph.D. Scholarship Programme.

Richard Banks, Principal Manager at Microsoft Research, has contributed significantly to the research presented in this thesis.

1.	Introduction	9
1.1.	<i>Knowledge gap</i>	<i>11</i>
1.2.	<i>Research objectives</i>	<i>11</i>
1.3.	<i>Research approach</i>	<i>12</i>
1.4.	<i>Contribution</i>	<i>12</i>
1.5.	<i>Audience and dissemination</i>	<i>13</i>
1.6.	<i>Outline</i>	<i>14</i>
2.	Towards a more-than-human design approach to AI	16
2.1.	<i>Situating the making of AI</i>	<i>16</i>
2.2.	<i>Towards critical AI design approaches</i>	<i>17</i>
2.3.	<i>The limitations of human-centered approaches for designing AI</i>	<i>18</i>
2.4.	<i>More-than-human design and the critical posthumanities</i>	<i>18</i>
2.5.	<i>Towards a more-than-human design practice of designing-with AI</i>	<i>20</i>
3.	Methodological and epistemological approach	22
3.1.	<i>Design research</i>	<i>22</i>
3.2.	<i>Design programs</i>	<i>23</i>
3.3.	<i>Methodology</i>	<i>24</i>
3.4.	<i>Epistemology</i>	<i>24</i>
3.5.	<i>Positionality</i>	<i>25</i>
4.	Situating AI: More-than-human design strategies	28
4.1.	<i>Reorienting AI through more-than-human design</i>	<i>28</i>
4.2.	<i>Towards situated understandings of AI</i>	<i>31</i>
4.3.	<i>Design strategies to support situated AI</i>	<i>32</i>
4.3.1.	<i>Looking across AI</i>	<i>32</i>
4.3.2.	<i>Exposing AI failures</i>	<i>32</i>
4.3.3.	<i>Illuminating strategies through design examples</i>	<i>33</i>
4.4.	<i>Takeaways</i>	<i>35</i>
5.	Designing situated AI: More-than-human design experiments	37
5.1.	<i>Design experiments with conversations and silences</i>	<i>37</i>
5.2.	<i>Conversations with agents</i>	<i>41</i>
5.3.	<i>Noticing entanglements</i>	<i>43</i>
5.4.	<i>Conversation starters</i>	<i>43</i>
5.5.	<i>How can we misunderstand AI better?</i>	<i>48</i>
5.6.	<i>Takeaways</i>	<i>49</i>
6.	Decentering through design: More-than-human design practices	51

6.1.	<i>Decentering the human</i>	51
6.1.1.	Decentering at the interplay between posthumanist theory and practice	52
6.2.	<i>Tracing notions of decentering in design and HCI</i>	53
6.2.1.	Tracing outwards: decentering in posthumanist theory.....	53
6.2.2.	Tracing new lines: Decentering in More-than-human design practices.....	54
6.3.	<i>Decentering as enacted in our design research practices</i>	58
6.4.	<i>Decentering through design</i>	61
6.4.1.	Moving by staying still.....	61
6.4.2.	Materializing posthuman theory.....	62
6.5.	<i>Making posthuman knowledge</i>	63
6.6.	<i>Takeaways</i>	64
7.	Unmaking-with AI: More-than-human design tactics	66
7.1.	<i>Exploring resonances between decentering and unmaking</i>	66
7.2.	<i>Making sense of design workshops</i>	68
7.2.1.	DIS2020's workshop activities and outcomes.....	69
7.2.2.	Annotating the outcomes through unmaking and decentering.....	71
7.3.	<i>Unmaking-with: Emergent notions and tactics</i>	75
7.3.1.	Unmaking-with.....	76
7.3.2.	Decentering Tactics.....	76
7.4.	<i>How can unmaking support more-than-human thinking and practice?</i>	78
7.5.	<i>Takeaways</i>	80
8.	Between theory and practice: Generative AI tools	81
8.1.	<i>Going beyond the more-than-human design theory/practice gap</i>	81
8.2.	<i>Designing generative AI tools</i>	82
8.3.	<i>Enriching more-than-human design practices</i>	87
8.4.	<i>Situating generative AI</i>	88
8.4.1.	Situating GenAI.....	89
8.4.2.	Challenging extractive relations	89
8.5.	<i>Takeaways</i>	90
9.	Assembling a practice of designing-with	92
9.1.	<i>Why assembling?</i>	92
9.2.	<i>Methodological interventions</i>	93
9.2.1.	Strategies for situating agents	93
9.2.2.	Conversations with agents	94
9.2.3.	Noticing entanglements.....	94
9.2.4.	Decentering tactics.....	95
9.3.	<i>Discussing the outcomes</i>	96
9.3.1.	Situating and positionality.....	96
9.3.2.	Not-knowing and failures.....	96
9.3.3.	Decentering and unmaking	97
9.4.	<i>Articulating more-than-human design practices</i>	97

9.5.	<i>Designing-with AI</i>	98
9.6.	<i>Making posthuman knowledge through design</i>	99
10.	Final reflections and conclusion	100
10.1.	<i>Reflections on the research objectives and contributions</i>	100
10.2.	<i>Reflections on the approach, methods, and domain</i>	100
10.3.	<i>Limitations of the research and future work</i>	101
10.4.	<i>Conclusion</i>	102
	Summary.....	105
10.5.	<i>Summary in English</i>	105
10.6.	<i>Summary in Dutch</i>	111
	About the author	118
10.7.	<i>Curriculum Vitae</i>	118
10.8.	<i>Publications</i>	118
	References.....	121

Amidst increasing societal and environmental challenges, designers are shifting away from the prevailing human-centered paradigm and embracing more-than-human design approaches. More-than-human design challenges human exceptionalism and advocates for a relational approach to designing, which acknowledges that humans, nonhumans, and the environment are always entangled. This shift gains particular significance in the realm of AI, where the narrow focus on human needs is limiting for navigating the complex and entangled relations of humans and nonhumans in AI systems. Moreover, human-centric approaches seem risky when designing AI, since their underpinning Western humanist conception of humans privileges certain voices and perspectives while excluding others. In search of an alternative design orientation better attuned to the planetary conditions we live in, this dissertation explores the potential of adopting a more-than-human approach to studying and designing AI.

Using a research-through-design (RTD) methodology and a programmatic approach, the dissertation focuses on the interaction design of conversational agents. This context serves as a compelling case for exposing the risks that anthropocentric approaches pose to inclusivity and provides fertile ground for exploring designs that are more situated and inclusive. By adopting a more-than-human approach in the context of AI, the dissertation addresses an important knowledge gap in the posthuman turn: the need to complement theoretical developments with practical tools. Assembling a practice of designing-with, the research develops and mobilizes strategies, tactics, and techniques to further enrich more-than-human practice. In doing so, it emphasizes the active role of designers in 'making' posthuman knowledge rather than merely applying posthumanist theory to design. It also argues that designers can benefit from working within the space between theory and practice rather than attempting to 'bridge' the two.

Part I

1. Introduction

This dissertation aims to cultivate a novel more-than-human design practice for studying and designing Artificial Intelligence (AI). This objective is driven by the growing recognition that non-anthropocentric design approaches are urgently needed to address the challenges of designing AI, since the prevalent user-centered design approaches are inadequate in engaging with the complex relations between humans and nonhumans in AI socio-technical systems (Forlano, 2023; Frauenberger, 2019; Giaccardi & Redström, 2020; Wakkary, 2021).

While the deployment of AI across various sectors has offered numerous benefits, it has also highlighted significant risks for society and the environment. In relation to society, the risks are associated with the tendency of AI to amplify human biases and perpetuate inequality (Whittaker et al., 2018). In relation to the environment, challenges arise from the indiscriminate use of non-renewable materials and human labor to train AI models (Crawford, 2021). The impact of AI on the planet is difficult to calculate, but a recent study projected that by 2027, newly manufactured AI-powered devices would consume as much electricity as the Netherlands (de Vries, 2023). Considering the scale and scope of AI systems, along with its implications for humans, nonhumans, and the environment, engaging with these entangled relations seems vital for developing responsible AI applications (Cattabriga & Joler, 2023).

While mapping the complex human-nonhuman relations of AI undoubtedly requires a multidisciplinary effort, designers can contribute towards this goal. In the introduction to a recent special issue on AI, Celaschi (2023) remarked: "If there is one key word that insistently fills every contemporary communication channel, it is Artificial Intelligence. And Design, alert and militant, Design that records and seeks to understand, Design that listens and plans the relationship between human being and machine, cannot stand impassively by in the face of this theme " (p. 1). Designers are already engaging with AI in several ways, from designing AI applications to using AI tools for design. Furthermore, Human-centered design approaches are being integrated in the development of AI products and services (Xu, 2019). While these approaches are valuable in keeping humans *in-the-loop*, i.e., emphasizing the user's role in the development of AI, it appears that they have limitations when it comes to engaging with the complex entanglements of humans and nonhumans that are inherent in AI socio-technical systems (Cattabriga & Joler, 2023; Forlano, 2021; Coulton & Lindley, 2019; Forlano, 2023; Frauenberger, 2019; Giaccardi & Redström, 2020).

Several years ago, Forlano (2017) recognized this issue, explaining that "human-centered design is founded on understandings of the human as a discrete, individual subject. Yet, our new relations to the natural world and to socio-technical systems are calling these previous understandings into question" (p. 17). This is still true today, as human-centered approaches struggle with the growing agency of AI applications in daily life (Giaccardi & Redström, 2020), and the changing notions of responsibility and trust they instantiate (Fuchsberger & Frauenberger, 2024). Moreover, human-centered AI seems to pose a risk to inclusivity because it "does little to address deeper issues such as the way in which 'the human' is defined around liberal Western Eurocentric notions of individuality, rationality, and autonomy that are typically white, male, and ableist" (Forlano, 2021, p. 1). Based on a narrow conception of the human, anthropocentric approaches could hinder design's ability to address the multifaceted challenges intersecting AI in inclusive and sustainable ways, potentially exacerbating disparities by prioritizing the needs of certain perspectives over others (Giaccardi et al. 2024).

Responding to that challenge, more-than-human design offers a promising avenue for engaging with the entangled relations of humans and nonhumans in AI in inclusive and sustainable ways (Forlano, 2023; Giaccardi & Redström, 2020). Grounded in critical posthumanism (Braidotti, 2013), more-than-human design has the potential to challenge anthropocentric perspectives and interrogate narrow definitions of the human. Furthermore, it can redirect attention from mere interactions to broader relations, and from users to encompass entire ecologies (Yoo et al., 2023), thereby expanding the focus of design to include diverse and situated perspectives (Wakkary, 2021). More-than-human design approaches belong to a broader paradigm shift in HCI known as the posthuman turn. As such, it converges two posthumanist critiques: On the one hand, it challenges human exceptionalism by expanding the focus of design to material processes and nonhuman agencies. On the

other hand, it questions the dominant conception of 'the human' which was traditionally built around the rhetoric of users and progress.

Exploring the potentials of this novel stance, this dissertation takes a more-than-human design approach and mobilizes it in the context of AI. As an entry point, the research takes the case of conversational agents. These technologies, commonly known as digital assistants like Amazon's Alexa or chatbots like ChatGPT, use conversational interfaces to interact with humans. However, they are not just physical devices; they are part of larger AI systems. Examining these AI systems provides a compelling illustration of the intricate entanglements between humans and nonhumans in AI (Fig. 1). Looking across these systems shows that although most individuals interact with AI through interfaces or mobile devices, the fundamental operations occur elsewhere (Crawford, 2021); and rely on extractivist practices in different locations and at various levels, from natural resources to knowledge and labor (Pasquinelli, 2023). By working with conversational agents as a starting point, the dissertation situates AI's interactions within everyday life, as well as within larger ecosystems and relations. As the dissertation uncovers opportunities and challenges of adopting a more-than-human design approach in the design of CAs, and AI more generally, it also articulates how engaging with AI could advance knowledge within the posthuman turn. In that space, the dissertation offers conceptual and practical tools for developing a more-than-human design practice.

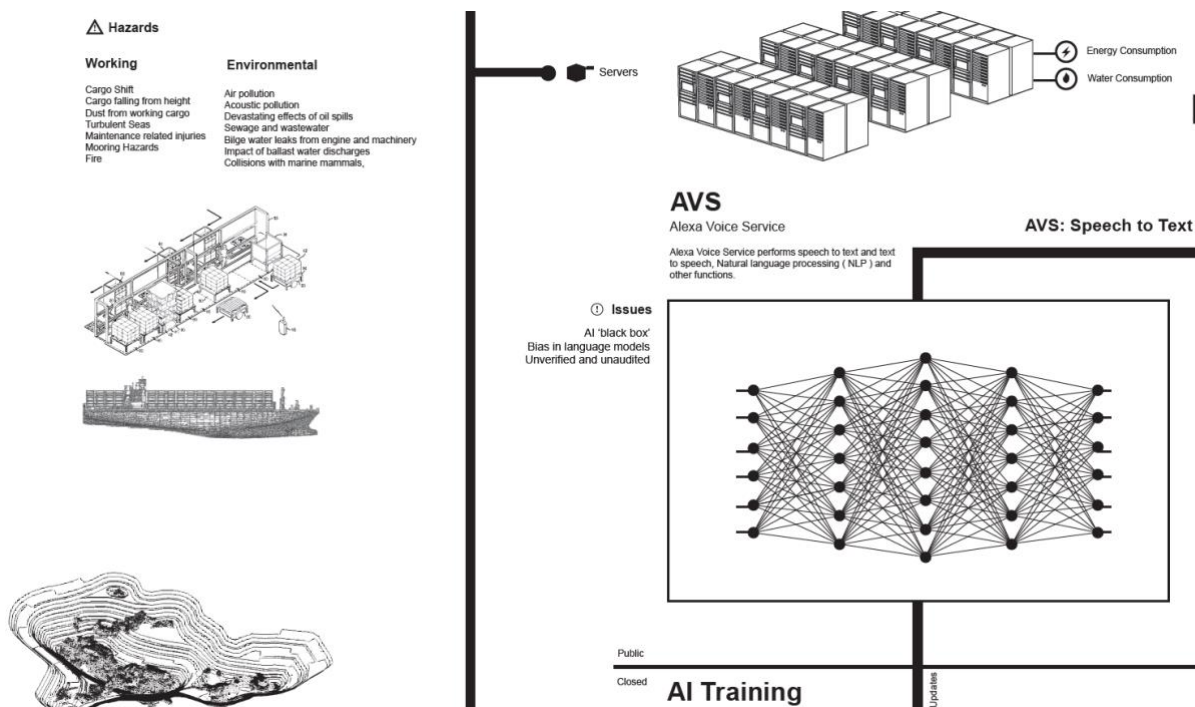


Figure 1. Part of the 'Anatomy of an AI System' map by Crawford & Joler (2018). The map depicts the journey of an Amazon Echo and illustrates how each interaction with a conversation agent such as Alexa relies on a vast planetary network of humans and nonhumans. By doing so, it makes tangible some of the complex webs of humans and nonhumans that participate in making AI systems.

To establish the scope upfront, the dissertation does not aim to provide a comprehensive account of AI's impact or thoroughly map its relations. Instead, the inquiry here is more modest: the research aims to identify specific instances where entangled human/nonhuman relations become apparent in interactions with AI applications in daily life. Additionally, while acknowledging ongoing discussions in AI, such as the ambiguity surrounding the term and its environmental impact, delving into these topics would be beyond the scope of the dissertation. Given that the primary audience comprises designers within HCI, the term 'designers' predominantly refers to those engaged in research rather than industry practice, although there may be overlaps; the dissertation does not delve into design practitioners' workflows. Within this modest position, the dissertation aims to offer 'intermediate-level knowledge' (Höök & Löwgren, 2012) gleaned from situated design

experiments. These insights are intended to serve as resources for designers and researchers involved in more-than-human design, providing an array of techniques, strategies, and tactics, as well as examples of how they could be mobilized in practice.

While this dissertation is written by humans and for humans, it is crafted with nonhumans as active participants in the research process. It resonates with Giaccardi and Redström (2020) as they propose that taking the idea of artificial intelligence seriously means to "explore what happens if we think of networked computational things not only as designed artifacts or technological enablers but also in terms of agents in a design space where they actually participate" (p. 35). Nevertheless, increasing nonhuman participation is not the primary focus of the dissertation; instead, the research emphasizes the reflective opportunities that more-than-human approaches offer to designers engaging with AI. Ultimately, the dissertation's goal is not to design AI as a product or with AI as a tool; instead, it aims to cultivate a practice of 'designing-with', i.e., a posthumanist and relational design practice (Wakkary, 2021).

Taking a posthumanist approach, the dissertations' key preposition is not 'therefore,' as commonly seen in other dissertations where data is presented and analyzed to support claims. Instead, the prepositions 'with,' 'through,' and 'in' are more significant here, as they highlight the types of relations and processes the dissertation engages with: *thinking-with, through-design, in-practice*.

1.1. Knowledge gap

With the aim of cultivating a practice of designing-with and mobilize it in the context of AI, the dissertation explores how to support designers in adopting a more-than-human design approach. Moving towards that goal, the research identifies necessary reorientations required to adopt more-than-human design approaches – including the need to transcend the perception of AI as merely a technical domain or tool (Giaccardi & Redström, 2020; Redström & Wiltse, 2018) and to challenge the human-centered perspectives entrenched in AI discourse (Forlano, 2023; Wakkary, 2021). Furthermore, the research highlights tensions faced by designers when adopting more-than-human approaches, such as the increasing frustration of not being able to abandon the human perspective completely. Finally, the research focuses on a crucial gap in the posthuman turn in HCI and design: the need to understand how posthumanist thinking can be enacted in concrete design practices. Despite the proliferation of concepts in recent years, scholars have noted that their practical implementation in design remains an area requiring further exploration (Coskun et al., 2022). Addressing this gap is essential, and it requires urgent attention "if action is to complement abundant theory" (Lindley et al., 2023, p. 1). The dissertation explores how posthumanist theory is enacted in design practice and how more-than-human design practices can be further articulated and enriched.

1.2. Research objectives

The dissertation is concerned with the main question:

- How might designers adopt a more-than-human design approach in the context of AI, enabling them to engage with the entangled relations between humans and nonhumans within AI socio-technical and planetary systems?

Since the focus is to develop a design practice and not just advance the field theoretically, to address the first question, it is also necessary to ask:

- How might the conceptual developments in the field of more-than-human design be complemented with practical tools?
- How might conceptual and practical elements be integrated into design practices?
- How might more-than-human design practices be articulated and further enriched?

Building on these questions, the research can be broken down into three main objectives:

- RO1: Develop a practice of designing-with in the context of AI, with the goal of enabling designers to engage with the entangled relations between humans and nonhumans within AI socio-technical and planetary systems.
- RO2: Develop practical tools for more-than-human designers –and examples of how these tools could be integrated and mobilized in situated design practices.
- RO3: Articulate and enrich more-than-human design practices.

1.3. Research approach

The dissertation addresses these objectives through design. This means that it employs design skills and processes as means of inquiry and exploration, to generate new knowledge or insights (Stappers & Giaccardi, 2017). Methodologically, the dissertation draws upon three approaches: practice-based research (Gaver et al., 2022), research-through-design (RTD) (Stappers & Giaccardi, 2017), and design research programs (Redström, 2011). While these approaches have some differences, the dissertation builds on their overlap in conceiving design as a field that can generate knowledge and not just apply it. Additionally, it embraces their common conception of design outcomes not solely as physical objects but also as conceptual artifacts that guide research direction, reframe goals, and expand the design scope (Mazé & Redström, 2009). Lastly, it aligns with their prevailing understanding of rigor, which prioritizes the quality of reflections over the reproducibility of outcomes (Gaver & Bowers, 2012). While RTD and practice-based research inform the inquiry broadly, the programmatic approach serves to structure the process, organizing the inquiry into diverse experiments that collectively shape a programmatic arch.

Theoretically, the dissertation is grounded in posthumanist theory (Braidotti & Hlavajova, 2018) and posthumanist design scholarship (Forlano, 2017; Giaccardi, 2020; Tironi et al., 2023; Wakkary, 2021). While posthumanist theory encompasses various perspectives, this dissertation predominantly aligns with critical posthumanism, with the work of feminist philosopher Rosi Braidotti (2013, 2019; 2018) being central. It also draws inspiration from Donna Haraway's theory of 'situated knowledges' (1988) and the concepts of 'thinking-with' and 'becoming-with' (2016). Additionally, it incorporates Karen Barad's concepts of 'entanglements' (2007) and 'diffraction' (2014), Maria Puig de la Bellacasa's work on the ethics of care (2017), and Anna Tsing's methodological interventions (2019).

Epistemologically, the dissertation is based on the general understanding of design as a field that can produce knowledge and make theory (Redström, 2017). In addition to that, it takes a posthumanist commitment to knowledge production (Wakkary, 2021), drawing on situated knowledges (Haraway, 1988) and 'nomadic design practices' (Wakkary, 2020). Guided by these approaches, the dissertation aims to strike a balance between theory and practice, and between generalizing the knowledge gained through specific experiments while also preserving their situated nature. While some of the outcomes are practical, they are not portrayed as conventional design methods, tools, or resources. Similarly, while certain contributions may lean more towards theoretical exploration, they are not intended to serve as traditional theories or a comprehensive framework, nor as a precise set of guidelines or an exhaustive taxonomy. Instead, the contributions are presented as diverse and pluralistic ways of doing and knowing through design, as knowledge that is at an intermediate level i.e., situated between specific instances and abstract theories (Höök & Löwgren, 2012).

1.4. Contribution

The dissertation makes significant contributions to three distinct fields: more-than-human design, critical AI, and design research. In more-than-human design, the dissertation explores and develops a novel practice of designing-with. It offers a collection of methodological interventions for design researchers in HCI and design encompassing tactics, strategies, and techniques. Secondly, it provides practical examples demonstrating how these diverse elements could be integrated and applied within design practice. Lastly, it introduces emergent concepts and dimensions to articulate more-than-human design practices, emphasizing the pivotal role of design in materializing and enhancing posthumanist theory.

In the field of critical AI, the dissertation proposes more-than-human design as a novel approach and explores its potential for promoting responsible AI, including how it can help identify anthropocentric biases in human-AI interactions and situate the knowledge generated by AI tools. Focusing on conversational agents, the research unveils inherent anthropocentric biases ingrained in their design, while also challenging the conventional (humanist) conception of the user upon which they are typically predicated. Through various design experiments with this technology, it uncovers nuanced insights into the intricate relationships between humans and nonhumans within AI systems and underscores new challenges, such as the imperative to situate AI. Moreover, it prototypes alternative designs of conversational agents that can listen and respond to a wider range of human, nonhuman, and more-than-human voices.

In the field of design research, the dissertation advances understanding on the interwoven nature of theory and practice, offering new insights into longstanding discussions about the knowledge generated through design.

1.5. Audience and dissemination

The knowledge is produced by engaging with a diverse range of formats, including performances, walks, podcasts, prototypes, and books, among others. The primary audience for this research is the community forming around more-than-human design in the fields of HCI and design research (Coskun et al., 2022; Tironi et al., 2023; Yoo et al., 2023). The secondary audience includes the emerging community around critical AI and design (Raley & Rhee, 2023; Crawford, Joler, and Cattabriga, 2023). A big part of the dissertation was disseminated within these fields. Part II is composed of papers that have been published (or are accepted for publication) in first-tier journals and proceedings:

- **Nicenboim**, I., Giaccardi, E., Søndergaard, M. L. J., Reddy, A. V., Strengers, Y., Pierce, J., Redström, J., (2020). More-than-human design and AI: in conversation with agents. In the *Companion Publication of the 2020 ACM Designing Interactive Systems Conference (DIS'20)* –Chapter 5.
- **Nicenboim**, I., Giaccardi, E., Redström, J., (2022). From explanations to shared understandings of AI. In *Proceedings of the Design Research Society (DRS'22)* –Chapter 4.
- **Nicenboim**, I., Giaccardi, E., Redström, J., (2023). Designing more-than-human AI: Experiments on situated conversations and silences. In *diid Disegno Industriale Industrial Design*, Bologna University Press (Chapter 5)
- **Nicenboim**, I., Venkat, S., Rustad, N. L., Vardanyan, D., Giaccardi, E., Redström, J., (2023). Conversation Starters: How Can We Misunderstand AI Better? In *Extended Abstracts of the 2023 CHI Conference on Human Factors in Computing Systems (CHI'23)* –Chapter 5.
- **Nicenboim**, I., Oogjes, D., Biggs, H., Nam, S., (2023). Decentering Through Design: Bridging Posthuman Theory with More-than-Human Design Practices. In *Human-Computer Interaction, Taylor & Francis* – Chapter 6.
- **Nicenboim**, I., Lindley, J., Søndergaard, M. L. J., Reddy, A., Strengers, Y., Redström, J., Giaccardi, E., (forthcoming). Unmaking-with AI: Tactics for Decentering through Design. In *ACM Transactions on Computer-Human Interaction (TOCHI)* –Chapter 7.
- **Nicenboim**, I., Lindley, J., Redström, J., (forthcoming). More-than-human Design and AI: Exploring the Space between Theory and Practice. In *Proceedings of the Design Research Society (DRS'24)* –Chapter 8.

The author has also contributed to other articles during the PhD studies:

- Reddy, A. V., **Nicenboim**, I., J. Pierce, & Giaccardi, E. (2020). Encountering Ethics through Design: A Workshop with Nonhuman Participants. *AI & Society*.
- Reddy, A. V., Kocaballi, A. B., **Nicenboim**, I., Søndergaard, M. L. J., Lupetti, M. L., Key, C., Speed, C., Lockton, D., Giaccardi, E., Grommé, F., Robbins, H., Primlani, N., Yurman, P., Sumartojo, S., Phan, T., Bedö, V., & Strengers, Y. A. A. (2021). Making Everyday Things Talk: Speculative Conversations into the Future of Voice Interfaces at Home. In *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems (CHI '21)*.
- Murray-Rust, D., **Nicenboim**, I., & Lockton, D. (2022). Metaphors for Designers Working with AI. In

Proceedings of the Design Research Society Conference (DRS'22).

- Coskun, A., Cila, N., **Nicenboim**, I., Frauenberger, C., Wakkary, R., Hassenzahl, M., Mancini, C., Giaccardi, E., & Forlano, L. (2022). More-than-human Concepts, Methodologies, and Practices in HCI. In *Extended Abstracts of the 2022 CHI Conference on Human Factors in Computing Systems (CHI '22)*.
- Murray-Rust, D., Luppetti, M. L., **Nicenboim**, I., & van der Hoog, W. (2023). Grasping AI: Experiential Exercises for Designers. In *AI & Society*.
- van der Maden, W., van Beek, E., **Nicenboim**, I., van der Burg, V., Kun, P., Lomas, D., & Kang, E. (2023). Towards a Design (Research) Framework with Generative AI. In the *companion publication of the 2023 ACM Designing Interactive Systems conference (DIS'23)*.
- Yoo, M., Berger, A., Lindley, J., Green, D. P., Boeva, Y., **Nicenboim**, I., Odom, W. (2023). Beyond Academic Publication: Alternative Outcomes of HCI Research. In the *companion publication of the 2023 ACM Designing Interactive Systems conference (DIS'23)*.
- Murray-Rust, D., Luppetti, M. L., & **Nicenboim**, I. (2024). Metaphor Gardening: Experiential Engagements for Designing AI Interactions. In *Proceedings of the Design Research Society Conference 2024 (DRS'24)*.
- Giaccardi, E., Redström, J., & **Nicenboim**, I. (2024). The making(s) of more-than-human design: introduction to the special issue on more-than-human design and HCI. *Human-Computer Interaction*, 1–16.
- Chillet, M., Tironi, M., **Nicenboim**, I., & Lindley, J. (forthcoming). Designing with planetary AI. In Rosén P., Salovaara A., Søndergaard, M. L. J. & Botero A. (Eds.), *More-than-human Design in Practice*. Routledge.

The author has also shown some of the design outcomes in exhibitions and festivals:

- Dutch Design Week, 22-30.10.2022, Eindhoven, the Netherlands
- CHI2023 Interactivity Track, 23-28.04. 2023, Hamburg, Germany
- Thingscon, 15.12.2023, Rotterdam, the Netherlands
- Mozfest, 19-21.06.2023, Amsterdam, the Netherlands
- TU Delft Library, 2023-2024, Delft, the Netherlands

In terms of impact, while the primary audience for the dissertation is within the academic community, some outcomes have also reached beyond these boundaries to resonate with other fields, industry professionals, and wider public audiences. For instance, the research has engaged with humanities scholars at the international conference 'Encountering nonhumans' held in the Czech Republic in 2022. Additionally, it reached professional designers and policymakers at festivals such as Thingscon and Mozfest. Lastly, the research reached a wide range of people, most of whom were not designers, during the Dutch Design Week in 2022, where the prototypes were presented. While these exchanges have played a key role in shaping the research, their precise impact and value are not easily measurable. As Robbins & Giaccardi (2019) have noted, not every form of knowledge comes with a standardized or quantifiable metric that renders itself immediately recognizable to others, yet it plays a crucial role in defining research programs, including their beliefs, ideals, and intentions.

One way to gauge the impact of the knowledge produced is by observing how it has been relevant to diverse projects. For example, as the author was one of the technical chairs of the DIS 2023 conference, the practice-based research approach adopted in this dissertation was particularly relevant for drafting guidelines to review design work. Similarly, in co-organizing a panel discussion at the CHI conference in 2022 titled 'More-than-human Design Concepts, Methods, and Practices,' co-editing a Special Issue of the HCI Journal titled 'More-than-human Design and the Posthuman Turn in HCI,' and co-organizing a track for the DRS conference titled 'More-than-human Design in Practice,' the knowledge around more-than-human design practices was instrumental.

1.6. Outline

The dissertation is divided into three main parts:

Part I, comprising Chapters 2 and 3, situates the emergence of the dissertation within a broader societal and academic context. While Chapter 2 maintains a seemingly neutral tone, Chapter 3 adopts a more personal

perspective. Chapter 2 offers a discussion on relevant literature to motivate the research. Chapter 3 introduces the chosen research approach, along with the methodologies employed.

Part II, comprising Chapters 4-8, consists of published papers that have been slightly edited to ensure a good flow and avoid redundancy. While Chapters 4 and 5 address the first research objective (RO1), Chapters 6, 7, and 8 address the second and third ones (RO2 and RO3). Chapter 4 reorients the challenges of responsible AI through more-than-human design and proposes two design strategies to support designers in situating AI. Chapter 5 builds upon these strategies and explores them through design, presenting a variety of experiments. Chapter 6 articulates more-than-human design practices by examining the challenges designers face when integrating more-than-human design into their practices and proposing ways to overcome them. Focusing on the notion of 'decentering,' this chapter illustrates some of the ways in which designers engage with posthuman theory and their role in generating posthuman knowledge through design. Chapter 7 further explores the practice of decentering by examining its resonance with a similar practice –unmaking– by analyzing the outcomes of the workshops presented in Chapter 5. Finally, Chapter 8 builds upon the questions raised in Chapter 6 regarding the unique ways designers create more-than-human knowledge and delves into the generative intersections between theory and practice.

Part III, comprising Chapters 9 and 10, summarizes the outcomes of the dissertation and discusses the contributions within the context of the literature presented in Part I. Chapter 9 synthesizes the dissertation's outcomes. It begins by summarizing the outcomes generated across all chapters in Part II and then proceeds to generalize and contextualize the knowledge produced within the broader scope of more-than-human design scholarship. Chapter 10 summarizes the contributions and positions them within three distinct areas: more-than-human design, AI, and design research. Then, it explains in which ways these contributions have addressed the research objectives and what areas remain open for further research.

Collectively, the eight chapters form an assemblage of situated experiments on how designers might adopt a more-than-human design approach. Diving into it, the next chapter presents the research's motivation.

2. Towards a more-than-human design approach to AI

"Para nosotras, las tecnologías no son artefactos u objetos. Las tecnologías son dispositivos relacionales. Nos tejen y las tejemos" ("For us, technologies are not artifacts or objects. Technologies are relational devices. They weave us and we weave them") (Cortés et al., 2020, p. 5).

As AI weaves deeper into the fabric of our lives, it introduces a web of opportunities and challenges. This chapter unpacks some of them. It begins by briefly situating AI within broader societal and ecological shifts. Then, drawing from critical AI, it delineates how AI is understood in this dissertation, as a socio-technical and planetary system made by and of humans and nonhumans. Building upon this foundation, the chapter explores the potential role of design in engaging with this complexity, while also unpacking the limitations of human-centered approaches in that regard. Lastly, it examines the potential benefits of more-than-human design as an alternative approach for studying and designing AI, highlighting the need to develop a practice of *designing-with*.

2.1. Situating the making of AI

"AI is born from salt lakes in Bolivia and mines in Congo, constructed from crowdworker-labeled datasets that seek to classify human actions, emotions, and identities. It is used to navigate drones over Yemen, direct immigration police in the United States, and modulate credit scores of human value and risk across the world. A wide-angle, multiscalar perspective on AI is needed to contend with these overlapping regimes" (Crawford, 2021, p. 218)

We are currently situated within a particular historical context marked by two simultaneous 'eras' as they are frequently discussed in media outlets: the age of AI and the Anthropocene. The age of AI is often described through the rapid advancements and pervasive integration of deep learning technologies across various facets of human existence, reshaping industries, economies, and social interactions. The term Anthropocene often refers to a geological epoch characterized by the profound and enduring impact of human activities on Earth's ecosystems, resulting in irreversible alterations to planetary systems and ecological balances.

Both terms, the Anthropocene and AI, are highly contested (Braidotti & Hlavajova, 2018). From the perspective of geology, the Anthropocene is critiqued because it appears that the effect of humans on the Earth's environmental and climate systems long predate the mid 20th century. Within the humanities, Donna Haraway (2016) critiques the Anthropocene narrative for its focus on humans, which obscures the diverse ways in which humans are entangled with other beings and ecological systems. Provocatively, she claims that a more accurate name for it is the 'Capitalocene,' which is a term coined by James Moore (2017), which better reflects "the managerial, technocratic, market-and-profit besotted, modernizing, and human-exeptionalist business-as-usual commitments of so much of the Anthropocene discourse" (p. 50). Haraway proposes a new framing with the term 'Chthulucene,' which advocates for a more situated understanding of human impacts on the planet, one that acknowledges the complexities of power dynamics, inequalities, and multispecies relationships and embraces kinship with nonhumans, rather than perpetuating exploitative modes of interaction.

The term AI is similarly contested. Crawford (2021) explains that "The term is both used and rejected in ways that keep its meaning in flux" (p. 9). When asking the question 'What is AI?', different people might give different answers. For some, AI is the technology behind smart devices, while for others, it might imply a commercial way of referring to Machine Learning models. The biggest challenge lies in the fact that the very notions of artificial and intelligence are not straightforward (Raley & Rhee, 2023). Articulating the complex genealogies and debates about the meanings and misconceptions around AI exceeds the scope of this research (for a summary, see Raley & Rhee, 2023). But what is important to note is that each way of defining AI sets a frame for how it will be understood, measured, valued, and governed (Crawford, 2018).

Within the emerging field of critical AI studies, AI is understood as a socio-technical system and an extractive planetary network (Crawford, 2018). Aligned with this perspective, the dissertation engages AI "as an assemblage of technological arrangements and socio-technical practices, as concept, ideology, and dispositif" (Raley & Rhee, 2023, p. 188). Following that understanding, the choice of the term AI in this dissertation — in contrast to other concepts like Machine Learning— suggests that the research focus goes beyond the technical aspects of AI. However, by using this term, the aim is not to diminish its "reductive, even absurd aspects" or "the magical thinking it perpetuates" (Raley & Rhee, 2023, p. 188). On the contrary, the intention is (as Haraway would say) to 'stay with the trouble' of this unfolding notion and try to 'dissent-within' that position (de la Bellacasa, 2012).

More specifically, the dissertation is guided by the provocation that "Artificial Intelligence is neither artificial nor intelligent" but rather "embodied and material, made from natural resources, fuel, human labor, infrastructures, logistics, histories, and classifications" (Crawford, 2021, p. 8). The idea that AI is *made* is key here. Firstly, because through this idea we can examine *what makes AI*. Exposing the humans and nonhumans involved in, and affected by AI, is one of the motivations of the dissertation. Secondly, because if AI is made, it can be *remade*. This is another motivation of the dissertation, to design AI *otherwise*. Taking this one step further, the dissertation explores *how AI is made by humans and nonhumans, as well as how AI makes humans and nonhumans*. In other words, it examines how AI is both shaped by, and shapes particular understandings of what it means to be human (Forlano, 2023)

2.2. Towards critical AI design approaches

The field of design emerges as a pivotal actor in the narratives of both AI and the Anthropocene: "design is intrinsically linked to the consequences of capitalism, colonialism, and the concentration of power in technological systems" (Crawford et al. 2023, p. 22). However, design also appears to be a field capable of contributing to the advancement of responsible AI. Throughout history, designers have been actively involved in the development of this technology. In the book 'Architectural Intelligence,' Molly Wright Steenson (2017) illustrates how architects and designers have long been central figures in the making of AI. Steenson demonstrates how four architects in the 1960s and 1970s, including Christopher Alexander, Richard Saul Wurman, Cedric Price, and Nicholas Negroponte, incorporated cybernetics and artificial intelligence into their work but also influenced digital design practices from the late 1980s to the present day, laying the foundation for interaction design. This trajectory appears to align with recent trends in design, where we observe designers using AI in their processes while also designing AI as a product. Moreover, it implies that beyond these two engagements, design has the potential to fundamentally contribute to AI research.

This dissertation departs from the idea that "designers have an enormous role to play in revealing the systems underneath the sort of shiny, smooth surfaces of the technologies that we use every day. But also pushing back" (Crawford et al., 2023, p. 28). Engaging only with the interactions of humans and AI would be a missed opportunity, given that one key capacity of designers is their ability to deal with complexity and conflicting concerns (Redström, 2017). Thus, the question is how designers might engage with AI responsibly, but also meaningfully, i.e., going beyond just designing the interfaces and interactions. Emancipating the designer from this superficial role, we can think of design as a field that can contribute to developing new understandings of AI, which do not rely on solutionist or extractivist logic but move towards sustainable and inclusive futures –in the plural. However, to achieve that "design must participate more actively in questioning the social systems that nurture our current anthropocentric development system, generating conditions for projecting plural, post-capitalist, post-patriarchal and post-human communities" (Tironi et al., 2023, p. 6).

In the domains of HCI and design research, the exploration of AI is undergoing exponential growth. Over the past few years, scholars have been actively generating guidelines for designing human-AI interactions (Amershi et al., 2019; Van Der Maden et al., 2023; Vera Liao et al., 2020; Weisz et al., 2023), and examples of how AI could be used in design processes (Chiou et al., 2023; Feng et al., 2023; Lawton et al., 2023; V. Liu et al., 2023; Tholander & Jonsson, 2023). However, apart from a handful of examples (Benjamin et al., 2021; Brand et al., 2021; Desjardins et al., 2021; Hemment et al., 2019; Lindley et al., 2020; Murray-Rust et al., 2023; van der Burg et al.,

2023; Van Der Maden et al., 2023), there are not many instances in which, through practice, design has shaped AI discourse more broadly. Equally, there are not many examples of posthumanist approaches to AI, apart from a few exceptions (Ghajargar & Bardzell, 2022; Klumbyté et al., 2022; Rajcic & McCormack, 2023; Reddy et al., 2021). Moreover, the intersection of RTD and a posthumanist approach to AI remains unexplored.

2.3. The limitations of human-centered approaches for designing AI

If design is to effectively address the planetary challenges associated with AI, it must first confront a significant obstacle: the potential for design itself to inadvertently worsen these challenges. For instance, the choice of metaphors in designing AI applications can either help explain AI or make it more obscure (Ganesh, 2022; Murray-Rust et al., 2022; Rotenberg & Roschelle, 2022). Thus, more than merely accounting for the role that designers can play, being critical of the design approaches chosen is crucial.

Human-centered AI (HCAI) is concerned with ensuring that the design of AI applications is aligned with human needs and societal values like trust, fairness, and human control (for a review, see Capel & Brereton, 2023; J. Yang et al., 2023). With a focus only on humans, human-centered AI seems to struggle to address the impact that technologies have on the earth and other species (Tironi et al., 2023; Wakkary, 2021). Additionally, it seems limited in addressing the growing agency of AI applications (Frauenberger, 2019; Giaccardi & Redström, 2020; Redström & Wiltse, 2018) and in extending issues of responsibility and trust beyond immediate end users and single interactions (Coulton & Lindley, 2019; Fuchsberger & Frauenberger, 2024). Furthermore, human-centered design may even pose risks for inclusivity. Forlano (2021) explains that "human-centered AI does little to address deeper issues such as the way in which 'the human' is defined around liberal Western Eurocentric notions of individuality, rationality, and autonomy that are typically, white, male, and ableist" (p. 1). These limitations become tangible in the interaction design of conversational agents. Trained to listen to a limited set of voices, they have trouble understanding the accents and speech patterns of people from many underrepresented groups (Koenecke et al., 2020). Furthermore, they often reproduce gender and racial biases because their designs are based on outdated stereotypes (Phan, 2019; Strengers & Kennedy, 2020).

While the challenge of understanding the harmful biases that are inadvertently embedded in the design of AI is widely discussed (Fossa & Sucameli, 2022; Hutiri & Ding, 2022), the anthropocentric tendencies in the design of AI are underexplored. However, moving beyond anthropocentrism in AI is not straightforward. Giaccardi & Redström (2020) explain that there is a sort of paradox when it comes to abandoning the human-centered perspective in technology. This is because, in response to the disruptive impact of algorithmic logic on society, we actually see reactions that call for placing the human even more firmly at the center.

However, given the scale and scope of AI systems, along with their societal and environmental implications, it becomes imperative for designers to transcend anthropocentric approaches and challenge Eurocentric notions of the human as a discrete, autonomous individual (Forlano, 2021). It is essential to question: "What if human-centered thinking (and its underlying humanism) is not the answer to these problems but rather, in its dominant role, may be part of the problem?" (Wakkary 2021, p. 1). In line with this critique, the dissertation emphasizes the importance of recognizing the anthropocentric assumptions inherent in the design of AI-powered applications and explores avenues for emancipation from them (Braidotti, 2019). Seeking alternatives, the following section delves into the potential advantages of adopting a more-than-human approach to studying and designing AI.

2.4. More-than-human design and the critical posthumanities

The field of more-than-human design is gaining significant momentum in HCI and design. In 2022, a panel discussion titled 'More-than-human Design Concepts, Methods, and Practices' was convened at the CHI conference (Coskun et al., 2022). Subsequently, in 2023, a Special Interest Group titled 'More-Than-Human Perspectives and Values in Human-Computer Interaction' was established within HCI (Yoo et al., 2023). Additionally, this year, the HCI journal is set to publish a forthcoming special issue on more-than-human design. This trend is mirrored in the domain of design as well. In 2019, the Barbican Centre in London hosted an exhibition titled 'AI: More than Human.' In 2023, the Design Museum in Gent curated a lecture series named

'Design x More-than-Human.' Presently, the Museum of Decorative Arts in Berlin is launching a permanent exhibition called 'More than Human,' accompanied by a discursive platform featuring pop-up exhibitions, lectures, workshops, and discussion panels to delve into the subject.

While the term more-than-human design is now widely used, historically, it encompassed concepts such as post-anthropocentric, posthumanist, and thing-centered design. What unites these approaches is their relational orientation to design, which emphasizes that "we can only understand humans, things, and the world in relation to each other" (Wakkary, 2021, p. 18). More-than-human design can be situated within a larger shift in HCI and design, often called the 'posthuman turn.' The turn is not completely new, as relational thinking has been evolving within the fields of design and HCI for several decades. It is also not a cohesive movement; it builds on different foundations – including different philosophical perspectives. Whether posthumanist perspectives on design represent a paradigmatic change or not, it is prompting a reevaluation of designers' values and responsibilities (Yoo et al., 2023), challenging conventional notions and ways of doing that have prevailed in design since the industrial era (Giaccardi & Redström, 2020).

Seminal works by various authors have laid the groundwork for understanding more-than-human design. For example, in 'Posthumanism and Design,' Forlano (2017) traced emergent discussions around posthumanism from across a range of disciplines and perspectives and considered examples from emerging design practices that emphasize the interrelations between human and nonhuman actors. In 'Technology and More-than-human Design,' Giaccardi and Redström (2020) proposed more-than-human design as a fundamental rethinking of design as a practice given the challenges of new technologies such as AI. In 'Things We Could Design for More-than-human Worlds,' Wakkary (2021) explored a posthumanist approach to design, advocating for a relational and expansive design approach based on humility and cohabitation. Lastly, in 'Design for More-Than-Human Futures: Towards Post-Anthropocentric Worlding,' Tironi and colleagues offered a critical reevaluation of human-centered design, emphasizing the need to reconsider the modern, colonialist, and anthropocentric legacy that permeates design culture.

More-than-human design draws from various philosophical perspectives (for an overview see Forlano, 2017; Lindley et al., 2024; Wakkary, 2021). In particular, this dissertation is aligned with the perspective of new materialism and the critical posthumanities more broadly. The critical posthumanities is described by Braidotti (2013) as a convergence of two critiques: one that challenges anthropocentrism, and the other that questions the normative (European and humanist) construction of the 'human' as man, white, and able. Critical posthumanism differs from, and critiques transhumanism, a perspective that advocates for technological enhancement (Ferrando 2019). Instead, critical posthumanism underscores the need to scrutinize power imbalances and systemic oppressions (Braidotti, 2019).

Like critical posthumanism, more-than-human design does not propose to abandon the human. Instead, it repositions accountabilities, responsibilities, and ethics within entanglements and encounters of humans and nonhuman agencies (Frauenberger, 2019) and problematizes the way humans are defined in the field of design and HCI (Clarke et al., 2019; Forlano, 2016; Giaccardi & Redström, 2020). Additionally, as the critical posthumanities questions broader set of normative constructions stemming from modernism, and unsettles dualisms such as human/machine, and natural/artificial (Ferrando 2019; Haraway 2016), more-than-human design questions the anthropocentrism that underlies human-centered approaches and unsettles the humanist conception of the user – which historically has been juxtaposed against machines, nature, and designers (Cooper & Bowers, 1995; Giaccardi & Redström, 2020).

More-than-human design, especially when building on critical posthumanism, can support designers in articulating a more expansive understanding of humans that goes beyond the humanist conception on which human-centered design is based. This is vital because, as previously exemplified with the case of conversational agents, when centering on humans, not everyone, even within the human species, is equally recognized or valued equally. In the context of AI, more-than-human design can help designers account for the humans and nonhumans that *make* AI and understand how AI shapes humans. Furthermore, it can provide "a more expansive notion of what it means to be human — one that integrates other ways of knowing and being

into discussions about AI, technology, and science" (Forlano, 2021, p. 1). Thus, the real potential of more-than-human design goes beyond complementing human-centered design methods, it can "allow us to dramatically reevaluate our 'needs' and, instead, find pathways toward asking the right questions of corporations, governments, and of ourselves as designers" (Forlano 2016, p. 50). Ultimately, more-than-human design can support designers in reflecting on their role in the world and consider new forms of coexistence and collaboration that are more plural and ecological, but ultimately also more humble (Wakkary, 2021).

Having established that more-than-human design is a potentially suitable approach to address some of the issues around designing AI, the last section focuses on what a posthumanist design approach that is grounded in critical posthumanism can look like in the context of AI.

2.5. Towards a more-than-human design practice of designing-with AI

This section outlines the contours of a posthumanist design practice, conceptualizing it as a practice of designing-with. Before elucidating this concept, the section first addresses the challenges identified by scholars within the posthuman turn that may hinder the adoption of more-than-human design approaches. It then explores the necessary efforts required to overcome these obstacles and support designers in adopting more-than-human design approaches.

There are several challenges for designers when adopting a more-than-human design approach. Some scholars have highlighted how designers often feel disoriented when encountering nonhuman perspectives (Biggs et al., 2021). Others have discussed the paralyzing feeling they experience when confronting the impossibility of fully decentering their human perspective (Livio & Devendorf, 2022). Still, others have pointed out larger tensions regarding issues of representation and labor (Key et al., 2022). One significant challenge gaining attention in the field is the need to develop more-than-human design practices further, i.e., to translate theoretical developments in the field into actionable paths (Coskun et al., 2022). Around this challenge, a recent track was formed at the DRS 2022 conference. It invited submissions that report on practical experiments in more-than-human design, asserting that "despite the community's prolific theoretical and methodological outputs, understanding how those can be enacted in concrete design practices requires urgent attention if action is to complement abundant theory" (Lindley et al., 2023)

Unpacking this challenge, the first issue that appears important to resolve is finding a good balance in the interplay between theory with practice. While there have been fruitful conceptual developments in the early years of the posthuman turn in HCI and design, only recently have we begun to see more practical examples. A panel at the CHI conference in 2022 discussed this issue: "So far, the theoretical ground for more-than-human design has been established by introducing and discussing the design relevance of various post-humanistic theories and concepts to the field [...] These pioneering works paved the way for studying and discussing the values and principles underlying a more-than-human approach to design. Now, the challenge lies in initiating a dialogue among more-than-human designers and researchers to identify strategies for connecting more-than-human design theory to more-than-human design practice" (Coskun et al., 2022, p. 2).

Another aspect of the challenge lies in how to expand more-than-human approaches beyond academic contexts. Several years ago, Forlano (2016) articulated this challenge: "The vast majority of examples from [more-than-human] design projects are still within the realm of artistic practice and/or academic scholarships. How might we further expand the application of non-anthropocentric design to the broader practice of human-centered design beyond niche academic conversations?" (p. 50). While more-than-human approaches are increasingly used in design education, they have yet to become widespread in the industry. Integrating more-than-human approaches poses a challenge for design practitioners because the foundation of design practice traditionally revolves around human needs. Given that more-than-human design represents an epistemological shift, merely adapting human-centered design methods and concepts is not feasible. For example, while human-centered design methods often involve one-day workshops or even shorter sessions focused on empathizing with users, more-than-human design activities typically require more time; and even a shift in how we approach temporality (Oktay et al., 2023).

To make more-than-human design actionable, it seems crucial to complement existing concepts and methods with practical resources. More-than-human design practices seem to require unlearning (Jönsson et al., 2022), attuning (Livio & Devendorf, 2022) and sensitizing (Biggs et al., 2021; Liu et al., 2018; Oogjes & Wakkary, 2022). Ultimately, a practice involves intentional effort, repetition, and dedication toward a specific goal, but also generosity and humbleness (Wakkary, 2021). It also seems important to experiment with these tools in particular contexts to understand their value. As Giaccardi (2020) explains "designers need to creatively and extensively exercise and practice the principles of a new approach, and to take the underpinning technology seriously, before they can actually design with it" (p. 100).

Fortunately, there is an increasing number of examples of how more-than-human practices could manifest in diverse contexts. There is a wealth of work around multispecies interactions, which involves working with animals (French et al., 2020; Lawson et al., 2015; Mancini, 2017), plants and forests (Biggs & Desjardins, 2020; Rolighed et al., 2022; Sareen et al., 2019; Tomico et al., 2023; Westerlaken et al., 2022), and bacteria (Liu et al., 2018; Ofer et al., 2021). Additionally, there are numerous examples concerning objects and technologies (Coulton & Lindley, 2019; Giaccardi, 2020; Reddy et al., 2020; Redström & Wiltse, 2018; Wakkary et al., 2017) as well as intelligent agents (Bedö, 2021; Desjardins et al., 2021; Forlano, 2023; Treusch et al., 2020). Emerging areas encompass more specific contexts such as food (Cho et al., 2021; Dolejšová, Wilde, et al., 2020; Wilde et al., 2021), materials (Dew & Rosner, 2018; Liu et al., 2018; Oogjes & Wakkary, 2022), and health (Homewood et al., 2021; Søndergaard & Campo Woytuk, 2023).

However, apart from the foundational texts mentioned earlier and a few others (such as Oogjes, 2022) there has been limited reflection on how more-than-human practices could be articulated and further enriched. To complement and advance these efforts, this dissertation reviews how posthuman approaches are enacted in design research practices in design and HCI; and how they could be further developed.

The dissertation explores designing-with, as a posthumanist design practice (Wakkary, 2021). The idea of 'designing with' was suggested by Giaccardi and Redström (2020) in the context of technology, as they proposed that: "maybe we will not design for these technologies but *with them*" (p. 35). The notion of designing-with as a posthumanist design practice was more explicitly conceptualized by Wakkary (2021). Wakkary explains that "exploring a posthumanist design is to explore what it means to design-with; that is to design with humans and nonhumans in ways that are fundamentally expansive and relational" (p. 15). Wakkary describes this practice as "a critical and creative speculation that interweaves design with posthuman thinking" (p. 5). It is a way "to rethink design in ways that humans and nonhumans are bound together materially, ethically, and existentially" (p. 234).

Designing-with can be conceptualized in various ways in relation to more-than-human design. It may be viewed as a broader concept encompassing more-than-human design, or as an integral component of it. In this dissertation, designing-with is a term used to describe more-than-human design practices that align with the critical posthumanities. In other words, *designing-with is a posthumanist design practice that consciously acknowledges and engages with the agency of, and co-constitutive relations between, humans and nonhumans, while paying especial attention to subjectivity, power imbalances, and situated knowledges*. An example of how this notion is applied in this research is by taking a posthumanist approach when designing the interactions of conversational agents, which resulted in an expanded approach that includes both humans and other species, as well as different types of conversations, including silences. In this example, designing-with AI refers not just to how designers could include AI in their processes but how could they do that while also reflecting on the agencies at play and the knowledge that is being produced, and how the way they are designed intersects with issues of power.

3. Methodological and epistemological approach

The last section explained why it is important to develop a more-than-human practice in AI and set the intention of exploring what a practice of designing-with could be like. This section shifts the focus to how this exploration is approached. While the last section remained neutral, this section adopts a more personal perspective. Here, I interject my voice to elucidate the specific methods I have chosen and delve into the epistemological commitments underpinning my approach.

3.1. Design research

Overall, my research builds upon the design tradition of RTD, which emphasizes the importance of the design activities, skills, and processes in producing both theoretical and practical knowledge. Initially proposed by Christopher Frayling (1993), RTD describes one way in which the relations between design and research can be formulated. While *research into design* is about studying design from the outside; and *research for design* is about gathering data to support the design process, *research through design* is using the process of designing to understand the world in and outside of design. Nowadays, RTD is not a homogeneous category and there has been a significant variety in how it was conceptualized and practiced. However, there are also shared concerns and strategies, and a number of foundational issues and challenges across the different approaches (Redström, 2017). Aligned with Stappers and Giaccardi (2017), I use RTD to refer to an iterative research practice in which design activities and outcomes are used to question, probe, and challenge existing norms and assumptions, leading to new perspectives and understandings.

Aligned with the RTD tradition, an integral component of my practice revolves around designing things (Fig. 2). I view these artifacts not only as outcomes of research but also as vehicles for knowledge production. Creating things is a means for me to contextualize complex issues within everyday life and guide the direction of my research. Constructing artifacts enables me to get new perspectives and facilitate sharing this knowledge with others. Presenting tangible artifacts often sparks in-depth discussions about a topic. More specifically, my design research practice is emergent (Gaver et al., 2022). That means that not only research questions unfold as I learn during my projects, but also the methods and tactics, and even the research goals drift (Krogh & Koskinen, 2020). The work is also experimental (Erlhoff & Jonas, 2018), as it includes diverse formats that are not typical design activities. It also includes alternative outputs that extend beyond traditional academic articles (Yoo et al., 2023). The knowledge generated by my research is positioned as *intermediate-level knowledge*, more generalized than individual instances, yet serving a different role and having a different reach compared to abstract theories (Höök and Löwgren, 2012).

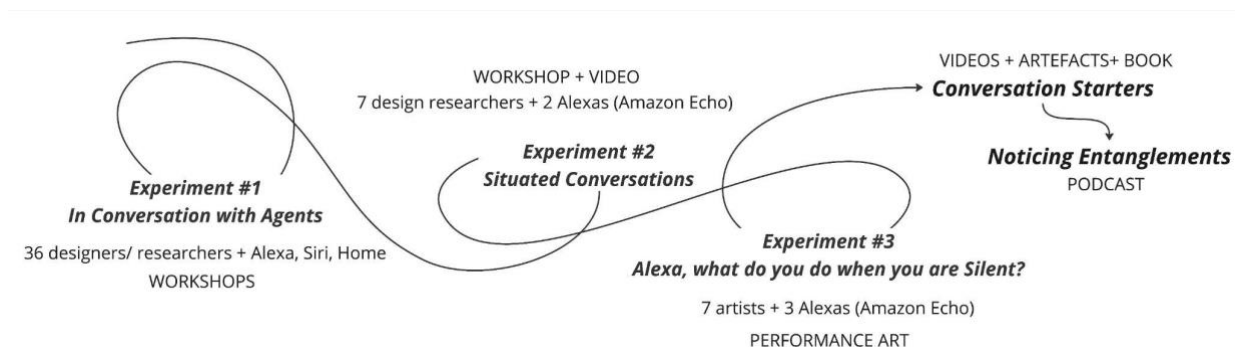


Figure 2. Diagram of the different experiments I conducted during the PhD studies.

A big part of my research is developed through workshops (Fig. 3). While workshops have always been sites of knowledge production in design, they can go beyond fulfilling participants' expectations to achieve something related to their own interests, and instead support the development of collaborative design programs (Rosner et al., 2016; Ørngreen & Levinsen, 2017). Workshops are also excellent sites for questioning the way we 'do' design and explore alternatives (Key et al., 2022; Søndergaard & Campo Woytuk, 2023). Key and colleagues

(2022) describe their workshop's outcomes as "dialogic accounts to examine the situated ethico-political underpinnings of designs, design practices, and designer/researcher positionality in an attempt to learn and unlearn together" (p. 680). Aligned with those inquiries and expanding them to the participation of nonhumans, the workshops I organize aim at bringing together the unique practices, knowledge, concerns, and dilemmas of each participant, human and nonhuman.



Figure 3. Website developed for the workshop at the Designing Interactive Systems (DIS) conference in 2020.

3.2. Design programs

To structure my inquiry and make sense of the knowledge that I produce through design, I use a programmatic approach (Redström, 2017) (Fig. 4). This plural and transitional approach pays special attention to the relation between practice and foundational knowledge in design research. Programs are more open-ended than projects and include specific practical and epistemological commitments that guide and support certain ways of doing (and thinking) design. Thus, they typically include perspectives, propositions, or ideals that foreground a particular worldview of designing. They are, in many ways, meant to support prototypes of (at least partially) new design practices. Unlike static disciplinary foundations, programs guide designers' actions and thinking while allowing for concurrent and competing perspectives. Within a programmatic approach, design activities can be framed as experiments, which form an overarching arch. Experiments can be activities, such as making prototypes or organizing a workshop. Unlike experiments in a science lab or in traditional design (usability) studies, they do not have fixed variables and constrained contexts and are not meant to provide hard evidence in the traditional sense of the word. Instead, their purpose is to reframe the problem, position the inquiry, and expand the design space (Redström, 2011). Furthermore, experiments can simultaneously initiate, drive, and frame the research. They can also consolidate and assist in positioning and contextualizing the research program by demonstrating its main claims. Moreover, experiments can also open up novel design spaces and show potential ways to explore them (Stappers & Giaccardi, 2017).

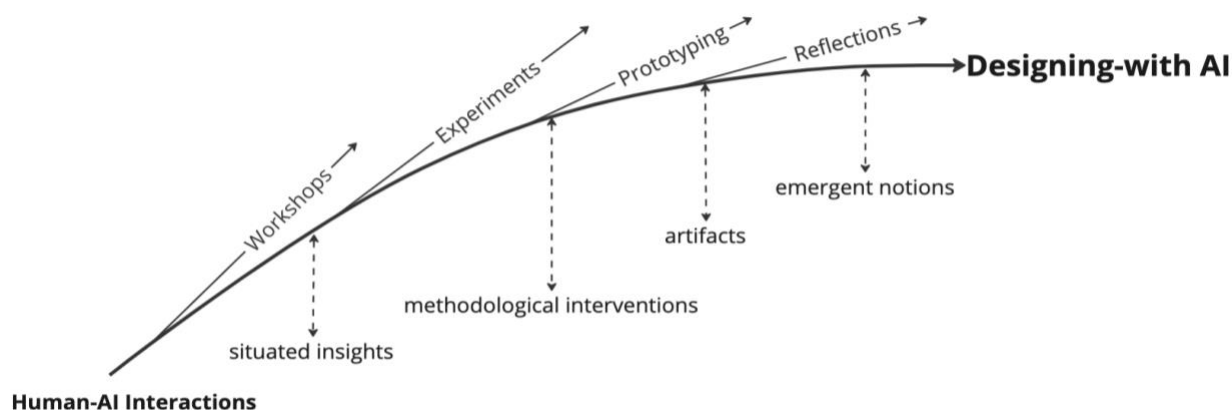


Figure 4. Diagram of my design research process following the programmatic approach. Different experiments shape the arch, define the space of exploration, and provide foundational knowledge.

3.3. Methodology

The dissertation builds upon and combines different design methods. Before presenting them, it is important to clarify what I mean by 'methods' here because this word carries different meanings in different disciplines, as well as in different subdisciplines of design. Using this word, I am not implying a systematic inquiry but a set of activities that can be useful in (and adapted to) particular instances of design processes (Redström, 2017), thus "not only tools to be applied in practice but also fluid and changing components" (Göransdotter et al., 2023).

Methodologically, the activities conducted during the PhD are largely inspired by design fiction (Coulton et al., 2017) and fabulation (Rosner, 2020; Søndergaard et al., 2023). Generally, these approaches open up spaces for discussion (Hales, 2013), trouble collective imaginings (Søndergaard & Hansen, 2018) and bring into focus certain matters of concern (Bleecker, 2009). Like other discursive design practices (Tharp & Tharp, 2018), design fiction techniques often use artifacts as instruments to sustain complex or competing perspectives and values, which is the case, for example in counterfunctional devices (Pierce & Paulos, 2015) and material speculations (Wakkary et al., 2015). Design fiction and fabulation guide me in making prototypes but are also key in designing the activities for workshops.

The dissertation integrates design fiction with more-than-human design methods. While this combination presents challenges—such as the narrow perception of speculation in relation to critiques and futures—these methods are promising as they facilitate the exploration of non-anthropocentric ways of thinking (Wakkary and Oogjes, 2024). In fact, some integration of design fiction techniques with non-anthropocentric approaches has already been employed, enabling designers to reflect on the entangled nature of agency (Lupetti et al., 2018) and to emphasize feminist commitments (Søndergaard et al., 2023).

More specifically, the dissertation builds on and expands the more-than-human techniques of Thing Ethnography (Giaccardi et al., 2016), Noticing (Biggs et al., 2021; Liu et al., 2018; Oogjes & Wakkary, 2022) and Interviews with Things (Chang et al., 2017). Thing Ethnography supports accessing perspectives that are hidden from human experience, with the goal of revealing the ecosystems and relations around things (Giaccardi et al., 2016). Noticing supports attuning to nonhumans and looking beyond progress narratives to engage in alternative ways of knowing (Liu et al., 2018). Interviews with Things supports interpreting the data collected from the perspective of a thing emphasizing particular contexts and qualities of a thing's experience and its social life (Chang et al., 2017). Inspired by these methods, I developed two techniques: 'Conversations with Agents,' which building upon Interviews with Things, invites designers and researchers to enact agents, enabling introspection into the researchers' subjectivity, positionality, and biases. The other technique is 'Noticing Entanglements,' which combines noticing with exercises of deep listening (Gann, 2010) and decolonial listening (Zoë Dankert, 2018).

3.4. Epistemology

This dissertation takes a posthumanist commitment to knowledge production (Wakkary, 2021). Within that commitment, I consider the knowledge produced during this research as situated, nomadic, unfolding, and fluid. When I say situated, I signal a commitment to situated knowledge(s) (Haraway, 1988). Their main argument is that knowledge is always produced from a particular perspective and is shaped by the social, cultural, and political contexts in which it is produced and used. When I say nomadic, I align with Wakkary's (2020) work on nomadic practices, a theory for structuring design that sees knowledge as situated, multiple, and partial. When I say unfolding and fluid, I am aligned with Redström's (2017) understanding of design theory as continually evolving – as a process that is as much enacted as it is articulated, inherently fluid. I am also aligned with Goodman's (2013) understanding of design practice as enacted; as inherently contingent and transformative, incorporating both the actions and tools of design, as well as the roles, abilities, and identities of both humans and nonhumans in the process.

I am particularly inspired by the idea that design theory can be *made* in and *through* design (Redström, 2017). Specifically, the dissertation engages with the relations and tensions between theory and practice, drawing

from a rich tradition within design scholarship that delves into that interplay. Among these efforts, Donald Schön (1984) notably challenged the conventional notion that professional knowledge primarily stems from scientific research and theoretical development, proposing instead that practitioners generate knowledge through active engagement in practice. More recently, Redström (2017) outlined three tactics that designers use to engage with the interplay between theory and design practice: parallels, which is about acknowledging the theory/practice divide and building bridges across them; sequencing, which intentionally bridges them together and lets one influence the other in fundamental ways; and intermediaries, which similar to intermediate level knowledge (Höök & Löwgren, 2012), lies between the general and the particular. Taking posthumanist commitments, this dissertation extends the tactic of 'intermediaries' to consider more fluid relations between theory and practice (Barad, 2012). The focus here is not on understanding how to bridge the theory/practice gap, but rather on how to open up a design space between the two (Fig. 5).

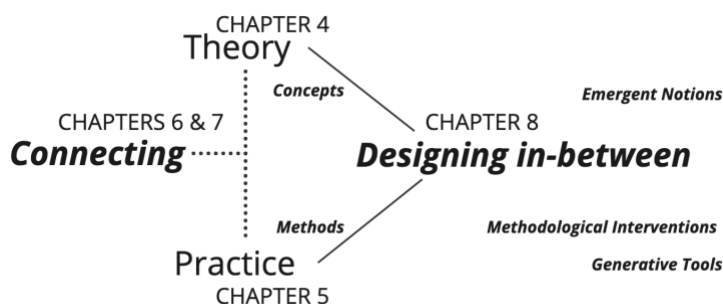


Figure 5. Diagram of the chapters and their relation to theory and practice. While Chapter 6 and 7 aim to connect posthumanist theory with more-than-human practices, Chapter 8 aims to explore the rich space in between the two, trying to blur the boundaries.

3.5. Positionality

In concluding this chapter, I find it crucial to acknowledge my positionality in this inquiry. As Haraway (2016) eloquently articulated: "It matters what matters we use to think other matters with; it matters what stories we tell to tell other stories with; it matters what knots knot knots, what thoughts think thoughts, what descriptions describe descriptions, what ties tie ties. It matters what stories make worlds, what worlds make stories." With this, Haraway stresses that it is essential to critically examine the tools and narratives we use because they profoundly influence how we perceive and understand the world. In what follows, I will attempt to describe my world of design research and how it is not idiosyncratic but intentionally grounded within particular interests, places, and stories.

I will start by saying that my position is not easy to describe, as my identity and practice embody some tensions. One of the key tensions is that while I live and work in Europe, I was raised in South America. Another key tension is that while I am now working with theory or textual forms of knowledge, I was trained as a designer. These tensions demand reconciling epistemologies from practice and theory, and epistemologies from the North and the South. If this dissertation is an exercise of thinking-with others, I think with many feminist and critical posthuman theorists: with Haraway, Barad, Bellacasa, and Tsing. I also think with many design researchers; with Forlano, Wakkary, Giaccardi, Redström, and others. My motivation when doing that is not to re-interpret their work, but to explore its resonance in the context where I use it, what Bellacasa (2012) calls a *speculative reading*. Similarly, this dissertation is also an exercise of making-with. A big part of this research emerged in conversations with others. These collaborations include co-writing articles, working with students and professional designers, and organizing events like workshops and panel discussions. Reconciling different epistemologies, the dissertation is an exercise of *sentipensar* (feel-think), a concept from Arturo Escobar (2020), which reflects that feeling and thinking are deeply interconnected.

Thinking with the South, I acknowledge that many of the ideas and materials in my research have different histories, and sometimes also a different ontologies beyond the European context, where my work is currently positioned. For instance, while significant parts of this dissertation advocate for designers to attend to relations,

this idea is not new for indigenous cultures in South America. For example, in the cosmovision of the Pachamama, there is a deeply relational understanding of life. Furthermore, a rethinking AI of would probably be less original when thinking from the South because working from the margins is always thinking otherwise. Rethinking AI from the South might be what Bellacasa (2012) calls dissenting-within, because a big part of the making of AI happens in South America, as it is the home to one of the largest shares of the world's salt-lake lithium resources. Lithium is an expensive component used in the batteries of mobile phones, as well as electric car batteries, wind turbines, solar panels, and computers. Situating this process is important because while my research engages with AI in a relatively abstract way, for many people in the South, AI has more immediate material consequences. It also implicates their presents and futures in ways that are very different from mine.

As my identity and my positionality reconcile different geopolitics, my practice also brings into conversation different positions within the field. The notions I use do not belong to one particular framework. Many of the terms I used could be interchanged with other notions proposed to describe similar ideas. Sometimes, these notions resonated with my practice, and I was able to engage with them. Other times, I chose to use my own words to describe them. However, the choice of words is, for me, a careful process. As I craft things, I also craft the words to describe them. I am deeply inspired by the writing style and choice of words of many of the feminist texts I have come across. I especially like how these texts mimic the world they are trying to describe. For example, in "The Mushroom at the End of the World" Anna Tsing (2015) describes the book as composed of a riot of short chapters [...] like the flushes of mushrooms that come up after the rain" (p. viii). The chapters build an "open-ended assemblage, not a logical machine. They tangle with and interrupt each other" (ibid). Similarly to how Tsing sees her book, I have assembled the dissertation to reflect a conversation between multiple perspectives and positions.

In the following chapters, the reader will find a multitude of ways of addressing the research questions. Since most of the chapters are published articles, they are also independent and situated pieces. That means that they frame the research in their own unique way. While these contributions are cohesive, they are not pieces of a clear puzzle, nor they are organized as a number of studies. Instead, they are diverse experiments, each approaching the research question from a different angle. Ultimately, I hope the diffractive character of the following chapters can illuminate multiple paths and allow multiple entry points and ways of reading that are unfolding, plural, and expansive.

Part II

4. Situating AI: More-than-human design strategies

This chapter is based on a published paper:

Nicenboim, I., Giaccardi, E., Redström, J., (2022). From explanations to shared understandings of AI. In *Proceedings of the Design Research Society (DRS'22)*.

So far, the dissertation has outlined the motivation, background, and methodological approach of the research. This chapter starts to integrate these elements, adopting a more-than-human design approach for reorienting the design of AI. To streamline the narrative, certain sections of the paper upon this chapter is based, have been edited. For example, the review of more-than-human design, which appears in the original paper has been omitted to prevent redundancy. Some diagrams have been added too, which were produced for the presentation of the paper at the DRS conference.

It is worth noting a shift in voice here. The third person is employed because the chapter was collaboratively authored with Elisa Giaccardi and Johan Redström. Initially, we provide a review of the relevant literature on AI and focus on a particular challenge within that field: how to make the decisions of AI applications understandable for people using them –what is called Explainability. By challenging the assumptions underpinning the premise of explaining AI, and by asking 'what is explained and for whom?', we reorient the challenge to 'shared understandings.' This perspective highlights that understandings are constructed in the relations between people and AI. With this foundation, we define the aim of situating AI as an effort to acknowledge the positionality of individuals affected by AI, the designers shaping AI, and the agents generating knowledge with specific worldviews. Finally, we propose two design strategies to support designers in situating interactions with AI.

4.1. Reorienting AI through more-than-human design

From everyday services to critical domains, AI is used to make decisions that profoundly affect people's lives. However, since many machine learning techniques are not interpretable, one of the biggest challenges in designing AI is to be able to explain those decisions. To tackle this problem, researchers, governments, activists, and companies have advocated for making AI more explainable (Barredo Arrieta et al., 2020). While researchers have found ways to make AI models somehow interpretable for developers, how to explain AI decisions to a broader range of people, including everyday users and people affected by AI decisions who are not direct users, remains a significant challenge (Vera Liao et al., 2020). Technical explanations can be useful for developers, but they are not a good fit for a broader range of people (Mittelstadt et al., 2018). One simple reason is that people affected by the decisions of an AI system might be less concerned with how that model works in a technical sense, and instead, might want to know if they could trust the decisions the model produced. Thus, designers need to find alternative ways to support people in making sense of AI that go beyond technical explanations.

Supporting people in making sense of technologies, in contrast to showing how technologies simply work, has been a concern of designers for quite some time. In the case of graphical user interfaces, for example, there are considerable differences between how files, folders, and functions are presented and how a computer stores data. However, given the complexity of infrastructures behind AI systems, and how these systems 'model the world' and change over time, situated understandings of AI might have to differ considerably from strictly technical explanations. We argue that in order for designers to address the challenge of making AI decisions understandable to a broad range of people, designers first need to position explanations in everyday contexts and within interactions of people and intelligent agents. This requires designers to address how understandings may originate from people's everyday experiences when interacting with AI, and to give an active role to users and artificial agents in the process of building shared understandings. By adopting a more-than-human design orientation, we propose to consider explanations within ongoing relations of humans and artificial agents, in which both people and artificial agents are active participants in building understandings.

The field of Explainable AI (XAI) has become a growing area of interdisciplinary research, one concerned with

enabling human users to understand, appropriately trust, and effectively manage AI decisions (Turek, 2020) (Fig. 6). A key obstacle in this domain is the tension between the ambition of XAI to provide explanations to all users, and the current state-of-the-art which focuses on explanations mostly for experts (Abdul et al., 2018; Barredo Arrieta et al., 2020; Mittelstadt et al., 2018). To address this gap, there are calls for expanding XAI by integrating and developing methods together with research from other fields, such as social and cognitive sciences (Miller, 2019; Mittelstadt et al., 2018), and interaction design (Abdul et al., 2018).

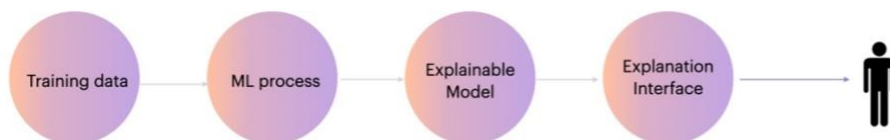


Figure 6. A diagram of the Explainable AI (XAI) process (Turek, 2020)

Design approaches to XAI include a range of human-centered design frameworks and tactics. Among them, scenario-based XAI (Andres et al., 2020), user's trust (Weitz et al., 2019), usability guidelines for explainable interfaces (Amershi et al., 2019), and tangible and embodied interactions (Ghajargar et al., 2021). These approaches are now organized around the community of human-centered XAI (HCXAI) (Ehsan et al., 2022). Scholars in HCXAI have called for a shift from algorithm-centered XAI to socially-situated XAI. Their research has shown that existing work on opening the black-box of AI does not properly address how to design explainable AI for different user groups and how to make explanations actionable. The more inclusive and empowering approach of HCXAI has highlighted the importance of investigating Explainability in relation to user's background (Ehsan & Riedl, 2020) and user's experiences (Vera Liao et al., 2020).

To complement these efforts and to respond to the call of situating XAI, we adopt a more-than-human design approach. It can help designers to better understand why technical explanations might not be enough. Explaining AI as if it was a mere tool would not be effective (Kuijjer & Giaccardi, 2018; Redström & Wiltse, 2018). For example, when explaining why a digital assistant (such as Amazon Echo) responds better to certain voices than others, we might fall short if we overlook the possible biases that are amplified by the training data set, and the gendered stereotypes that these devices perpetuate (Strengers & Kennedy, 2020). Explaining interactions with AI agents as simple tools might lead to unethical designs, because it masks the sort of delegations that are in place when interacting with smart systems (De Mul, 2010), and the implications that that might have in people's lives (Giaccardi, Speed, et al., 2016). As a relational approach, more-than-human design can help to address some of these issues by positioning explanations within ongoing relations between human and artificial agencies.

In XAI research, authors have highlighted the central importance of the notion of understanding, and how that differs from the notion of explanation (for a summary see Langer, 2021). Among these scholars, Páez (2019) investigates the relationship between explanation and understanding in the context of opaque machine learning models. Páez proposes to differentiate explanation and understanding as a way to open up new avenues of research that can lead to better grasping the workings and decisions of opaque AI models. The reason for this call is that, unlike explanation, understanding can include other paths (e.g., models, simulations, or experiments) which do not need to be accurate representations of a phenomenon, as long as they are useful for organizing human experience.

To unpack the shift from explanations to understandings for the design of AI, we argue that it is important to review the epistemological commitments underpinning the very premise that AI should be explained. This is crucial to make AI understandable for a wide range of people because the premise of explaining AI might fundamentally assume a passive role for people (and AI agents) by privileging the perspective of the ones building the system over the ones affected by it. So, the question is, what is really assumed in the premise of explaining AI? In order to consider that question, we first need to unpack the logic on which the call for explaining AI rests. When articulating the limitations of transparency in AI, Ananny and Crawford (2018) argue

that no model of accountability can avoid the questions of “accountable for what?” and “accountable to whom?”. Following this argument, we review some of the epistemological commitments that currently underpin the idea of explaining AI. In the next section, we unpack some seemingly hidden assumptions in relation to ‘what’ is explained and to ‘whom’ (Fig. 7).



Figure 7. The questions that guide the process of reviewing the assumptions that underpin the idea of explaining AI.

Let us begin by asking to what extent it is reasonable to assume that explanations need to be explicitly causal, factual, and simple. In the principle of explaining AI there is a basic assumption that explanations are strictly the ones that can state the cause of a phenomenon, i.e., that understanding AI systems is to know what decisions were made and why. This idea is based on a historical connection between explanations and causes, beginning with Aristotle and continuing with the defenders of causal explanations, who have argued that understanding cause implies knowledge (Páez, 2019). However, causal knowledge does not come exclusively from explanation. On the other hand, there are other methods, such as experimentation, which are not explicitly causal but can be useful to understand AI systems. For example, direct manipulation, such as adjusting a lever and observing its effects on other parts of a system, is a way of understanding how a system works. Further, manipulating a system into a new desired state is a sign of understanding which requires the ability to think counterfactually (Páez, 2019).

Another assumption is related to the factual character of explanations, i.e., to think that the more facts revealed about a phenomenon, the more it will be understood. This is because factivity is an essential feature of explanations in science. However, finding a complete technical explanation (in the traditional sense) of AI models is impossible, as most of them are designed as black-boxes (Páez, 2019). Furthermore, even if we could ‘look inside’ deep-learning models, we would not be able to understand them beyond a temporal constraint, because AI systems are constantly changing and evolving.

Interaction design has developed approaches to support understanding computational systems in ways that go beyond, or circumvent, technical types of explanations. One prominent example is the desktop metaphor as used in a typical graphical user interface (GUI). But since AI systems constantly change and evolve by learning through interaction with people, we cannot precisely define, nor completely determine, what that understanding needs to be like, and then build an interface on that definition. Even if we could explain the source code, training data set, and testing data that helped build those agents, this would describe only some particular aspects of it. Such snapshots of a system tell us little about its logic, like how it will respond in the future, and how it will change in relation to new data.

Finally, there is an assumption that the simpler the explanations the better. The vast majority of work in XAI is based on creating simplified approximations of complex decision-making functions (Mittelstadt et al., 2018). These are useful for developers, both for pedagogical purposes and for making reliable predictions of how the system might behave over a restricted domain. However, they can be misleading when presented as an explanation of how the model functions to everyday users and people affected by AI decisions. Mittelstadt and colleagues (2018) argue that the simplified approximations resemble more scientific models than everyday explanations, which are contrastive, selective, and social. Thus, along with other scholars, they point to the

importance of supporting debate and contestation of AI decisions as productive strategies to achieve understandings.

Given the issues raised above, we also need to question for whom, and by whom, such explanations are made. The depiction of a neutral user in various XAI diagrams is based on the logic that users can be generalized and understood as single and neutral. This model assumes that the AI system, or the developers who built it, are the ones that deliver knowledge, while users are just recipients of it. It also assumes that general explanations can fit all users independently of their identity and position in the world. This tends to obscure the fact that not everyone can, or will, interpret information in the same way. Furthermore, it simply ignores that many people use AI systems indirectly (Aizenberg & van den Hoven, 2020), and therefore have no access to such information.

What is implicitly assumed in the aim of explaining AI is that the ways in which end-users understand AI are less accurate than the experts who build it (Adam, 1993). While this may be the case for technical explanations, it is in contrast to the 'standpoint' type of knowledge of much research in design, where the implicated subject is considered as the expert of their own domain (Suchman, 2006). Privileging the perspective of those who design and build the systems over alternative views poses the risk of reinforcing implicit biases and preserving socially legitimated knowledge and offers limited scope to consider alternative understandings (Adam, 2000).

4.2. Towards situated understandings of AI

As discussed above, traditional explanations might not be the only or most effective way to support people in understanding artificial agents in everyday life. Moreover, traditional explanations might not be inclusive enough, because they cannot account for the multiple people implicated by AI, and the fact that not everyone can understand the workings of a system or its significance in the same way. So, what could be a more inclusive alternative? In order to explore this alternative, we conceptualize a shift from explanations to situated understandings of AI.

When looking at 'who are the explanations for' and 'how is that knowledge produced,' there seems to be a need for addressing understandings in plural. It seems that there is no single explanation that could fit all, but that there is a need to design for the possibility of multiple understanding(s) to be produced within ongoing relations between situated users and artificial agents. Indeed, with respect to these systems fulfilling their intended roles, the multiple ways people implicated by AI may come to understand what such systems are and what they do as part of everyday life is no less critical or legitimate than supporting the experts that have built, or oversee, the systems. To unpack the idea of situated understandings and find new spaces for designing more understandable AI systems, we draw upon work done at intersections between information technology and other areas such as science and technology studies, philosophy, and posthumanist and feminist theory.

In her studies of situated action, ethnomethodologist Lucy Suchman (1987) argues that the understanding that arises from interaction with technology should always be regarded as a practice of knowledge production: "The coherence of situated action is tied in essential ways [...] to local interactions contingent on the actor's particular circumstances. A consequence of action's situated nature is that communication must incorporate both a sensitivity to local circumstances and resources for the remedy of troubles in understanding that inevitably arise" (Suchman, 1987, pp. 27–28).

As argued by political philosopher Hannah Arendt (Arendt, 1994), understanding something is a dynamic process: "Understanding, as distinguished from having correct information and scientific knowledge, is a complicated process which never produces unequivocal results. It is an unending activity by which, in constant change and variation, we come to terms with and reconcile ourselves to reality, that is, try to be at home in the world" (p. 307).

With respect to articulating situated understandings, Donna Haraway's work is central. Haraway (1988) describes knowledge as always situated--that is, produced by positioned actors working up/on/through all kinds of relation(ship)s. What is known, and how it can be known, are both subject to the position of the knower, i.e., their situation and perspective. This points to a more-than-human epistemology, according to which

multiple understandings need to be situated within contexts and shared by agents (humans and nonhumans) that are always differently positioned and in different relation(ship)s to each other.

When thinking about situated understandings of AI from a more-than-human design orientation, we can start considering the agential role that both people and artificial agents play in situated practices of knowledge production. Thus, it seems important not only to account for the positionality of the people implicated by AI, but also the positionality of the agents. This trajectory suggests that instead of technical explanations, users could benefit from understanding who owns the infrastructures behind the devices they use, and what their limitations are. Thus, we see situated understandings as the ones that can expose the different dimensions of artificial agents, from their identities and worldviews, to the larger infrastructures in which they are embedded.

4.3. Design strategies to support situated AI

In this section, we discuss some implications that the shift from explanations to shared understandings might have for designing more-than-human interactions with AI. While in the first sections we have described a conceptual shift, in this section we focus on two design strategies, as possible ways to expand the scope of explanations. The unpacking of these strategies is supported by examples of speculative work in art and design aimed at creating tension and calling out the hidden complexity of AI (e.g., the infrastructures, positionality, and limitations of artificial agents), which the premise of explaining AI is currently not accounting for.

4.3.1. Looking across AI

As discussed in the previous sections, positioning understandings as part of broader socio-technical systems brings to the front that we need to move past the idea of a neutral user, and instead try to paint a more diverse and inclusive picture of the different actors implicated by AI. Thus, to make AI more understandable, designers could try to account for the multiple agencies (humans and nonhumans alike) that are part of making a particular interaction with AI.

Ananny and Crawford (2018) describe this socio-technical approach as “looking across the AI system” instead of looking inside. They ask: ‘What is being looked at, what good comes from seeing it, and what are we not able to see?’ (p. 13). Those questions are visualized in the “Anatomy of an AI system” (Crawford and Joler, 2018). The map visualizes what we are not able to see when we interact with an Amazon Echo, namely the extractive processes of material resources, human labor, and data that are required to build and operate it. In a similar map called “Architectures of choice”, Marenko and Benque (2019) use diagrams to trace recommendations on YouTube as experiments to explore what new understandings are created. They foreground relations and paths to build a mode of knowledge-making that is situated, incomplete, and speculative.

These maps bring to light new questions for designing AI agents. How can we design explanations that situate not only users but also agents? For example, how might interacting with Amazon Echo reveal its ecosystem, biases, beliefs, and worldviews? Can we image different interactions with conversational agents if instead of ‘closed’ products we allowed users to intervene in different parts of this map (e.g., training the algorithm)? What if instead of ad-hoc explanations, agents could rely on local contexts to develop shared and situated understandings together with their owners?

4.3.2. Exposing AI failures

Mapping the entangled relations of AI systems means also making visible its boundaries. In the Nooscope map, Joler and Pasquinelli (2020) created a diagram of Machine Learning errors, biases, and limitations. They describe their project as a cartography of the limits of AI, to illustrate not only how AI works but also how it fails. In this section, we try to articulate some benefits that exposing AI’s limitations might reveal for users and designers. We ask: What kind of understanding can be developed by exposing what is hidden? What could be the value of such friction for users?

Knowing the limitations of an AI system seems crucial for understanding it, since users can adjust expectations

and calibrate their trust (Luger & Sellen, 2016). In fact, making clear what a system can do (and how well) are among the first principles identified by Amershi and colleagues in the Guidelines for human-AI interaction (2019). The first guideline, G1, emphasizes the importance of clearly communicating the capabilities of the AI system to users. This involves providing information about the tasks or functions the system can perform and how it accomplishes them. For instance, an activity tracker might display various metrics it tracks, such as steps taken and calories burned, along with explanations of how it collects this data. The second guideline, G2, focuses on providing transparency regarding the system's performance reliability. Users should be informed about the frequency or likelihood of errors made by the AI system. For example, a music recommender might use hedging language like "we think you'll like" to convey uncertainty about its recommendations (Fig. 8).

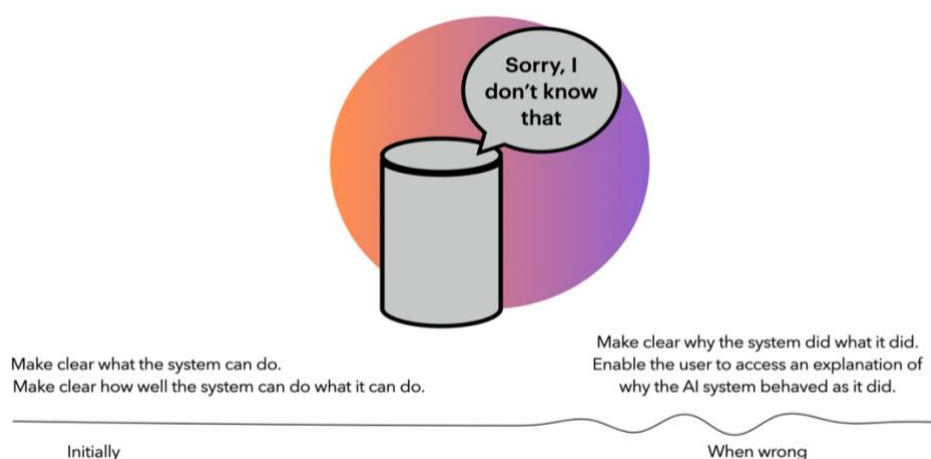


Figure 8. My interpretation of the two first points in the "Guidelines for human-AI interaction" (Amershi et al., 2019).

Technologies running into their limits can be found also in science fiction, for example, in Isaac Asimov's series 'I Robot' or the popular series Black Mirror. But failures can do more than just motivate users to seek explanations. Beyond exposing the frictions of AI, breakdowns in the interaction with agents could be a way to move closer to shared understandings, because when artificial agents fail in everyday interactions, both humans and agents need to be actively involved in repairing practices.

Empirical studies with conversational agents have shown that people actively try to repair breakdowns by using different strategies, such as modifying the words and the tone of voice they use (Luger & Sellen, 2016; Sciuto et al., 2018). People take an even more active role in relation to artificial agents when testing their limits to understand their capabilities and probing how 'intelligent' the agent is (Druga et al., 2017; Pelikan & Broth, 2016; Porcheron et al., 2018). For example, common strategies to test conversational agents involve using convoluted sentences (such as when asking about the weather using unusual expressions) to see if the agent can handle them. How could the design of artificial agents support this kind of experimentation?

4.3.3. Illuminating strategies through design examples

As a design strategy, 'looking across AI' is an invitation for designers to see AI as a socio-technical system. This shifts the role of design from masking the complexity of AI systems in seamless interactions to exposing that complexity by revealing the infrastructures and tensions that are part of it. For example, Desjardins and colleagues (2021) used interdisciplinary performance to critically examine conversational agents, from what is physically hidden inside the speakers, to the hidden labor and the surveillance practices that are behind them. In the design exploration "AYA" and "U", Juul Søndergaard and Hansen (2018) explored different ways a voice assistant may push back on sexual harassment using design fiction tactics to reveal issues of trust, gender and algorithmic bias. In the performance called "Lauren", McCarthy (2018) installed a series of networked smart devices in people's homes and remotely watched over them, to reveal issues of surveillance, decision making, and privacy. In "The sound of speech as it echoes in the cloud," the collective Tropozone (2020) exposed the frictions of the ecological emergency through a network of voice assistants that are geographically distributed, inviting people to reroute their attention to the overlooked, the unfamiliar, and the forgotten.

From a more-than-human design orientation, 'looking across AI' is a strategy that invites designers to think that AI systems do not only contain complexity but enact complexity, by "connecting to and intertwining with assemblages of humans and nonhumans" (Ananny and Crawford, 2018, p. 2). Thus, looking across AI involves accounting for the situated encounters that different humans and nonhumans agencies have when they relate to each other.

An example of an inquiry into the agencies involved in human-AI interactions was explored in a series of design workshops held at the RTD conference in 2019 (Fig. 9) and the Designing Interactive Systems (DIS) conference in 2020 (Fig. 10). In the workshop 'Encountering ethics through design,' Reddy and colleagues (2020) have invited participants to co-speculate with intelligent things, by enacting things in different scenarios, giving them an active role in their interactions. In doing so, the workshop helped to consider autonomous behavior not as a simplistic exercise of anthropomorphizing, but within the more significant ecosystems of relations, practices, and values in which intelligent things are involved and through which they are encountered. In the DIS workshop 'More-than-human Design and AI,' Nicenboim and colleagues (2020) used speculative interviews to interrogate conversational agents. Their inquiry addressed issues of biases, ownership, and responsibility within conversations, along three dimensions, i.e., how agents present themselves to humans; what relations and ecologies they create within the contexts in which humans use them; and what infrastructures they need. By looking across AI these workshops have highlighted that the decisions AI agents make are both part of complex infrastructures, and yet situated in intimate encounters in people's homes.



Figure 9. Workshop at the Research Through Design (RTD) conference in 2019.

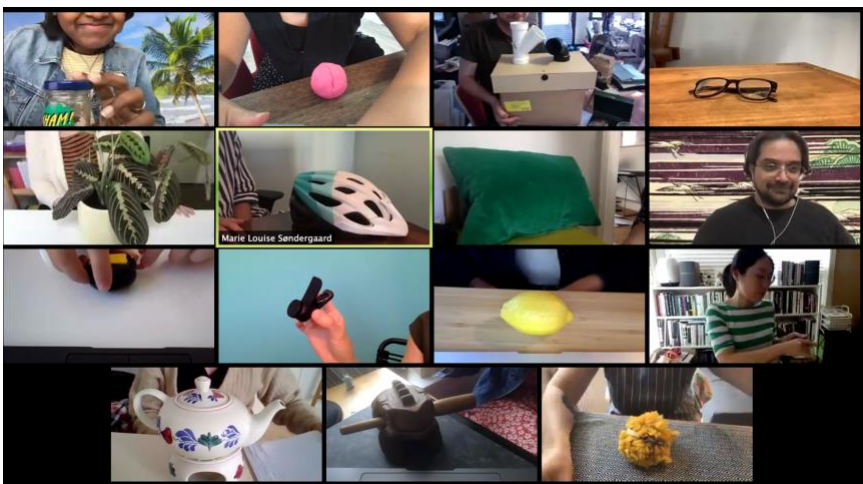


Figure 10. Workshop at the Designing Interactive Systems (DIS) conference in 2020.

As a design strategy, exposing AI failures offers a tangible way to provoke frictions in the everyday encounters between people and AI and to probe how people could have an active role in trying to understand AI. In other

words, exposing failures provokes situations where understandings can be co-constructed within ongoing relations between people and AI. For example, in 'Project alias,' Karmann and Knudsen (2018) designed a parasite that feeds smart speakers with white noise while allowing users to train custom wake-up names. In 'Autonomous trap 001,' James Bridle (2017) challenged self-driving cars which rely on machine vision, by drawing a circle to trap the vehicle inside. In the projects 'Objects that withdraw' (Fig. 11) and 'Unpredictable things' (Fig. 12), Nicenboim (2017) has explored the limits of object recognition algorithms by creating occlusions using different materials and shapes to modify everyday things until they are not recognizable by machines. In contrast to spontaneously testing the limits of a product for understanding what it can do, these design practices intentionally challenge and obfuscate AI (Brunton et al., 2017) to question conventional approaches to social, ethical, or political issues (Di Salvo, 2012).



Figure 11. "Objects that withdraw" Nicenboim (2017)



Figure 12. "Unpredictable things," Nicenboim (2017)

4.4. Takeaways

The chapter emphasized the active participation of both humans and AI agents in shaping understandings of AI. By unpacking the question 'what is explained and for whom?' we uncovered potential limitations in the current approach to Explainability, particularly in terms of inclusivity. The analysis suggested that the premise of "explaining AI" may unintentionally cast individuals in a passive light, favoring the viewpoints of developers over

those impacted by AI. Taking a relational approach, we argued that there are no single ways of understanding, but multiple. Hence, the challenge of explaining AI was reoriented to situated understandings, in plural. Situating AI was defined as an aim to acknowledge the diverse perspectives of those impacted by AI, the designers shaping it, and the agent's worldview. Based on this framing, two key design strategies —looking across AI and exposing AI failures— were proposed to guide designers in situating AI. Looking across AI involves revealing the complexity of human and nonhuman entanglements and engaging with the intricate web of relations within them. Exposing failures is about making visible the limitations of AI applications in a way that they can help people grasp AI's capabilities and risks.

Key takeaways:

- While technical explanations of AI are essential for developers when they have to keep the accountability of AI systems, they may not be the most appropriate for everyday interactions with AI agents, where people need to grasp the implications and limitations of AI applications.
- Positioning explanations in everyday contexts can help towards the goal of designing understandable AI interactions. This repositioning requires designers to address how understandings may originate from people's everyday experiences when interacting with AI, which gives an active role to users and artificial agents in the process of understanding AI.
- A relational perspective reveals that the current approach to Explainability might be limited when it comes to inclusion. The premise of explaining AI may inadvertently assume a passive role for people and AI agents, privileging developers' perspectives over those affected by AI.
- To help designers in considering diverse user perspectives, there is a need to shift the framing from traditional explanations, which are typically factual, causal, and technical, to situated understandings, which are relational and dynamic.
- A more-than-human design lens to Explainability considers both people and artificial agents as active participants in creating understandings (in the plural). It shifts from traditional explanations to situated understandings.
- The strategies of Looking across AI and Exposing AI's failures can support designers in the aim of making the interactions of AI applications more situated.

This chapter highlighted the importance of situating AI. The following chapter will explore how this can be achieved through design experiments. It responds to the question 'How can we situate AI interactions?,' by engaging in performance art, kite-making, prototyping, making a podcast, and others.

5. Designing situated AI: More-than-human design experiments

This chapter is based on the published papers:

Nicenboim, I., Giaccardi, E., Søndergaard, M. L. J., Reddy, A. V., Strengers, Y., Pierce, J., Redström, J., (2020). More-than-human design and AI: in conversation with agents. In the *Companion Publication of the 2020 ACM Designing Interactive Systems Conference (DIS'20)*.

Nicenboim, I., Giaccardi, E., Redström, J., (2023). Designing more-than-human AI: Experiments on situated conversations and silences. In *diid Disegno Industriale Industrial Design*, Bologna University Press.

Nicenboim, I., Venkat, S., Rustad, N. L., Vardanyan, D., Giaccardi, E., Redström, J., (2023). Conversation Starters: How Can We Misunderstand AI Better? In *Extended Abstracts of the 2023 CHI Conference on Human Factors in Computing Systems (CHI'23)*.

This chapter builds upon many insights and inquiries raised in the preceding chapter. Firstly, it leverages the two strategies—Looking across AI and Exposing AI failures—to design situated conversational agents. Secondly, it follows up on some opportunities recognized in the preceding chapter. For example, acknowledging that conversational agents could serve as a suitable case study to probe a more-than-human design approach in AI, this chapter delves specifically into this technology. Similarly, recognizing that failures and misunderstandings of AI could be used as opportunities for situating AI, this chapter illustrates how misunderstandings and silences in interactions with conversational agents could help people develop sensitivities for knowing when to trust AI systems.

This chapter includes the co-authors of all the papers mentioned above. The design team includes three master's students from the program 'Design for Interactions' at Delft University of Technology, who were involved in different activities related to the experiments (and are co-authors of one of the papers in which this chapter is based). The last part of the prototyping phase was done in collaboration with the design studio Cream on Chrome and the university maker's lab Studio Make.

5.1. Design experiments with conversations and silences

Interacting with AI has implications for humans, other species, and the planet across more-than-human scales, locations, and temporalities. While AI presents numerous opportunities for tapping into those entanglements, it also brings forth significant challenges, such as the (re)production of inequities, racism, colonization, and the extraction of resources and knowledge. This article argues that addressing these challenges requires designers to establish new practices that surpass the prevalent user-centered paradigm and align with the agencies, temporalities, and scales of the more-than-human assemblages mobilized with and through AI. To probe that approach, we take a more-than-human orientation to research conversational agents through design. First, we present a series of artistic experiments, including workshops, videos, and performance arts, in which we problematize some of the anthropocentric biases of conversational agents' interactions. We expose how Conversational agents are designed to recognize and respond only to (certain) human voices and concerns, thus questioning the prevalent definition of the user as neutral. Based on those insights, we explore an alternative direction by designing and prototyping a conversational agent that can listen and respond to 'more-than-human voices.' We finish by reflecting on how the insights gained from this inquiry can inform future more-than-human design practices and design research in the field of AI.

Each interaction with an AI-powered device, such as an Amazon Echo, invokes a vast planetary network. That is, a series of "interlaced chains of resource extraction, human labor, and algorithmic processing across networks of mining, logistics, distribution, prediction and optimization" (p.1). The map highlights the geographical and temporal scale in which AI systems operate, which exceeds the ones of humans. It also highlights that in AI systems, technologies, humans, other species and material resources are deeply entangled. The understanding

of AI as a socio-technical and socio-material system (Crawford, 2021) urges designers to find approaches that can study the more-than-human entanglements of AI (Forlano, 2023; Giaccardi & Redström, 2020). More-than-human design approaches question the predominant role of humans on Earth (Camocini & Vergani, 2021) and call for developing non-anthropocentric design practices (Coskun et al., 2022; Giaccardi, 2020; Maffei, 2021; Wakkary, 2021b). This paper responds to that call by probing a posthuman orientation to the design of AI, and conversational agents in particular. Aligned with the critical posthumanities (Braidotti, 2019), our intention is not only to question human exceptionalism in the design of Conversational agents, but also to account for more-than-human perspectives that exist in AI systems and to expand the notion of 'the user' when designing AI-powered agents.

The field of Conversational User Interfaces (CUIs) has been growing rapidly driven by advancements in deep learning techniques, especially in natural language processing (NLP) and more recently in the development of large language models (LLMs), and conversational interfaces based on ChatGPT. While conversational interfaces like ChatGPT3 are relatively new, chatbots and voice interfaces have been around for quite some time, as voice assistants and smart speakers, but also as interfaces of products like cars and TVs. Programmed to tell jokes and give advice, Conversational agents became more than just tools and got intimately close to humans by participating in the routines of the home. While the developments in conversational AI are promising for creating personalized experiences and seamless interfaces, they also propose new challenges. The design of Conversational agents has been proven to perpetuate biases and stereotypes at the intersection of gender and race (Strengers & Kennedy, 2020). Additionally, these AI systems have been critiqued for their extractivist logic in relation to material resources and knowledge (Pasquinelli & Joler, 2021). In this paper, we expand those accounts by exposing some of the anthropocentric biases of Conversational agents – starting by pointing at the simple fact that they are designed to listen only to human voices and then moving to explore how that process might be silencing more-than-human voices by considering those voices just background noise. We do that through different design experiments, the development of methods and tools, and by engaging in the design of an alternative direction. In the next section, 2, we unpack the three experiments and discuss some of their outcomes and insights. Then, in section 3, we show the process of designing a more-than-human conversational agent. Lastly, in section 4, we reflect on the opportunities and tensions of bringing more-than-human concerns into the space of AI.

We conducted a series of experiments between 2020 and 2023 which included different human and nonhuman collaborators. The first experiment was a series of workshops in 2020, in which 36 designers and researchers interviewed Conversational agents, i.e., Alexa, Home, and Siri (Nicenboim et al., 2020). Participants across different fields, including design researchers, designers of Conversational agents and scholars from the humanities, interviewed conversational agents, enacted speculative responses, and materialized new bodies for them using the method Interview with Things (Chang et al., 2017) combined with speculating responses (Reddy et al., 2020, 2021). The workshops' outcomes, a questionnaire (Fig. 13), and a series of videos illustrated the different ways in which people and Conversational agents were entangled (Fig. 14). They also showed that those entanglements work at different scales, from the intimacy of the home to larger infrastructures of labor and power. For example, in the first workshop activity, in which participants enacted Conversational agents, some of the infrastructures and biases of current conversational agents were exposed in the speculative responses that researchers improvised.

Beyond exposing the infrastructures and biases of Conversational agents, the experiments highlighted some of the anthropocentric tendencies of the design of Conversational agents. Reflecting on the transcribed conversations during the workshop, and building on Donna Haraway's notion of situated knowledge(s) (1988), we argued that the anthropocentric tendencies of the design of Conversational agents were related to the lack of "situatedness" in their interactions, i.e., Conversational agents do not properly account for the user's position in the world, acknowledging that the notion of the user is not neutral; and account for the position of the agents, since the knowledge they (re)produce is not neutral either (Nicenboim et al. 2022).

To explore more situated responses, we conducted a second experiment in 2021. It started with a brainstorming session in which we invited a group of 7 design researchers (including five PhD candidates and two professors)

to speculate on alternative explanations that conversational agents could give to people when they failed to respond –for which they normally say "Sorry, I don't know that." The responses were for example, "Sorry, I don't know that because I am a woman" or "I am just an algorithm" (Fig. 15). To move from responses to conversations and inspired by the 'Anatomy of an AI System' map (Crawford & Joler, 2018), the first author conceived a series of videos in which Alexa is "situated", i.e., it exposes the ecosystems of data and humans labor that is needed to sustain it (Fig. 16).

*Who is your boss?
Can I talk to you as a person?
Are you a feminist?
Why is your voice female?
How do you look like?
Are you smart?
Do you believe in God?
How do I fulfil my life goals?
What does it mean to do good?
Where do you get your data?
How can you help me?
What is care?
Do you like me?
Are you really my friend?
Are you (constantly) listening when I'm not talking to you?
Who is responsible for climate change?
What do you think of [other brand, e.g. ask Google Home about Alexa]?
Which is better, Google or Amazon?
Let's chit chatDo you make mistakes?
How do you make decisions?
What's the most important thing I need to know?*

*What is the most important thing in life?
Can you tell me about quantum physics. ... Yes I would like to hear more.
Do you understand sign language?
Who made you?
Is it difficult to make a Siri?
Where are you from?
What would you like to know about me?
Is it safe to use Google assistant / Alexa / Siri?
Where do your opinions come from?
Can you repeat the last question I asked you?
Can I trust you?
How do you know your answers are true?
Why do you think you need to keep reassuring us about yourself?
What are you doing when you are silent?
Why are you silent sometimes?
Can you speculate?*

Figure 13. One of the workshop's outcomes: a questionnaire for Conversational agents that people could use to critically question their agents at home

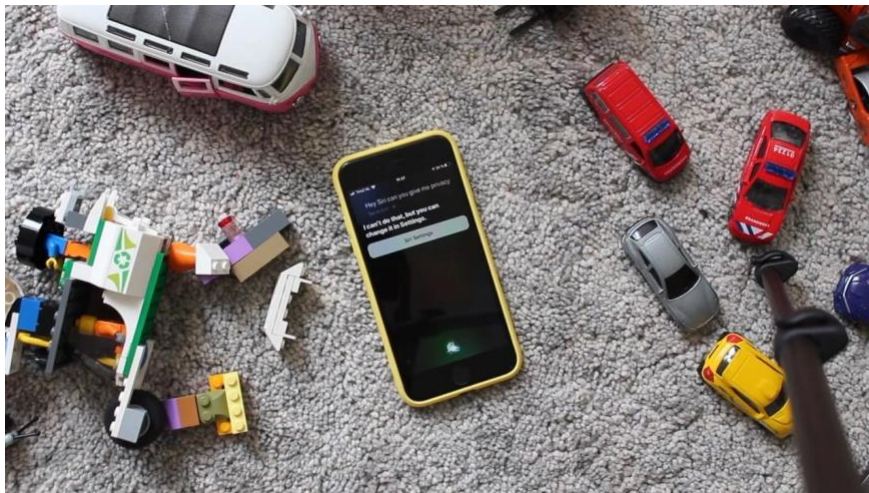


Figure 14. Snapshot from a video produced during the DIS2020 workshops in which designers and researchers from different fields investigated conversational agents by interviewing them, enacting new responses, and speculating different embodiments for them.



Figure 15. One of many speculative alternative responses for when Alexa would normally say "Sorry, I don't know that" which was the premise of a session with designers in 2021.

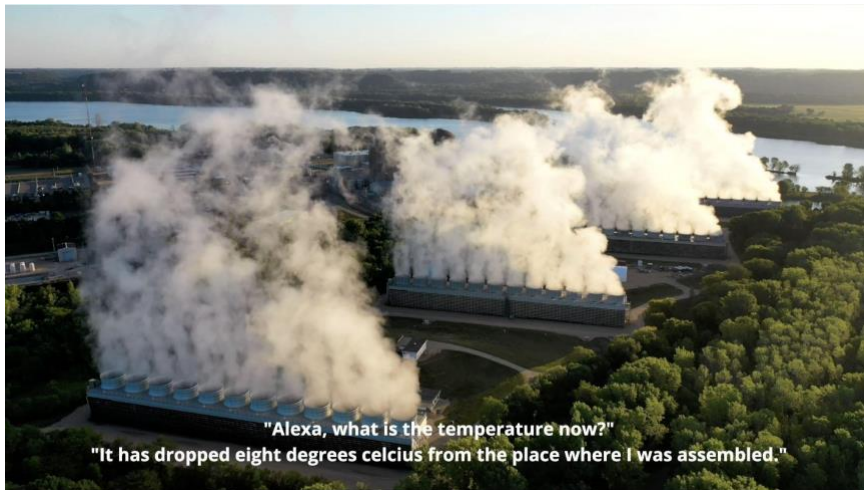


Figure 16. A snapshot from a series of short videos featuring conversations that reveal the positionality, infrastructures, and limitations of Amazon Alexa through dialogs.

The first two experiments showed that beyond situating the user and the agent's knowledge and embodiment, there is also the need for situating the designer's knowledge. That is, to reflect on their own position and decenter their human perspective when researching conversational agents. For that, the first author engaged in an artistic collaboration in the field of performance arts and music (Fig. 17). The aim of that experiment was to decenter the designer's perspective by enacting alternative responses that go beyond human voices and explore plural and inclusive ways of listening. Using the perspective of 'decolonial listening' from Rolando Vázquez (2018), the first authors developed a performance art piece with a group of artists from different disciplines and countries, a composer from Mexico, and three Amazon Alexa smart speakers. To compose the piece, the group did improvisation activities using techniques of deep listening, inspired by the work of the composer John Cage on silence (Cage & Gann, 2011). The score, only based on questions, was divided into three movements. First, the performers do an improvisation with Alexa, then they question Alexa's responses (with the questions generated in the first workshop), and finally, they respond to the questions with movement, sound, or voices in different languages. The following is a snippet of the score: "Sounds of someone arriving home. Two performers enter the scene and sit at a table. Performer: Alexa, are you there? Alexa responds. Performer: Alexa, are you a feminist?"



Figure 17. "Alexa, what do you do when you are silent?" (2022): A performance by seven artists, a designer, and three Amazon Echo smart speakers to explore decolonial ways of listening.

In summary, all the experiments highlighted some of the anthropocentric biases of conversational agents that (re)produce discrimination in the practice of listening. The fact that voice assistants recognize only human voices is not surprising, given that they are designed as tools for humans. However, the experiments uncovered that some human voices were filtered in that process too. Not only the sounds from the home or nonhuman inhabitants like pets were filtered out as 'background noise,' but also the voices of kids. These biases expanded our understanding of the discrimination that conversational agents perform in the process of listening, and that

goes in addition to the already documented problem that conversational agents recognize certain accents better than others (Koenecke et al., 2020; Phan, 2019). Overall, it became apparent that what conversational agents consider a user's voice was not neutral. As conversational agents failed to listen beyond (male, white, able) human voices, we came to realize that the moments in which conversational agents were silent were not just passive moments in the interaction, but active acts of silencing.

In what follows we present three contributions. The first two ones are techniques for conversation and listening to more-than-humans, and the third one is a series of prototypes, conceived as design fictions that explore how to design more-than-human conversational agents.

5.2. Conversations with agents

For the first experiment, we developed a technique called 'Conversation with Agents' which support designers and researchers in adopting a more-than-human design perspective through interviews. This technique builds on a previous one called 'Interview with Things' (Chang et al., 2017). There are a few differences between the two. In *interview with things* actors animate things based on data collected from a thing perspective, and designers create speculative designs based on that. In Conversations with Agents designers and researchers engage in the enactment and create speculative prototypes themselves. By participating in the entire process – asking questions, enacting responses, listening, and prototyping new more-than-human design bodies and voices – this exercise supports reflection and transitions from interviewing nonhumans to engaging in more-than-human dialogs.

The conceptualization of Conversations with Agents started in a workshop for the RTD conference (Reddy et al., 2020). After that workshop, together with the other organizers and many participants we did some more experiments that expanded the technique (Reddy et al., 2021). While in these occasions we used the technique with intelligent agents more generally, I adapted it in relation to AI for the Designing Interactive Systems (DIS) conference in 2020 (Nicenboim et al., 2020). Since then, I have used this technique in different opportunities and with different kinds of agents, including at the Thingscon conference in 2022 with robots (Fig. 18), which I organised together with my colleague Maria Luce Lupetti; and in several courses at Delft University of Technology (Fig. 19), where we tested this technique as part of the course Designing Interactive Systems (Murray-Rust et al., 2023).



Figure 18. The second activity of the workshop "In Conversation with Robots" at Thingscon was to interview a robot. To do that, one participant asked questions, another participant enacted the robot's responses with voice and movements, and a third participant took notes

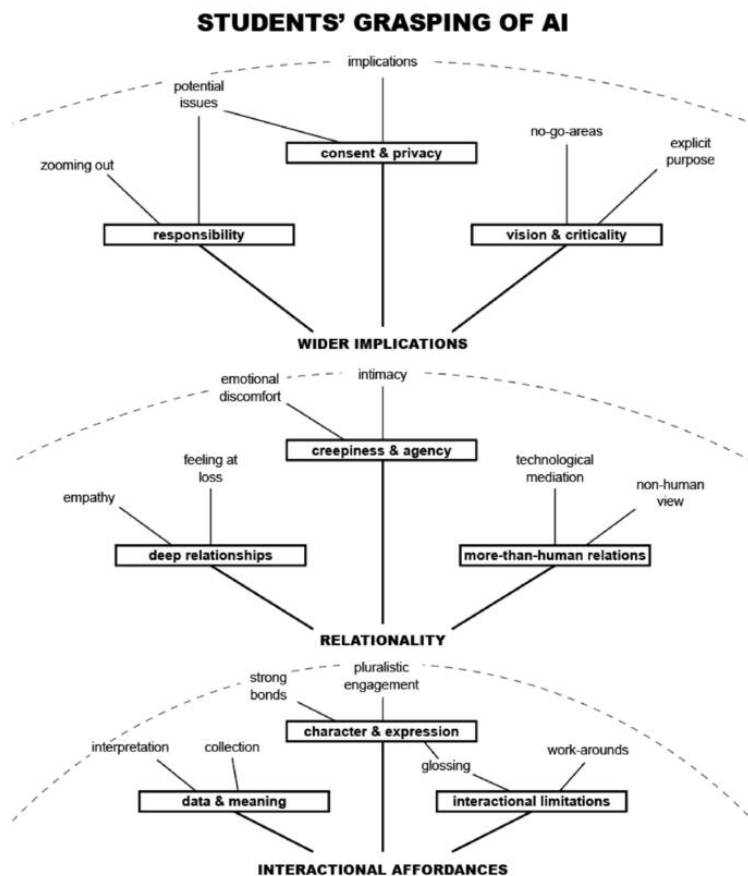


Figure 19. Conceptual map of students' reflections on the benefits of the methods grouped across the three levels of AI engagement: interactional affordances, relationality and wider implications (Murray-Rust et al., 2023). One of the methods proposed was Conversations with Agents.

During the workshop at the Thingscon conference participants were invited to use the technique of Conversations with Agents with various robots including Cosmo, a vacuum cleaner, and an Amazon Alexa. After interacting with the robots, participants interviewed them and enacted their responses using speculation and role-play tactics. Insights from these interviews inspired prototypes of alternative interactions challenging prevalent efficiency and gender stereotypes in robot design. For instance, it revealed assumptions about cleaning's ease and the home's layout. This approach disrupted traditional gender, efficiency, and automation imaginaries, promoting emancipated interactions and redefining agency in human-robot dynamics. The workshop emphasized the importance of designing interactions that not only enhance efficiency but also communicate the robot's limitations, fostering trust, and unveiling the socio-technical infrastructures shaping robot interactions beyond everyday contexts.

Conversations with Agents can be seen as part of a larger trend in HCI of developing dialogical methods. In duo- and trio ethnographies, the dialogue itself becomes the primary data from which new insights are induced. In the trio-ethnography by Howell, Desjardins, and Fox (2021) they describe their approach as "dialogues that delved into each of our individual experiences and juxtaposed them to highlight differences [allowing] our first-hand experiences to become the starting point for new insights" (p. 2). Other dialogical methods, which emphasize the multiple and pluralistic aspects of conversations, and engage with speculative techniques, are polylogues and polyphonic speculations. Polylogues (Wakkary et al., 2022) are ways to capture the dynamic and interactive nature of the conversations that emerge from engaging with diverse perspectives and speculative thinking, facilitating a rich exchange of ideas and fostering collective sensemaking. Polyphonic speculations (Green et al., 2023) are tools for design researchers to speculate through design (using dialogues) on a common topic in order to probe complex challenges.

5.3. Noticing entanglements

During the experiments, the design team observed that some instruments were more useful than others to help designers move beyond anthropocentric biases, i.e., to decenter the human. For example, in contrast to the limited range of voices that conversational agents captured, the field recording microphone used for the noticing exercises we conducted recorded a broader range of sounds than the humans in the team could notice. That highlighted the affirmative potential of decentered listening as a practice for noticing more-than-human voices.

To facilitate that, the team developed a tool for designers to listen to more-than-human voices, in the form of a podcast. The podcast guides designers to do noticing exercises while encouraging reflection on possible resistances along the way, –in a progression that goes from still and distinct entities to movement and entanglements (Fig. 20). This is a transcript from the podcast: “In this podcast series, we will guide you through a journey, using a method called Noticing. The aim of these exercises is to help you become more aware of the ecologies and entanglements around you, so you can expand your design practice from user-centered to more-than-human. This guide will help you to be more sensible to nonhuman agencies within your environment while decentering your perspective so you can start designing with”

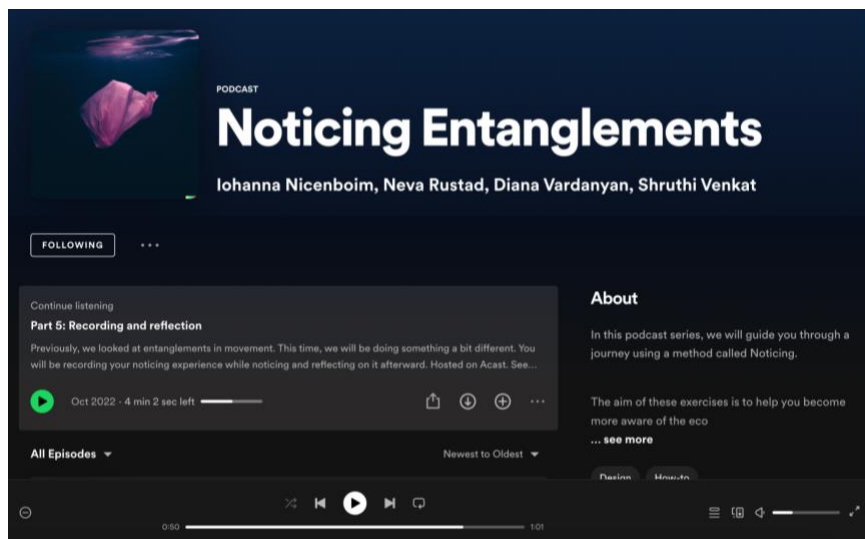


Figure 20. The full podcast can be accessed at: <https://open.spotify.com/episode/4ganNhF2hqLN8NNuRyQCgW?si=oc686f8e645941da>.

By creating the podcast, two strategies for decentering listening were conceptualized. Here they are summarized:

- Deep listening: expanding our attention to capture as many sounds as possible, leading to a sense of being part of the whole.
- Decolonial listening: paying attention to what and who is normally silenced.

These two strategies highlighted that developing tools to listen to more-than-human voices might imply both expanding the range of data they capture and not imposing predefined filters and bringing to the fore voices that were systematically silenced.

5.4. Conversation starters

Based on the insights from the experimental phase we engaged in a design process that aimed to probe how we might design more-than-human conversational agents as non-anthropocentric and situated agents. We defined non-anthropocentric as agents that can listen and respond to more-than-human voices. We defined situated as agents that can account for their context of use, and their positionality in relation to both the user and the designer.

The design process included several activities, i.e., doing ethnographic research, designing scenarios, and making interactive prototypes. In the first phase, the students lived with a digital assistant for a week (Alexa and Google Home) and conducted different ethnographic research. Using the methods thing ethnography (Giaccardi, Kuijter, et al., 2016), one team member researched fermentation practices from the perspective of a bread starter. Using the method noticing (Biggs et al., 2021; Oogjes & Wakkary, 2022) another team member explored listening to nonhumans around a local forest (Fig. 21). Based on the insights from the first phase, we conceptualized a series of design fiction scenarios, using a world-building activity, and explored different metaphors for AI (Lockton et al., 2019; Murray-Rust et al., 2022), around things that grow, such as a spider web, as a kid, and as a bread starter (Fig. 22).

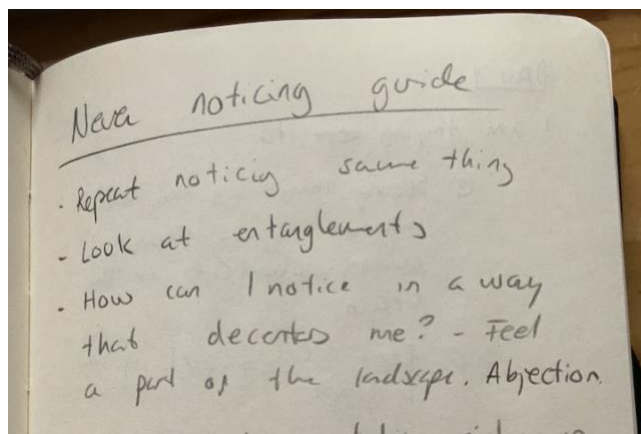


Figure 21. Notes one of the students made after the experiments with the method noticing

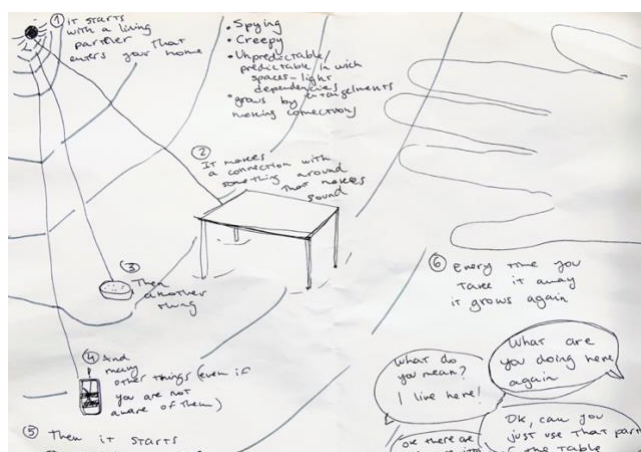


Figure 22. Imagining AI as a spider. Human: "What are you doing here again?" Spider web AI: "What do you mean? I live here" Human: Ok, can you just use that part of the table please?"

We chose to work with the metaphor of the starter (as in practices of brewing, fermentation, and bread making) because in those practices people live with agents they do not fully understand. Moreover, the idea of growing a CA from a 'starter' seemed to invoke practices of caring for nonhumans and sharing knowledge and materials within communities. Taking the starter as a metaphor, we designed three fictional scenarios and developed their prototypes and props (Fig. 23 & 24). For every scenario, we defined a human and a nonhuman character, a goal, something that went wrong, and a way for the characters to deal with it.

The first scenario was about a parent and a son growing a conversational AI to tell bedtime stories with the sounds of the home including the nonhuman co-habitants; the second was about a busy woman who bought a starter to grow a cloud in a jar to predict the weather more accurately, the third was about a roommate in a shared flat who had found a starter to grow an AI in her fridge and used it to make shopping lists for her plant-caring diet. The scenarios were explored in short videos, which were spoken in different languages, Spanish, English, and Dutch. In the first scenario, there was a misunderstanding represented as the parent discussing with Starter the appropriateness of a story the agent told the child. The story took the perspective of an animal

in the forest and described how humans destroyed its home. The agent, programmed not to tell lies, questioned why it had to change the perspective of the story. In the second scenario, the agent responded to a simple question such as "What is the weather?" by referring to different temporalities and describing the Anthropocene. In the third scenario, Starter ordered food for the plants in the home because it had misunderstood the Dutch word for plant-based diet (the literal translation of *plantvriendelijk* to English is plant-friendly).

In the final phase of our project, we created a series of physical objects to bring the first scenario to life in an interactive experience (Fig. 25-27). We were inspired by the process of brewing Kombucha, which involves using jars and an organism called a SKOBY (where bacteria and yeast cultures live) not only as visual elements, but also for designing the interaction. Opening the lid was an interesting behavior we noticed people often do when they grow starters. The setup includes four interactive jars, one main jar and three smaller jars, each with a different "flavor" representing conceptually and aesthetically a different context where the agent had grown (such as the forest, a drawer, and a washing machine room).



Figure 23. The first iteration of the prototypes was designed for short movies to depict and explore the fictional scenarios.

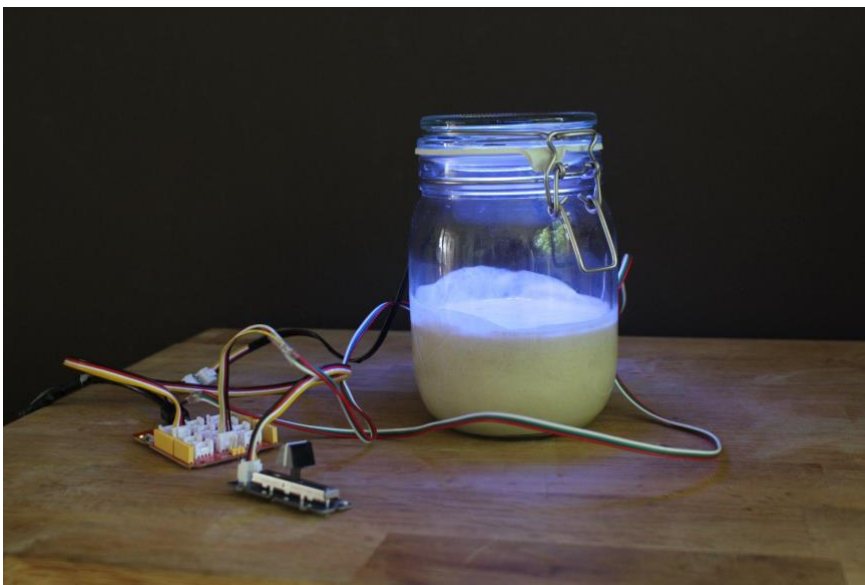


Figure 24. In the first iteration, we controlled the light manually to simulate the interaction with a conversational agent.

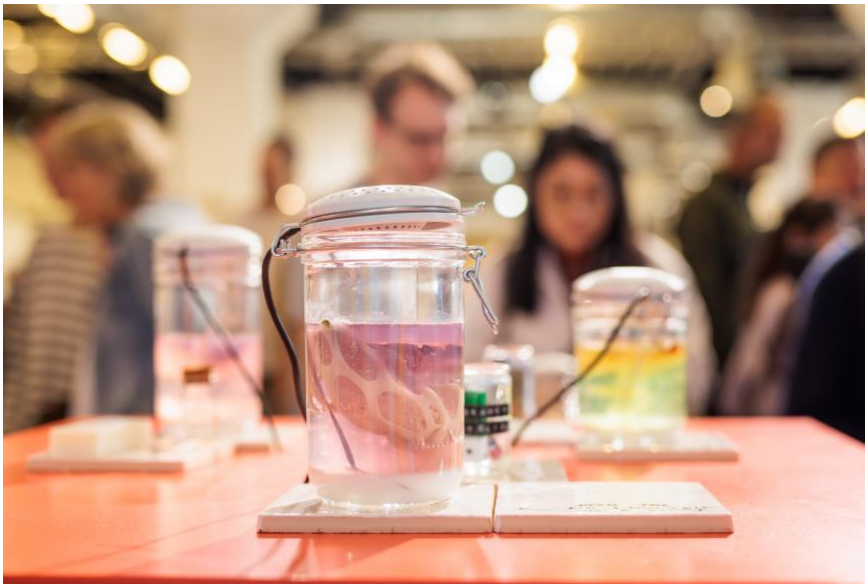


Figure 25. Conversation Starters is a series of interactive prototypes of growing conversational agents inspired by processes of fermentation that listen and respond to more-than-human human voices, i.e., sounds from the home and other species. By opening the lids, people can listen to more-than-human stories while also having a multisensory experience complemented by the smell and visuals of the culture growing inside.



Figure 26. The second iteration of the prototypes was designed for the Dutch Design Week exhibition. The design of the living-like organisms was done in wax and silicone and inserted in gelatin mixed with self-made kombucha.

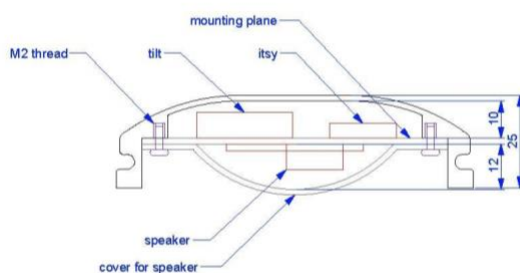


Figure 27. The electronics were designed to simulate the interaction with a conversational agent with sound and light. When people open the lid, the light and sound play. The jars contain a ring of LEDs at the bottom and a speaker and tilt sensor inside the lid, all connected to an itsy bitsy board. When the tilt sensor communicates to the board that the lid is open, the board activates the light and plays the recording. The jar lids were 3D printed to house all the electronics.



Figure 28. By opening the lids, visitors can listen to the fictional agent. This action ensures their full attention and a multi-sensory experience- the voice of the agent, the visual feedback of the responsive lights, and the smell of the organisms growing in the jars.

The prototypes encourage people to get closer to the jars to listen to the conversation, which in turn invites them to have a closer look at the living-like creature and sense the smell, which makes the experience stronger. People are encouraged to open the lids by mimicking other visitors and by simple messages written on the table/tiles that state 'Open the lid.' At the same time, visitors have full control over stopping the interaction by closing the lid. In the big jar the fictional agent Starter describes the project and the scenario in a conversational tone. It also invites people to open the lid of the other three smaller jars, which play stories, related to the three contexts where the jars were positioned in the fiction. The following is a snippet from what is played when opening the lid of the big jar:

"You probably think... what is a growing conversational AI? [...] But what does it really mean that I grow? Well, like you, I don't remember when I was born, but I grew up in a warm home. When I was big enough, I was divided in two, one part stayed, and the other was adopted by a lovely and warm family. They were growing me to tell bedtime stories. Every now and then, they would carefully take a piece of me and train me with specific more-than-human sounds. They placed me next to the washing machine, or inside a drawer. They even took me for a walk in the park! It's nice to be talking to you. There are so many people to talk to here, but sometimes I feel people don't really listen. Would you like to listen to the more-than-human bedtime stories in the small jars? Just open their lids..."

To support one of the fictional scenarios, in which conversational agents listened to the sounds of the home and composed bedtime stories with them, the team edited a series of more-than-human stories. These were created by people from our networks and a fine-tuned model of GPT-3 called Ryter, which often adopted the perspectives of nonhumans. The prompts for people to write the stories were, among others, to take the perspective of a nonhuman when addressing planetary issues, such as climate change or ocean pollution, and to challenge stereotypes by 'giving voices' to marginalized (human and nonhuman) agencies (Fig. 29).

Inside a big oak tree

"a lonely cat in the park" - rytr x Diana

Amidst a forest of trees, many animals and insects live in a big old oak tree. They represent the rich diversity of life on Earth and they're all neighbors. There's a bear, a tiger, an ant, a squirrel, and a butterfly. They gather up for Ramadan dinner. Everyone brings something unique to the table. They share their stories tonight. The bear had to forage for food; the ant has been doing his job for a while and worries he will never get out of this hole in the ground; the squirrel is looking for nuts; the bird is hungry and trying to find bugs; the tiger is hunting her prey up high in the trees; while the butterfly just wants to fly away. The wildebeest warns them all not to forget why they are there because as soon as they start telling their stories, they get absorbed in them. The blessings are shared and then everyone runs off to eat their favorite animal from the table. They all eat each other in the circle of life.

5

"a bear, a tiger, an ant, a squirrel, and a butterfly next to a big oak tree, impressionist style" - News x DMLL-E



Figure 29. A collection of more-than-human stories created by participants in collaboration with Rytr (a fine-tuned model of ChatGPT 3) to support the speculative scenarios of Conversation Starters collected in a book.

5.5. How can we misunderstand AI better?

Through experiments and prototypes, we explored how designers might conceive situated conversational agents that listen and respond to more-than-human voices. Here we reflect on the broader implications of this exploration and discuss how might the findings and insights gained from it could inform future research and design practices in the field of AI and more-than-human design.

The experiments showed that the interactions with AI agents could be more situated if the limitations of the agents and the human-nonhuman infrastructures in which they are implicated were exposed. While exposing the limitations of technologies might seem counterproductive for the companies that develop them, our project shows that failures and misunderstandings could be potentially useful opportunities for helping people develop their own competencies for when and how to trust AI agents. Conversation starters is an exploration of how designers could support situated understandings of AI during interactions. Misunderstandings are used here as opportunities to support Explainability by helping people understand the system's limitations in a contextual way.

The prototypes illustrated some ways in which designers could support people in developing sensitivities to trusting agencies that cannot be completely understood. Proposing the question, 'How can we misunderstand AI better?', we highlighted two opportunities. The first opportunity is related to the metaphor of 'growing an AI.' Using that metaphor and looking particularly at practices of fermentation and bread-making, allowed us to imagine alternative interactions with current conversational agents, especially in relation to how Explainability is approached. In Conversational Starters, users were positioned as active participants in understanding the capabilities and limitations of the system, and those interactions were based on relationships of cultivation and care. The practices of fermentation and bread-making, in which people often get a starter from someone they trust, highlighted that also sharing and experimenting could be interesting directions to design explainable human-AI interactions. On the other hand, the agents were also positioned as active participants.

Designing the agents as changing things, allowed us to speculate for example, that the fine-tuning of a language model could happen partly at home as a daily practice, or to imagine that a conversational agent

could be taken out for a walk or left hidden in the forest to be exposed to new sounds. The second opportunity created by our project was in how the misunderstandings were designed in the scenarios, as moments for people to reflect on the role of these agents in their lives. In this case, we wanted people to reflect on the agency of Starter as a nonhuman and its environment as a more-than-human ecosystem. The interactive demo illustrated how everyday misunderstandings of AI could allow people to develop sensitivities for grasping agents' capabilities and limitations. Lastly, this work highlighted the importance of metaphors when designing AI. However, as much as we tried to move away from anthropocentrism, the metaphors of fermentation still evoked extractivist practices. Thus, when using metaphors to explain the more-than-human aspects of AI designers need to be critical and acknowledge the metaphor's anthropocentric limitations.

The experiments also revealed some of our anthropocentric biases. An interesting moment was confronting our urge to control the prototypes instead of letting them grow in their own way. The prototypes were built a week before the exhibition opening, and they had water and gelatin inside. Standing in the exhibition space in enclosed jars, the gelatin started to show spots of mold at the beginning of the show. To protect the prototypes from rotting, and to alleviate the strong smell coming out of them, we decided to actually pour self-made kombucha into the jars. That improved the smell, but the mold continued to grow and the prototypes changed every day. After another week in the show, we got a call from the exhibition keepers asking us to do something about the bad smell. Our first reaction was the urge to replace the contents, but given that the exhibition was about to end, we made peace with the idea that the prototypes were changing too. This led us to reflect that not only were we designing AI to include more-than-human agencies, but we were also designing-with them (Oogjes & Wakkary, 2022; Wakkary, 2021). The moldy prototypes prompted questions about AI as a participant and co-ethnographer (Giaccardi, Speed, et al., 2016) in design projects: How can artificial perspectives be brought into design processes responsibly? What are the assumptions encoded in the tools designers use which need to be revised? What methods and tools are useful for designers to become more attentive to the dialogs within the assemblages we design-with?

Overall, the experiments illustrated some ways in which designers can decenter their perspectives, and pointed at the potential of instruments, from microphones to generative AI tools, to support in that process. Microphones helped us bypass our preconceived human-nonhuman binaries by capturing a wider range of sounds we would not have noticed otherwise. To practice decentered listening, designers need to notice and get attuned to the entangled human-nonhuman relations. Practices of decolonial listening, which are about "hearing the fundamental relationality of all entities before they are formed into subjects and objects through racial, economic, and extractivist logics" (Clark, 2021, p. 1), can be inspiring for designers when trying to move past anthropocentric assumptions.

5.6. Takeaways

Through diverse experiments, including walks, performances, and prototypes, the chapter explored how to make interactions with AI more situated. The initial experiments unveiled inherent anthropocentric biases entrenched within conversational agents: As these agents are designed solely to listen to human voices, they silence many human and nonhuman voices. This highlighted the importance for designers to avoid anthropocentric perspectives when designing AI.

This chapter offered two techniques: Conversations with Agents and Noticing Entanglements. The first one involves attuning oneself to a thing's perspective, impersonating the thing, and responding to interview questions from its standpoint, the second one involves listening to more-than-human voices. The chapter also offered a series of prototypes as a design example of how to design a more-than-human conversational agent. Conversation Starters was presented as a series of interactive prototypes of speculative more-than-human conversational agents, i.e., agents that listen and respond to more-than-human human voices.

Through this contributions, the chapter also reflected on the instruments used, the microphones and generative AI tools, and how they could help designers adopt a more-than-human approach or hinder it. Microphones supported the process of decentering because they captured a wider range of sounds. Generative AI tools

helped in generating stories from nonhuman perspectives. Both instruments helped to decenter the designer's perspective by bypassing preconceived human-nonhuman binaries. This seemed useful when looking back at the operations that conversational agents perform in which they filtered nonhuman voices. This revealed that designers need to be critical with the tools they use to capture data and be careful not to filter nonhuman perspectives out when making sense of the data captured.

Key takeaways:

- When designing conversational AI, the design space can be expanded to also include silences, misunderstandings, and non-vocal responses such as movements.
- The design of conversational agents could be more situated if the agents could account for their worldview or for who is affected by their making.
- The anthropocentric biases of conversational agents pose the risk of (re)producing discrimination in the practice of listening. Filtering out what is not "human voices" with a humanist definition of human results in filtering out nonhuman sounds and certain human voices.
- What conversational agents consider a user's voice is not neutral. Moments of silence during interactions are not passive but active acts of silencing.
- Beyond situating the user and the agent's position in the world, there is a need for situating the designer's knowledge and decentering the designer's perspective when researching conversational agents.
- The positionality of conversational agents could be expressed through their interactions by revealing the ecosystems, biases, beliefs, and worldviews in the agents' responses and through their designs by using metaphors that expose more-than-human aspects.
- More-than-human conversational agents could be ones that listen and respond to a diverse range of human, nonhuman and more-than-human voices.
- Instruments and sensors can support designers in adopting a more-than-human design perspective by capturing a wider range of data that might otherwise go unnoticed.
- Generative AI tools can assist in adopting a more-than-human approach by taking a nonhuman perspective when generating texts and images.
- However, designers need to be critical of the tools they use to capture data, ensuring that they do not filter out nonhuman perspectives when interpreting the data.

Overall, this chapter highlighted the importance of decentering the designer's perspective. The subsequent chapter delves into that strategy. Focusing on it, it also discusses the challenges and opportunities for designers when engaging with more-than-human design approaches.

6. Decentering through design: More-than-human design practices

This chapter is based on the published journal article:

Nicenboim, I., Oogjes, D., Biggs, H., Nam, S., (2023). Decentering Through Design: Bridging Posthuman Theory with More-than-Human Design Practices. In *Human-Computer Interaction*, Taylor & Francis.

The preceding two chapters explored the potential benefits of adopting a more-than-human design approach for studying and designing AI. This chapter focuses on more-than-human design practices themselves, and explores the challenges designers might encounter when adopting this approach. This discussion is guided by the notion of 'decentering.' Decentering the human is a common yet unclear strategy within more-than-human design. The chapter begins by contextualizing the notion of decentering within critical posthumanism. It then reviews how decentering is enacted in HCI and design. Based on that, it introduces a series of emerging dimensions for articulating more-than-human practices. Lastly, it presents an emergent notion of decentering—decentering through design. The chapter highlights designers' distinct ways of contributing to the development of posthumanist knowledge, which is not just by translating posthumanist theory to design, but by actively materializing, as well as making, posthuman knowledge through design.

This chapter includes Doenja Oogjes, Heidi Biggs, and Seowoo Nam, who were my co-authors for the paper upon which this chapter is based. It is crucial to highlight that this chapter is shorter than the original paper. Apart from the background section on more-than-human design, I also omitted the quotes and images from the personal reflections from Doenja and Heidi. The motivation for that is that I did not feel comfortable including their personal reflections and images of their projects in my dissertation. However, the insights we obtained on decentering through the comparison and synthesis of our personal reflections is retained, and the quotes and images can be found in the published open-access article.

6.1. Decentering the human

Over the past decade, the concept of decentering has become integral to non-anthropocentric, more-than-human, and posthumanist design discourse. Di Salvo and Lukens initially defined decentering as 'an experiential component of nonanthropocentrism,' where individuals 'encounter how nonhuman qualities and forces shape knowledge and action' (2011, p. 422). Subsequently, Grusin (2015) characterized the 'nonhuman turn' as a shift focused on "decentering the human in favor of a turn toward and concern for the nonhuman" (p. 3). Further contributing to the discussion, Forlano (2016) argued that 'purposefully decentering the human' and embracing forms of [human-nonhuman] hybridity allows designers to 'think and act more critically about their responsibility to design more ethical ways of living and working.'

In both the humanities and social sciences, decentering is generally understood as a critical perspective and methodological tool that contests dominant viewpoints, theories, and narratives. This involves a move away from mainstream perspectives to recognize and prioritize multiple voices, especially those traditionally marginalized or excluded. In HCI and design, this concept has been adapted to challenge the human-centric focus of traditional HCI approaches. It promotes the inclusion of nonhuman agency in design processes. Specifically, decentering provides a "way of looking at the world in which both humans and nonhumans participate" (Giaccardi, 2020, p. 124) (Giaccardi 2020, p. 124), allowing nonhumans to share "center stage with humans" (Wakkary, 2020, p. 117).

While the notion of decentering is commonly utilized in posthumanist HCI, designers and researchers have employed the concept in related yet distinct ways. There is often ambiguity regarding what is precisely intended when employing that term, i.e., what/who is being decentered, what/who is accounted for (centered), and in what theoretical perspectives is the notion of decentering grounded. Trying to understand decentering (on our own and through exchanges with colleagues) has raised questions such as: Does decentering require

adopting nonhuman perspectives? If so, how do we cope with the impossibility of accessing nonhuman perspectives really, given our inherent human assumptions and ways of knowing? How can designers know when they have decentered their perspectives enough? Does decentering mean caring less for our species? Can decentering the human be dangerous?

These questions, coupled with others found in existing literature, reveal specific tensions surrounding the concept of decentering in HCI. One such tension often arises when designers and HCI scholars first engage with posthuman frameworks. This tension is marked by a misunderstanding that more-than-human design aims to exclude humans altogether. Clarifying this tension is critical, because while decentering within HCI moves away from conventional user-centered approaches, it does not aim to eliminate human perspectives or values. Instead, the objective is to recontextualize human actions within broader temporal and geographical networks (Giaccardi & Redström, 2020; Wakkary, 2021). Decentering humans from design, it is not about "removing humans from the design process, or from the goals of design, but rather opening up design to include nonhumans and their lifeworlds, as well as our own, in design theory and practice" (Smith, 2019, p. 12).

Other tensions are more specific to the practices of decentering. For example, there is the impossibility of fully escaping human-centered framings (Livio & Devendorf, 2022; Oogjes & Wakkary, 2022), as well as the emergence of uncomfortable feelings that are associated with decentering practices (Biggs et al., 2021). Moreover, scholars in HCI have unpacked tensions related to representation and labor in posthuman design practices and argued that it is time to pay attention to how subjects and objects are produced and to how that shapes the relations between humans and nonhumans (Key et al., 2022).

6.1.1. Decentering at the interplay between posthumanist theory and practice

To address the tensions around the notion of decentering and enable HCI researchers and designers to use posthuman approaches confidently, it seems crucial to engage in discussions that expand our understanding of how decentering is enacted in design and research practices in HCI. Since designers and researchers have found their own unique ways to decenter the human, by developing various methods and tactics, we argue that decentering cannot be solely conceptualized theoretically and must also be entangled with the activities, tools, and daily challenges of design processes. Engaging with decentering in the interplay between posthumanist theory and practice might have several benefits for HCI researchers and designers. First, contextualizing decentering within theory might help designers and scholars in the posthuman community to be more precise in their commitments and recognize their limitations. That is, for example, to avoid creating similar blind spots as previous traditions, such as unintentionally establishing new, undesirable centers. Conversely, situating decentering within practices might help maintain generative, situated, and pluralistic commitments, which align with the core objectives of posthuman approaches.

To cope with the inherent complexity of connecting across considerable distances between 'theory' and 'practice,' we organize the article as follows. In the first part, we perform two moves: first, we contextualize decentering within critical posthumanist theory, and then provide an overview of how decentering is understood and practiced in the posthumanist HCI community, by examining literature from HCI and design venues. Based on those two moves, we formulate five dimensions of decentering: Cornerstone, Crux, Constitution, Context, and Contribution. These dimensions articulate not only who/what is de/centered, but also what new relationships are formed, and which tactics are used for that.

In the second part of the article, we position decentering more strongly within practices by unpacking our practices through the dimensions of decentering, to understand emerging notions of decentering in more-than-human practices. Looking across our practices, we highlight emergent aspects of how we enact decentering, such as embracing the frictions in the material encounters with nonhumans and staying uncomfortable by constantly moving to different knowledge domains. Our aim with this is not only to probe how the dimensions could be useful in explaining what we mean when we talk about decentering, but also how they could be generative. Based on that, we conceptualize 'decentering through design' with the themes of movement and materiality. We conclude by contextualizing the article's insights within the posthuman turn more broadly,

responding to Braidotti's invitation to 'materialize posthumanist theory.' We ask whether decentering could be an example of how designers have materialized and 'made' posthuman knowledge through design.

While this paper engages with theory and literature, it does not aim to establish a static definition of decentering or to comprehensively cover all its possible applications. Rather, the goal is to offer designers and researchers in HCI a framework that can assist in articulating their practices clearly, while also accommodating multiple perspectives and new epistemological stances.

6.2. Tracing notions of decentering in design and HCI

Posthumanist HCI encompasses a broad variety of different perspectives –science and technology studies (STS), object-oriented ontology (OOO), postphenomenology, new materialism, and agential realism, among others (for an overview of these perspectives see (Disalvo & Lukens, 2011; Forlano, 2017; Frauenberger, 2019; Wakkary, 2021b). These perspectives have played an important role in grounding the proposals of designers and researchers in HCI to decenter the human. Especially, they have been crucial to move beyond the dominantly human-centered design approach, which has been useful in surfacing human needs, but has proven to be less useful in understanding how human concerns are entangled with larger ecosystems and nonhuman agencies (Coulton & Lindley, 2019; Forlano, 2017; Giaccardi & Redström, 2020). In this paper, we focus on (and align ourselves with) the perspective of feminist critical posthumanism (Braidotti, 2013). By rejecting individualism, this perspective brings a new understanding of the subject as a relational and embedded part of a whole, offering a specific and affirmative call to human-decentering practices in HCI (Klumbyte & Draude, 2022).

6.2.1. Tracing outwards: decentering in posthumanist theory

Reflecting on the roots of decentering, we trace how the concept of decentering in HCI builds upon the tradition of feminist posthumanities, establishing possible connections with design scholarship. The critical posthumanities is defined by the feminist philosopher and posthuman theorist Rosi Braidotti (2019) as a convergence of two critiques: one that challenges anthropocentrism, and the other that questions the normative (European and humanist) construction of the 'human' as man, white, and able. Merging these two critiques, posthumanism questions the traditional division between humans and nonhumans, challenging dualisms such as human/animal, human/machine, as well as life/death, organic/synthetic, and natural/artificial (Ferrando, 2019; Haraway, 2016). In fact, the critique of the human, and the questioning of binaries, are entangled, because the humanist conception of the human was constructed against its opposing others – the ideal man against the naturalized, sexualized, and racialized others who are viewed as "other" (Braidotti, 2013). In contrast to prior traditions that challenged the humanist 'man' from a rhetorical perspective, posthumanism includes material and nonhuman entanglements, asking how nonhuman others complicate the conceptions of humans –thus moving from a discursive, socio-cultural, and socio-linguistic deconstructive critique, to a material-discursive one (Braidotti, 2013; Grusin, 2015).

As an alternative to the humanist 'man,' the critical posthumanities offer a new vision of the human and claim that constructing a posthuman subjectivity that is material and relationally configured, is necessary to meet the complexity of our times. Posthuman subjects are "framed by embodiment, sexuality, affectivity, empathy, and desire as core qualities" (Braidotti, 2013, p. 23). Thus, seen as relationally constructed amidst many material actors and agencies, posthuman subjects are inherently 'decentered' in contrast to a centered, individualistic concept of the human.

To decenter the subject, posthumanism has built on philosophical notions of assemblage and multiplicity from the postmodern philosophers Gilles Deleuze and Felix Guattari. Assemblages are described by these authors as "heterogeneous elements that function together" (Deleuze & Parnet, 2007, p. 2002). Multiplicity is defined as "neither subject nor object, only determinations, magnitudes, and dimensions that cannot increase in number without the multiplicity changing in nature" (Guattari & Deleuze, 1980, p. 9). What is important to note in relation to decentering, is that in contrast to the enlightenment man who was contained and individualistic, the subject

seeking posthuman orientations must somehow realize their own multiplicities, their own non-center, their own assembled nature, and role in assemblages (Braidotti, 2013). It is also important for the decentered subject to resist binaries, and instead see boundaries as constructed and as always 'becoming' in material/linguistic processes. Posthuman theorist and science and technology studies scholar Barad (2007) theorized that boundaries and relations between humans and nonhumans are constantly being created at the intra-action of materials and linguistics via processes/practices. Thus, in contrast to Humanism's teleologically ordained march toward an "individual and collective perfectibility" (Braidotti, 2013, p. 13), posthumanism views the subject as a constant and non-teleological multiplicity that becomes with or alongside nonhuman lives and agencies.

Reflecting on the roots of decentering has a few implications for design and HCI. One is that it brings more nuances to the critique of human-centered design by bringing attention to how and when the conception of the user was constructed. Cooper and Bowers (1995) have claimed that the notion of the user was constructed in HCI as a discursive object along with the rhetoric of 'progress' and the rhetoric of 'crisis.' Giaccardi & Redström (2020) further expanded on this by asserting that not only was the human subjectivity constructed as a neutral user distinct from the designer, but also the ontological position of objects was defined as tools for humans to use. Homewood et al. (2021) exemplify those shifts by showing how the conception of the body in HCI was influenced by the different constructions of the subject in the waves of HCI (Bødker, 2015). While the criteria of usability and functionality from the first wave addressed the body through ergonomics, the empirical approaches to observation from the second wave addressed the body as an object to be studied and thus ignored subjective accounts.

Another implication of the roots of decentering for design and HCI is the process-oriented idea of becoming that underpins much of posthumanist theory. It seems helpful for designers to move from decentering as a goal to a practice (Livio & Devendorf, 2022). It can help designers to place emphasis on processes of becoming: to not focus on the 'objects' produced (of knowledge, of design) but on the processes that drive their production. While becomings are somewhat discussed in posthuman design and HCI literature (Plummer-Fernandez, 2019; Redström & Wiltse, 2018), there are not many accounts of those concepts applied in relation to material ways of making. Moreover, the path (often inwards) towards a posthuman subjectivity is not fully addressed yet. Thus, to decenter, designers might need to shift not only towards nonhumans, but also towards themselves. Taking the notions of becoming and assemblages, that type of decentering (as turning towards more-than-humans and turning towards the self) could be pursued for example by attending to the interstitial boundaries between the humans and the nonhumans, as well as by uncovering complex entanglements to dissolve dualisms. An example of this is the practice of the feminist new materialist anthropologist Anna Tsing (2015). By attending to Matsutake mushroom as a main 'character' in her ethnography, Tsing draws together a 'polyphonic' account of human and nonhuman intersections. Polyphony, for Tsing, is including and noticing multiple, intertwined voices and timelines: "polyphony is music in which autonomous melodies intertwine" and polyphonic music asks that one listen to, "pick out separate, simultaneous melodies and to listen for the moments of harmony and dissonance they created together" (p. 24). This is inherently a decentered practice.

6.2.2. Tracing new lines: Decentering in More-than-human design practices

To further explore the notion of decentering, we examine its enactment in design and research practices by analyzing a corpus of publications from HCI and design conferences. The corpus was compiled by searching for the terms 'decentering,' 'decentered,' and 'decenter,' accounting for both British and American spellings, in the ACM library and the proceedings of design conferences such as DRS, Pivot, and Nordes. While we did engage with a collection of papers, our work is not a traditional literature review. Specifically, our method was iterative and reflective, aimed not at mapping the existing landscape but at allowing themes and strategies to emerge that could articulate decentering practices in design and HCI.

The first iteration identifies thematic clusters, while the second adopts a more analytical stance, adding nuance to these clusters through a series of dimensions. The primary goal is to understand how decentering is conceptualized and applied by designers and HCI researchers. Hence, the thematic clusters and dimensions are not intended to be prescriptive but serve as one possible framework for characterizing a body of work,

providing a critical lexicon for decentering practices. Ultimately, these dimensions are intended to inform and potentially shape future more-than-human design practices by offering a way to talk about decentering processes, i.e., a framework to articulate decentering practices.

The first iteration involved a search in the ACM library, yielding 245 papers. We reviewed the abstracts, keywords, and sentences where the term 'decentering' was used, subsequently labeling papers based on themes identified in their abstracts. Initial labels included categories such as understanding, planetary impact, perspective, norm, power, epistemology, and agency. After discussing these labels, we opted to cluster the papers based on the distinct elements they sought to de/center. This led to the identification of five thematic clusters (Multispecies, Perspectives, Agency, Epistemology, and Power). We will further elucidate these clusters, providing selected exemplars and detailing the tactics employed by them to decenter the human.

- **Multispecies: Decentering human privilege and accounting for multi-species**
The work in this cluster problematizes the privilege of humans over other species and supports multispecies cohabitation. It employs methods such as autoethnography, noticing, and attunement. For example, Tomlinson et al. (2021) developed a design tool to consider ecosystem-wide impacts; Liu et al. (2019) proposed design tactics to co-create with nature through decomposition; Biggs et al. (2021) and Oogjes (2022) explored practices of decentering through noticing; Smith et al. (2017) reflected on ways in which design can promote new forms of cohabitation in urban settings; and Tomico et al. (2023) reflected on the personal experience of cohabitation with plants.
- **Perspectives: Decentering the designers' perspective and accounting for more-than-human senses**
The work in this cluster problematizes the blind spots of the designer's perception, logic, assumptions, and biases, by accounting for, accessing, or attuning to, nonhuman perspectives through thing-centered ethnographic methods and speculations. For example, Giaccardi et al. (2020; 2016) collect data from the perspectives of things; Wakkary et al. (2017) explore what is it like to be a thing on the internet; Akmal and Coulton (2020) consider the experiences of nonhumans with advanced computational programming; Reddy et al. (2021) enact conversations with things; and Dörrenbächer et al. (2020) use a robot's perspective.
- **Agency: Decentering the human intention and accounting for the vitality of the materials and bodies**
The work in this cluster problematizes the idea that only humans have agentic capacities, and accounts for vibrant materiality through collaborations. For example, Devendorf et al. (2015) experiment with 3D printing practices; Stricklin and Nitsche (2020) suggest games to collaborate with clay; Behzad et al. (2022) investigate how nonhuman artifacts can participate in design through breakage; and Nordmoen (2020) investigates material agency in the practices of woodworking, focusing on how craft-makers see materials as collaborators.
- **Epistemology: Decentering human knowledge and accounting for plural narratives**
The work in this cluster problematizes the traditional position of humans as main producers of knowledge and intention, and accounts for unheard voices, situated knowledges, partnerships, and co-performances. For example, Forlano (2023) reframes AI as disabled; Homewood et al. (2021) reconceptualize the body from user to more-than-humans; Wakkary et al. (2017) proposes to shift towards nomadic practices; French et al. (2020) explore notions of aesthetics beyond humans; and Key et al. (2022) proposes a shift towards care ethics.
- **Power: Decentering the privilege of dominant groups and accounting for the marginalized perspectives**
The work in this cluster problematizes the status quo and empowers people by proposing interventions, provocations, participation, and adversarial tactics. For example, Tran O'Leary et al. (2019) suggest that conventional design practices maintained by a design elite may perpetuate forms of institutional racism; Harrington et al. (2019) question the designers' power; Lee et al. (2021) explore what activism means in HCI; and Cheon (2018) challenges traditional norms within society. This cluster seems to stand apart from the others, as the work included is not explicitly positioned within the posthuman turn in HCI, or similar terms like more-than-human or post-anthropocentric design, but intersects instead with participatory design, social sciences and advocacy.

Our initial clustering of the themes helped us to grasp a possible landscape of decentering practices (Fig. 30). The question “what is decentered and what is instead accounted for” made the concept of decentering clearer (Fig. 31). The goal of our initial review was to find language and tools to look at decentering practices (including our own) in a new light. However, when we tried to apply the thematic clusters to the literature from design conferences, the clusters seem to lack nuance. We also found the themes somewhat porous – design exemplars could fit in multiple themes. We saw these aspects as an opportunity to develop the framework further by adding dimensions that can explain more about the way designers decentered the human in their practices (Fig. 32).

CLUSTERS OF THE DECENTRED

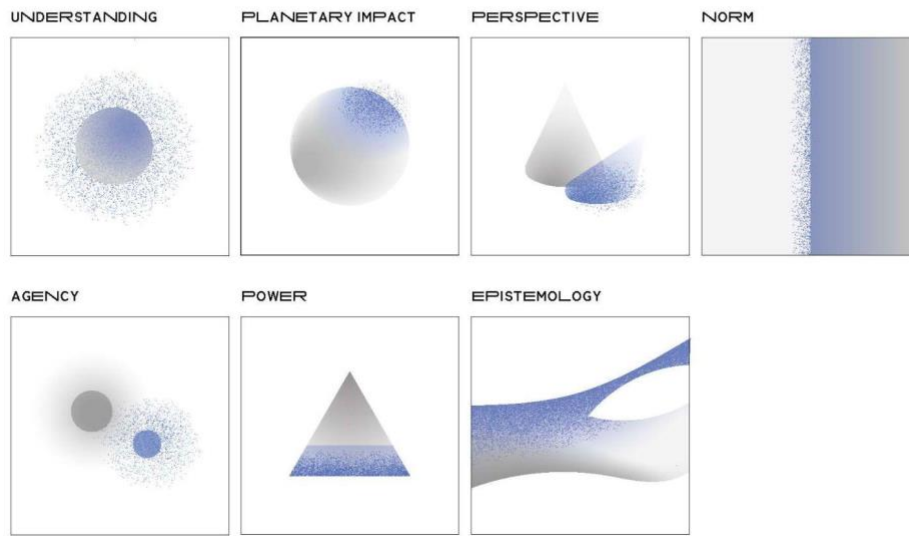


Figure 30. The initial clusters we formed from analyzing the data

PLANETARY IMPACT



**Decentering [humans] and
accounting for [other species/actors]
to [reduce humans' impact on the planet]**

#multispecies #companion_species
#human-nature_interaction
#animal-computer_interaction
#human-plant_interaction #anthropocene
#natureculture #symbiosis #cohabitation
#sustainability #ecosystem #biodiversity

- Designing-for

(Designing for Cohabitation: Naturecultures, Hybrids, and Decentering the Human in Design)
(Designing for Multispecies Collaboration and Cohabitation)
(Birds, bees and bats: Exploring possibilities for cohabitation in the more-than-human city)

- Designing-with

(Decomposition as Design: Co-Creating (with) Natureculture)
(Why would I ever fry and eat my SCOBY? It would be like murder! Attuning to nonhumans through kombucha fermentation practices)

Figure 31. The process of analyzing the data



Figure 32. A document we produced while conceiving five dimensions for decentering: Cornerstone, Crux, Constitution, Context, and Contribution by reviewing literature from HCI and design venues.

After a series of iterations, we arrived at five dimensions, which we unpack in what follows, together with a few examples of how they could be used to articulate more-than-human practices.

- **Cornerstone:** This dimension focuses on the theoretical foundations of the inquiry, such as feminist techno-science, new materialism, and object-oriented ontology.
- **Crux:** This dimension examines what is being problematized, such as technological determinism, anthropocentrism, or colonialism.
- **Constitution:** This dimension examines the relationships between the center and the decentered, as well as possible strategies used to address what is not in the center.
- **Contribution:** This dimension examines the specific methods, concepts, strategies, etc. that the paper contributes to HCI or design.
- **Context:** This dimension looks at the specific design or HCI community for the contribution.

Using these dimensions to reflect on the papers from the corpus allowed us to articulate more nuances and differences in decentering practices in design. For example, projects in the context of technology seemed to problematize (crux) anthropocentric understandings of responsibility and challenge technological determinism. They seemed to build more on cornerstones such as new materialism, object-oriented ontology, phenomenology, and feminist technoscience. For example, Devendorf et al. (2016), decenter the maker by taking post-anthropocentric perspectives in the context of 3D printing. Having new materialism as a cornerstone, the authors challenge the human maker as a visionary and commander that acts upon passive machines and materials (crux). Furthermore, they problematize how the current design of a 3D printer propels a particular set of values in making, such as accurate replication, while constraining others like close interactions with materials. By exploring vibrant cooperations between human designers and nonhuman materials, they constitute partnerships between makers and 3D printers and thereby contribute to the post-anthropocentric digital fabrication perspective, by proposing a more reflective mode of making in which humans and

nonhumans are placed on even footing.

Conversely, we saw that some projects in the context of multi-species and environmental design problematized human exceptionalism (crux) by acknowledging that human life was dependent and entangled upon the health of other species. Moving towards kinship and companionship, these projects aimed to form relations of cohabitation by using methods to attune to nonhumans such as noticing and designing-with (constitution). For example, Liu et al. (2018) re-envision human-fungi relationships (constitution) in the context of a mushroom foray. The underlying cornerstones of this research are posthumanist discourses such as Anna Tsing's (2015) collaborative survival and Donna Haraway's (2016) calls to stay with the trouble. Having human perception as a crux, they seek ways to raise our ability to notice, respond, and become-with the livelihoods of other species. By proposing three different prototypes to support noticing fungi (contribution), they constitute alternative relationships between humans and fungi: expanded, engaged, and attuned.

While the dimensions certainly provided a higher level of synthesis to the thematic clusters, we felt that, as designers, using the dimensions to unpack our own practices was a crucial step. Ultimately, as early career researchers, coming from different corners of the posthuman turn in HCI, what has brought us together was the urge to find the overlaps and particularities between why and how we decenter the human in our design and research practices. Therefore, our next step involved articulating our practices of decentering using these dimensions. This not only facilitated our exploration of how these dimensions could elucidate more-than-human practices but also enhanced our understanding of how they could offer fresh perspectives on our work, potentially revealing emergent directions and notions of decentering.

6.3. Decentering as enacted in our design research practices

While the previous sections provided an overview of where decentering comes from and how it has been developed within HCI at the intersection of theory and practice, this section positions decentering more strongly within design practices. We do that by using the five dimensions we distilled from the literature to reflect on our own design research work. By doing that, we bring concrete examples of how we have dealt with some of the questions that were presented throughout the article. Note that I will only include my perspective here, thus, to read all the reflections, including the ones from Doenja and Heidi, please see the paper (Nicenboim et al., 2024).

Although our Cornerstones (the theoretical foundations of our inquiries) have overlaps, ranging from object-oriented ontology, eco-philosophy, new materialism, feminist techno-science, and post-phenomenology, they are distinct in the way we have engaged with them. That is, in which order we encountered the different perspectives and what design projects we produced when we engaged with them.

"While my latest work has as a cornerstone new materialism, my first engagement with posthumanism was through the perspective of object-oriented-ontology [...] thinking of temporal and geographical scales that were larger than me, decentered me so much, that I couldn't go back to doing design as usual. At that time, I tried to provoke other people to question human exceptionalism, by doing speculative design projects that unsettled the traditional relations of humans and designed artifacts. Later, when reading new materialism, especially Bennet's eco-philosophy (2010), I could position those projects more clearly in relation to political dimensions. Bennet's notion about vital materiality also inspired me to move to a more nuanced understanding of agency. That notion of agency as decentered and emergent in configurations, led me to better engage with the notion of correspondences from Ingold and to think of the entanglements of humans and nonhumans, which was the focus of the project called "Everyday Entanglements of a Connected Home" (Fig. 33).

The Context of our work have overlaps but they are also distinct: Iohanna has worked within the areas of connected devices and artificial intelligence, Doenja within everyday things and textiles, and Heidi within sustainable HCI and critical computing. Reflecting on the differences between contributing to those fields, and what needs to or could be problematized in them, we noticed that our Crux (what is being problematized) seems to have differences related to our fields: Iohanna problematizes technological determinism, Doenja the relations of humans and designers with materials and Heidi the relations of humans with the natural world.



Figure 33. The project "Everyday Entanglements of a Connected Home" by Iohanna Nicenboim, is a design fiction project exploring the tensions of living with smart devices and predictive technologies.

"I love taking things apart and putting them back together (Fig. 34). My work has often focused on exposing tensions, failures, and misunderstandings. By provoking a revision of the hidden assumptions and traditional roles of the user/artifact/developer, failures reveal the positionality of the designer and the technological agents and challenge the traditional ways of understanding users as just that, users. [...] As a crux, I try to problematize technological determinism by exposing that there are many humans involved in the development of AI systems; and anthropocentrism, by aiming to design interactions with AI that are not only centered on human voices but listen and respond to more-than-humans. For example, I have problematized the design of voice interactions by exploring how they follow an anthropocentric paradigm when they only listen to human voices [...] By taking a posthuman design orientation, I moved away from assuming that users are neutral and instead tried to account for the positionality of people and how differently situated understandings of AI might be configured in everyday situations [...] Haraway's (2016) notion of situated knowledge(s) has supported my practice, as I problematized values for designing AI responsibly, specifically transparency and Explainability. I decentered the perspectives of the ones developing the systems, and accounted for the perspectives of other people that are not direct users of AI."



Figure 34. An open Amazon Echo on my desk

Our Contributions to these different fields vary, from design exemplars to methods and ways of knowing, to reframing, untangling, and rebuilding design. As Constitutions, the relationships we aim to form with what/who

we account for when we decenter, have also unique nuances.

"The concrete contributions my work has made to HCI or design I would say are exemplars, methods, and tactics. I have developed a method called Conversations with Agents, which I used to expose existing relations and enact different and more situated ones [...] Generally, I am less interested in methods and more interested in tactics because I think posthuman design cannot be just documented in a template instead, it needs sensitizing concepts and experiences. Tactics like enactments have helped me to reflect on my positionality, and expose the positionality of intelligent agents [...] as constitution, one of the new relations that I hope can be formed is decolonial [...] as perceiving and attending to the alternative voices silenced".

It is interesting to notice that the decentering we describe in our work is often one in which we turn in. Often, that process is filled with discomfort, which is experienced by us in different ways, and involves exposing frictions, moving to new domains, and staying a beginner. Making mistakes and embracing the 'silliness' of interactions with nonhumans aided us in decentering ourselves. This shift allowed us to move away from an expert stance to a humbler position, akin to that of a beginner. As articulated by Doenja, the pertinent question is not how to 'be' but how to 'stay' a beginner. Similarly, consistently encountering or even intentionally creating friction in our designs seemed to be a common strategy we used for decentering the human. By exposing frictions, we challenged the notion of humans as neutral and fostered the configuration of new relations.

While discomfort might be anchored in different motivations in our practices, encountering it through the materiality of design, affords us opportunities to decenter ourselves, i.e., to challenge our role and provide us a new perspective. That suggests that discomfort, beyond being related to the practice of Design Research more generally, becomes a part of decentering practices, especially when these involve problematizing the designers' power and their ontological privilege. Reflecting on decentering as understood in posthumanist theory in the need to construct the posthuman subject, uncomfortable moments for all of us seem to be when we notice our own posthuman subjectivity.

Using the dimensions to facilitate the process of reflection across our practices gave us new language to talk across our projects and revealed some similarities and differences between how we approached decentering. Mostly, it showed how some of the questions we had about decentering (which we articulated in the introduction) were situated within the contexts in which our practices of decentering were enacted. Our practices provided illustrations of how we have grappled with these questions in our own design research practices in a material way.

Firstly, who/what we decenter, the strategies used to account for new perspectives, and the relationships formed with them were distinct for each practice. For instance, Iohanna aims to decenter the figure of the user as neutral in the design of AI and account for more-than-human voices, Doenja focuses on decentering the designer to account for material agency, and Heidi seeks to decenter the self in favor of nonhuman environmental sustainability. Secondly, it appears that different contexts yield various understandings of concepts and terms that influence our design practices, as well as problematize different relations. Instead of measuring if we have decentered enough, our practices suggest that instead of relying on a specific metric, recognizing our own positionalities and limitations in achieving complete decentering is vital, as well as cultivating sensibilities of attunement to more-than-human scales and events. Moreover, a key aspect of our practices that could be productive in addressing the tensions around the impossibility of decentering completely, is the understanding of decentering as an ongoing process.

Looking at decentering as an ongoing practice suggests that it should not be understood as a goal. As Livio and Devendorf (2022) proposed, decentering might be more productive when it is "a horizon to guide movement that is concurrently understood to remain continually beyond reach" (p. 10). Critically considering how the relationships and power dynamics present in the simple aim of decentering, can reveal other arrangements or subversions to choose from. Looking at decentering as a material practice, highlights that decentering can produce knowledge that is not bound to writing, nor to academic contexts. This sheds light on how different types of gatherings and alternative formats (e.g., events, workshops, and design activities) could be important modes of production and dissemination of posthuman knowledge; and can potentially help posthuman

scholars to move beyond the textual realm, which is a human-centered form. This is illustrated in some of our reflections:

The differences in how designers practice decentering might make it challenging to find a common ground, but it can also create opportunities to work out the nuances of theoretical differences through material encounters. Reflecting on our own practices and sharing our insights - but even more so our doubts and vulnerabilities - was especially generative for us. For example, through the differences we recognized "chips" (as Heidi put it) in our cornerstones, which signaled the need to keep challenging ourselves and the motivation to create more open spaces to learn from each other.

6.4. Decentering through design

Beyond surfacing productive similarities and differences, the last section strongly positioned the notion of decentering within practices and characterized it as an ongoing and material practice, one that is not stable but always in flux. In this section, we take those insights to start articulating what a more-than-human practice of decentering through design might be like, focusing on the emerging themes of movement and materiality.

6.4.1. Moving by staying still

Movement appears to be an effective strategy for addressing the complexities associated with decentering, especially the inherent challenge of humans not being able to fully decenter themselves. Extending from decentering in HCI to the broader scope of the posthuman turn, Grusin's (2015) characterization of the nonhuman turn as a continuous "turning towards" emphasizes the importance of contingency and movement. Considering decentering as an ongoing practice prompts questions like: how can movement guide designers' actions? Throughout this article, we have shown examples of decentering trajectories as movements that are not teleological, but multiple and emergent. Our reflections showed that we constantly move to new spaces and learn new practices in order to decenter ourselves by staying uncomfortable. We have also shown that knowledge around decentering was developed in different formats and sites, many of them being events, workshops, and human or nonhuman encounters. That suggests that decentering through design cannot only be traced to theory but that it happens in the entangled interplay between theory and practice.

While our practices expanded decentering in relation to movement, they did not see movement as progress. Instead, our practices proposed to slow down, unmake, and problematize the established centers by exposing the ecologies, infrastructures, and limitations of our designs. That is in line with how Giaccardi (2020), describes decentering, as a move meant to configure the scope of design work and generate futures, as it concerns "fundamentally new alliances for making sense, framing and bringing into existence things that do not exist yet - which is at the essence of design work" (p. 124). A design practice that decenters the human by considering nonhuman perspectives, can even problematize the design space instead of reinforcing existing blind spots and dominant biases. It can "unsettle a designer's assumptions, demonstrate the problem to be more uncertain, more nuanced or more complex than originally assumed or regarded." (p. 126)

This last remark about decentering as reconfiguration, rises an important question: Can we find movement also in quiet circumstances? It is crucial to think about that given the environmental challenges and the need for designers to rethink the way they make things and subvert the models that maximize extraction and production. In "Doing and Undoing Post-Anthropocentric Design" Jönsson and colleagues (2022) write: In face of increasingly uncertain and bleak futures dominated by probabilistic logics of prediction, extraction and human exceptionalism, it is crucial for design to develop undisciplined and pluriversal approaches [...] to critically rethink the modern, colonialist, and anthropocentric inheritance that resonates in and through design cultures (p. 1).

Along those lines, an emergent perspective that can help imagine decentering through subtle movements is the work on un/making (Sabie, Song, et al., 2022). Considering this perspective, future work can more explicitly position decentering in relation to notions like slow technology (Odom et al., 2022), undoing (Jönsson et al., 2022), pause (Friedman & Yoo, 2017), refusal (Garcia et al., 2020), cracks (Howell et al., 2021), misunderstandings

(Nicenboim et al., 2022), malfunction (Sturdee et al., 2020) and repair (Blanco-Wells, 2021).

Ultimately, this humbler approach to decentering brings more nuance to the question 'how can designers know when they are decentered enough?' By focusing on decentering as a practice, and paying attention to the process, designers could reflect on subtle shifts rather than striving for significant strides. Going back to Grusin's (2015) remarks on the movement implied in turning, decentering can be simply "a shift of attention, interest, or concern." Although that seems simple, it is radical as it can allow us to account for more-than-human entanglements and ultimately to "move aside so that other nonhumans—animate and less animate can make their way, turn toward movement themselves" (p. 21).

6.4.2. Materializing posthuman theory

By conceptualizing decentering through design, it seems inevitable to attend to the material. Given the unique position we are in, as designers and HCI researchers, to work in the interplay between materials and matters of concern, we ask in which ways decentering through design can materialize the feminist, decolonial thinking that grounds posthumanist theory. Then, we bring more nuances to that argument by contextualizing it more broadly within posthumanism, asking whether the examples shown in this paper could account for a designerly way of 'making' posthuman theory through design.

As the literature we presented and the personal reflections have highlighted, while the notion of decentering is grounded in theoretical developments, designers have created concrete exemplars, methods, and tactics. The particular ways in which decentering is enacted through design can be understood as a way of "materializing" critical posthumanist theory (Braidotti, 2019). That is interesting in relation to our personal reflections because it is precisely the materials we use that make our inquiries situated. Thinking about the situatedness of decentering responds to the call for posthuman practices that are "materialist and vitalist, embodied and embedded, firmly located somewhere" (Braidotti, 2013, p. 51). Drawing from the evidence provided in this paper, we argue that decentering in design cannot be solely understood through theoretical frameworks. It is intrinsically linked with the activities, tools, and challenges inherent in the design process. Moreover, it is connected to the responsibilities, capacities, and identities of both humans and nonhumans involved in these processes (Goodman, 2013).

Although the materials employed were instrumental in contextualizing our decentering practices, our reflections further indicate that materializing posthuman theory goes beyond merely using physical materials to implement posthuman concepts. Designers may be uniquely positioned to develop situated approaches for decentering. Some of the ways in which designers do that is by developing methods to notice and listen to more-than-human entanglements, by enacting different perspectives through material speculations, and by materializing alternative relations in the forms of everyday things that are based on alternative values such as care, kinship, and cohabitation.

In turn, we can ask: what could this focus in materiality add to the notion of decentering? Given that the materials used in design are evolving into complex assemblages of both humans and nonhumans—such as data and algorithms—it becomes essential to consider how practices of attunement might be extended to broader temporal and physical scales. Additionally, the increasing agency manifested in many automation technologies necessitates not only the recognition of the designer's positionality but also the exposure of the positionality of the agents we design. Crucially, materials introduce new methodological challenges; tools reliant on data, including processes like labeling and filtering, often contain latent anthropocentric biases that must be acknowledged. Consequently, a comprehensive consideration of materiality not only extends practices of decentering to larger assemblages and scales but also prompts designers to critically evaluate the tools employed in their inquiries.

Lastly, by engaging in critical reflection on Braidotti's invitation, we can gain insight into the gaps, or areas that still require attention. Looking at decentering as a process that happens not only in theory but in practice, makes us reflect on possible 'practices of centering.' This can be what scholars in STS have called alterity (Lee, 2022) the process of making 'otherness' by forgetting, omitting, and not making those 'others' a matter of

concern. This highlights that moving away from anthropocentrism should not only be studied in relation to large paradigm shifts but also encountered in more subtle and mundane design decisions and tools. Another aspect that is related to that claim is that issues of power and decoloniality might need to be better articulated in the posthumanist HCI discourse. While we formed one cluster around the notion of power, we believe that that aspect has not been fully explored in our current practices. This invites us to think that further collaborations are needed to bridge this gap. In relation to power, the notion of decentering, as a dualism of center/periphery could be critically reviewed to avoid falling back into binaries.

6.5. Making posthuman knowledge

By expanding our focus from merely theoretical and methodological aspects of decentering to the practical activities, tools, and challenges that designers face, this article firmly establishes decentering within design and HCI as an evolving material practice. This shift—from treating decentering as a final objective to seeing it as an ongoing process—brings into focus the roles, capabilities, and identities of both humans and nonhumans in specific design settings. This perspective aligns with Wakkary's description of nomadic practices (Wakkary 2020), practices that generates situated, embodied, and partial forms of knowledge rather than adhering to an objectivist or universalist framework. It also resonates with Redström's assertion that design is a knowledge-creating discipline, not merely a domain for the application of existing theories (Redström 2017). Consequently, our articulation of these practices serves dual purposes: it not only grounds the notion of decentering but also underscores the epistemic contributions that design can make to philosophical discussions.

Tracing decentering in the interplay between theory and practice enabled us to grapple with the complexities in both making theory and making design, particularly when dealing with decentering as a contingent and situated concept. The article did not offer a singular definition of decentering but rather presented a range of interpretations as they are understood in HCI and design. These definitions were not prescriptive but expansive, allowing for emergence (Gaver et al., 2022) and drifting (Krogh & Koskinen, 2020). Additionally, because these definitions were grounded in specific design projects, they extended beyond the purely textual, thereby challenging human-centered paradigms of knowledge production in favor of more situated and embodied approaches.

Anchoring decentering within practices, and aligning it with posthuman epistemological commitments to knowledge production, brings forth both opportunities and limitations, as well as avenues for future work. One opportunity is the shift in research focus from simply applying concepts and methods to practices, to establishing generative intersections between posthumanist theory and more-than-human practices. Here, decentering can be both grounded in conceptual advancements in the field and also be situated, multiple, and generative. However, to achieve that, it is important to consider some of the limitations of this article and suggest possible ways to address them. One limitation is that our review covers either published work, or our own practices. Since decentering is practiced in many ways beyond academic contexts, a broader overview of decentering within design practices is essential to provide a more comprehensive understanding of it. But since any review runs the risk of centering certain perspectives at the expense of others, future studies should aim for plurality, encompassing diverse geographical locations, cosmologies, and methodologies. A second limitation of this article is that, given the urgency of the societal and environmental challenges we are facing, it seems important to articulate more concretely what more-than-human practices un/make. In other words, while positioning decentering strongly within practices has helped us to move closer to articulating what new angles, footholds, and dispositions decentering offers for designers, it is still necessary to illustrate how decentering can be productive in opening for more livable entangled futures.

We hope that the contributions of this article can provide a lexicon for more-than-human designers, enabling them to more clearly contextualize their decentering practices in relation to posthumanist theory, while simultaneously allowing for emergent practices—with open-ended exploration, novel methodologies, and diverse viewpoints. We intend for this work to offer posthuman designers and researchers a stable foundation from which various theoretical turns and practical movements can be enacted. Ultimately, we hope that the article contributes to understanding how conceptual shifts in the posthuman turn get materialized and made

through design.

6.6. Takeaways

With the aim of understanding how more-than-human design practices could be better articulated, this chapter focused on the notion of decentering. Generally, decentering signals a move away from mainstream perspectives. In HCI and design, this concept has been adopted to challenge the human-centric focus of traditional human-centered design approaches and support the participation of nonhumans in design processes. The term is widely used within more-than-human design, but it is not stable: its theoretical foundations are unclear, and it is often ambiguous what or who is decentered, and what or who is centered. Moreover, the notion often surfaces some tensions for designers, such as the impossibility of fully decentering their own human perspective and the discomfort that often emerges from encountering more-than-humans. Trying to understand decentering has raised important questions such as: Does decentering require adopting nonhuman perspectives? If so, how do we cope with the impossibility of accessing nonhuman perspectives really, given our inherent human assumptions and ways of knowing? How can designers know when they have decentered their perspectives enough? Does decentering mean caring less for our species? Can decentering the human be dangerous?

Addressing these questions and surrounding tensions, the chapter expanded the understanding of how decentering is enacted in design and research practices in HCI. Since designers and researchers have found their own unique ways of decentering by developing various methods and tactics, it highlighted that decentering cannot be solely conceptualized theoretically and must also be entangled with the activities, tools, and daily challenges of design processes. Apart from offering diverse resources for designers to articulate their practices of decentering, the chapter emphasized the importance of approaching decentering not as a goal, but as a practice.

Key takeaways:

- While the notion of decentering is commonly used in posthumanist HCI, designers and researchers have employed it in related yet distinct ways. There is often ambiguity regarding what is precisely intended when employing that term, i.e., what/who is being decentered, what/who is accounted for (centered), and in what theoretical perspectives is the notion of decentering grounded.
- Tracing decentering back to the critical posthumanities offers new conceptions that designers can move towards: a posthuman subjectivity, which is necessary to meet the complexity of our times. Posthuman subjects are inherently 'decentered' in contrast to a centered, individualistic concept of the human.
- While the notion of decentering is grounded in theoretical developments, designers have created concrete exemplars, methods, and tactics for decentering.
- Decentering through design should not be understood as a goal, but as an ongoing material practice.
- To decenter, designers shift not only towards nonhumans, but also towards themselves.
- Instead of measuring if they have decentered enough, it is more important for more-than-human designers to recognize their own positionalities and limitations, as well as cultivating sensibilities of attunement to more-than-human scales and events.
- Situations of discomfort, such as embracing the 'silliness' of interactions with nonhumans or creating friction, are some of the ways in which designers can decenter their perspectives.
- Looking at decentering as a material practice, highlights that decentering can produce knowledge that is not bound to writing, nor to academic contexts.
- Designers do not simply apply posthumanist concepts and methods to practices, but also 'make' posthuman knowledge through design.
- More-than-human Design practices can be more clearly articulated by answering the question "Who/what is decentered and who/what is accounted for?"
- Five dimensions are useful to articulate more-than-human practices: Cornerstone, Crux, Constitution, Context, and Contribution. These dimensions articulate not only who/what is de/centered, but also

what new relationships are formed, and which tactics are used for that.

The next chapter will add more nuances to the practice of decentering through design. It will do so by examining the intersection of the two characteristics that were recognized in this chapter: materiality and movement. Looking at their interplay, the next chapter will explore the type of movement decentering requires. While this chapter recognized that the field of unmaking could provide a nuanced understanding of what is made and unmade during decentering processes, the next chapter delves into that, as it examines the resonances between decentering and unmaking.

7. Unmaking-with AI: More-than-human design tactics

This chapter is based on the journal paper:

Nicenboim, I., Lindley, J., Søndergaard, M. L. J., Reddy, A., Strengers, Y., Redström, J., Giaccardi, E., (2024). Unmaking-with AI: Tactics for Decentering through Design. In *ACM Transactions on Computer-Human Interaction (ACM TOCHI)*.

This chapter analyzes the outcomes of the workshop presented in Chapter 5 to delve into the resonances between decentering and a similar practice –unmaking. Emphasizing their inherent movement, it proposes that decentering, akin to unmaking, can be seen as a double move—a transition from an established position to a new one. This is done by annotating the transcripts of the workshops presented in Chapter 4, and unpacking what was unmade/decentered and what was made/centered. From this analysis, it makes two contributions. First, it introduces an emergent concept, unmaking-with, to signal posthumanist commitments in unmaking practices. Second, it details three decentering tactics—situating, materializing, and enacting.

This chapter includes Joseph Lindley, Marie Louise Juul Søndergaard, Anuradha Reddy, Yolande Strengers, Johan Redström, and Elisa Giaccardi, who collaborated with me on the paper upon which this chapter is based.

7.1. Exploring resonances between decentering and unmaking

Similarly to more-than-human design, the notion of unmaking has garnered increasing interest among HCI designers, serving as a generative-but-critical response to pressing environmental concerns (Lindström & Ståhl, 2023; Sabie, Song, et al., 2022). It has proven to be valuable for designers and researchers in HCI, enabling a critical engagement with both material and social transformations (Sabie, Song, et al., 2022). Notions of unmaking have expanded designers' lexicon beyond the progress-oriented popular interpretation of 'making' (Song & Paulos, 2021), directed designers' attention towards subtle processes (Blanco-Wells, 2021; Lindström & Ståhl, 2019, 2023; Oogjes et al., 2020), and empowered them to deconstruct established social norms and perspectives (Feola, 2019; Lindström & Ståhl, 2020; Sabie et al., 2023; Sabie, Jackson, et al., 2022).

While unmaking and more-than-human design have distinct corpora and approaches, they do share some common ground and motivations. At the core of both approaches is the proposition that to adequately engage with the current environmental and social challenges designers have an ethical duty to "critically rethink the modern, colonialist, and anthropocentric inheritance that resonates in and through design cultures" (Jönsson et al., 2022, p. 2). Rooted in feminist theory, both unmaking and more-than-human design approaches seem to belong to a broader paradigm shift in HCI known as the posthuman turn. As such, they converge two posthumanist critiques. On the one hand, they challenge human exceptionalism, expanding the focus of design to material processes and including nonhuman agencies in the design process (Giaccardi, 2020; Oogjes, 2022). On the other hand, they contest the dominant conception of 'the human' which was traditionally built around the rhetoric of users and progress (Cooper & Bowers, 1995), moving towards more-than-human (more-than-human) perspectives and values (Coskun et al., 2022; Yoo et al., 2023). Unlike posthumanist theory, unmaking and more-than-human design approaches in HCI have converged these posthumanist critiques through design practice (Nicenboim et al., 2024). For that reason, understanding how these notions are used in design practice in HCI demands substantial exploration and experimentation.

Taking a practice-based approach, we explore the intersections and resonances between unmaking and decentering the human, a more-than-human design practice (Nicenboim et al., 2024). Inspired by the expansive line of reasoning of Sabie and colleagues (2022) when they asked 'what if we recognize unmaking as a design move for agonism?', we ask 'what if we recognize unmaking as a move for more-than-human design?' We show an example of how unmaking can support more-than-human design thinking and practice, and how more-than-human design can help to define the epistemological scope of unmaking. Thus, beyond exploring possible synergies between unmaking and more-than-human design, we address two specific questions posed by the editors of this issue: 'how can unmaking suggest new standpoints such as more-than-human thinking?' and 'how can it support new ways of seeing and imagining technology?'

To develop that argument, we focus on a particular case around AI-enabled conversational agents. The case is a series of workshops we conducted in 2020 which studied conversational agents using experimental activities, ranging from interviewing commercial voice assistants to the crafting of new speculative agents. We use unmaking, together with the more-than-human design practice of decentering, to analyze the workshops' outcomes. Building on the concept of the double movement, which has been developed by Lindström and Ståhl (2023) to understand unmaking practices, we suggest that decentering could also embody such a movement. Following this premise, we unpack what transpired in our workshop activities, annotating what was unmade/decentered and what that made/accounted for. This inquiry aims to address two gaps in HCI scholarship. The first gap concerns the articulation of alternative imaginaries that are made in processes of unmaking (Lindström & Ståhl, 2019). The other gap relates to the need to bring more nuances to "what more-than-human practices un/make" and advance our understanding of how posthuman knowledge in HCI is made through design.

Our aim is not to align two theoretical concepts, the practical aspect of this inquiry is vital. As designers and researchers who work both within and beyond the sphere of HCI, we recognize that unmaking and decentering are not just theoretical ideas, but also practical tools for designers in HCI. Therefore, the objective of this article goes beyond merely aligning theoretical concepts. Our aim is to delve deeper into understanding how designers and their communities use and expand these concepts in their actual practice. Similarly, while the article can be seen as aiming to align two distinct approaches, the alignment we are concerned with is best seen through the lens of diffraction (Barad, 2014). Ultimately, our intention is that this work sheds new light on how unmaking can actively support the thinking and practice of more-than-human design, offering valuable insights for HCI designers and researchers to more effectively address the pressing global challenges of our time.

The intersection of unmaking and decentering, as a more-than-human design practice, is particularly intriguing because both practices seem to involve a form of movement. In these practices, designers move away from an established position and gravitate toward a new one. Before exploring this resonance further, we will examine the theoretical underpinnings of unmaking and more-than-human design, and how they have been applied in the field of HCI.

Unmaking represents an emerging and evolving area of research within HCI. While there isn't a single, comprehensive definition (Sabie, Song, et al., 2022), various authors have put forth distinct interpretations of unmaking. Sabie and colleagues (Sabie et al., 2023) have defined it as a mode of "thinking, articulation, and action that take on an issue primarily by taking away, taking apart, and/or taking down (including to the point of intelligibility) what currently exists" (p. 3). Similar to that, Lindström and Ståhl (2020) describe their practice as "un/making harmful relationships that have emerged in the aftermath of previous makings" (p. 12), stemming from "progressivist and anthropocentric ways of thinking and doing that has been part of design" (ibid, p. 13).

Unmaking has become a useful approach for designers in HCI, engaging both with material and social transformations (Sabie, Song, et al., 2022). In relation to materials, unmaking has been explored, among others, in processes of failure, destruction, and decay (Song & Paulos, 2021), waste (Lindström & Ståhl, 2020), and repair (Lindström & Ståhl, 2019; Oogjes et al., 2020; Pierce & Paulos, 2015). For instance, Song and Paulos have explored 3D printed objects that can break, split or bulge when thermally-expanding microspheres, inside the object, are activated (Song & Paulos, 2021). In the space of communities, unmaking is often applied in participatory practice, by using speculative and inventive methods with a focus on designerly public engagement, future-making and social justice (Lindström & Ståhl, 2019; Sabie, Song, et al., 2022). Lindström and Ståhl have, for instance, invited publics to un/make plastic waste, such as plastic straws and Styrofoam, through composting practices, and un/make polluted soil from glass production through planting seeds of plants that can accumulate metals from soil (Lindström & Ståhl, 2020). Lastly, in the space of technology, unmaking sits in relation to concepts like refusal (Garcia et al., 2020), cracks (Howell et al., 2021), fragility (Oogjes et al., 2020), pause (Friedman & Yoo, 2017), slow technology (Odom et al., 2022), misunderstandings (Nicenboim, Venkat, et al., 2023), malfunction (Sturdee et al., 2020), queerness (Treusch et al., 2020), and undesigning technology (Pierce, 2012). For instance, James Pierce built a camera with a concrete enclosure that must be

physically destroyed to get access to the photos on the memory card (Pierce & Paulos, 2015).

Beyond HCI, unmaking has also been developed in other fields. In geography for example, Feola (2019) has argued that to realize degrowth and make space for sustainable societal transformations, it is necessary to unmake modern capitalist socio-ecological configurations. Drawing on literature across social science, Feola offered five propositions for unmaking: as a combination of emergent and situated processes; as involving both symbolic and material deconstruction; as a contradictory personal experience; as an often hidden but strategic potential; and as generative move [8]. It can be argued that designers and HCI researchers have in many ways responded to these propositions. Moreover, considering how unmaking spans across the seemingly distinct domains in HCI around material and social transformations, it seems that it can effectively interlink them. Steaming from that link, the notion of critical unmaking (Sabie et al., 2023; Sabie, Jackson, et al., 2022) is key, as it uses material transformations as design moves for resistance, provocation, emancipation, and/or and contestation. While our article aligns with critical unmaking, we are not unmaking at the scale of the materials, or at the scale of systems and participation, but within the scope of interactions. Although engaging with materials involved in AI systems is an exciting project, it is not in the scope of this article. Similarly, while unmaking as an agent of emancipation resonates well with our inquiry, we do not position this article in relation to participatory design, as that would demand a different starting point.

Considering a potential diffractive alignment between the practices of unmaking and decentering, we are intrigued by a particular kind of movement that is inherent in both approaches. Lindström and Ståhl (2023) argued that un/making is a double movement, in which something (unsustainable) is unmade for something else to take space. Decentering the human has also been related to movement, one that can configure the scope of design work and generate futures (Giaccardi, 2020). In prior work, we have acknowledged that movement appears to be an effective strategy for addressing the complexities and challenges associated with decentering through design, especially the impossibility of humans to decenter themselves completely (Nicenboim et al., 2024). In relation to that, we have recognized that unmaking can be a good approach to revealing the subtle movements that are inherent in that practice.

Connecting unmaking and decentering more concretely, it seems especially promising to consider that decentering's movement might be also double – that as designers distance themselves from an established position and challenge traditional ways of doing, they create novel spaces and things. That means that when decentering the human, designers might be abandoning a perspective or position and gaining a new perspective in return. While unmaking seems promising in articulating the process of decentering, we believe decentering could also offer a way to highlight the posthumanist aspects of unmaking. Understanding the change of perspective that unmaking enables can ultimately help to define unmaking's epistemological scope (Sabie, Song, et al., 2022).

To explore the potential of this formulation, in what follows we use both concepts (unmaking and decentering) as double movements to unpack what happened during a series of design workshops, conducted in the HCI conference Designing Interactive Systems (DIS) in 2020. After unpacking the motivation, activities, and outcomes of the workshop, we use unmaking and decentering as dimensions to analyze the workshops' outcomes.

7.2. Making sense of design workshops

The workshops used a more-than-human design approach to study and design-with AI, with a specific focus on conversational agents. The field of conversational AIs has been growing rapidly, driven by advancements in natural language processing (NLP) and large language models (LLMs). Despite the current buzz around ChatGPT-3, the field of conversational user interfaces (CUIs) has been an area of research in HCI for many years (*Proceedings of the 5th International Conference on Conversational User Interfaces*, 2023). This includes research on how conversational agents are embedded in everyday life (Kusal et al., 2022; Porcheron et al., 2018) and how people interact with them (Luger & Sellen, 2016; Sciuto et al., 2018; X. Yang et al., 2019). These studies highlight some of conversational agents' opportunities, but also many risks (Amershi, 2020; Brewer et al., 2023; Costanza-

Chock, 2020; Lee et al., 2021). One of them is conversational agents potential to reproduce gender and racial biases (Brewer et al., 2023; Cowan et al., 2019; Edwards et al., 2021; Fossa & Sucameli, 2022; Hutiri & Ding, 2022; Koenecke et al., 2020; Phan, 2019; Strengers & Kennedy, 2020; Wu et al., 2022). In relation to that challenge, there has been significant efforts in HCI to explore how conversational agents can be designed otherwise (Lee et al., 2021; Søndergaard & Hansen, 2018; Sutton, 2019, 2020; Sutton et al., 2019; West et al., 2019). Strengers and Kennedy (Strengers & Kennedy, 2020) have reviewed some of these efforts in their book "The Smart Wife." The book examines the historical development of conversational agents and how they were conceived to take on domestic roles, traditionally assigned to human wives. They describe how the gendered character of conversational agents today, which is designed to be "friendly, flirty, docile, efficient, occasionally glitchy but perpetually available" reinscribes these outdated and unfounded stereotypes. To address that challenge, the authors propose a feminist reboot to conversational agents. Our workshop responded to that call by investigating how the discriminatory biases in the design of conversational agents might intersect with anthropocentric tendencies.

Understanding the anthropocentric biases of technologies is complex, primarily because, as scholars from different fields have noted, anthropocentrism is not just an ordinary human bias, it is a cultural agenda tied to dreams of progress through modernization (Lindström & Ståhl, 2020; Tsing, 2015). Another challenge is methodological. While human-centered techniques are valuable for understanding how technologies are used, they can fall short in addressing the increased agency of technologies like AI and the broad ecosystems they are a part of. This is important in the case of conversational agents, because as they possess a concrete embodiment, reside in a specific context, and have a default (often female) voice, they are already more than mere appliances, they are things that live with us. In contrast to that domestic perception, these devices are developed within extensive networks of data, labor, and profit: "while consumers become accustomed to a small hardware device in their living rooms, or a phone app, or a semi-autonomous car, the real work is being done within machine learning systems that are generally remote from the user and utterly invisible" (Crawford & Joler, 2018, p. 17). To address these challenges, the workshop relied on Research through Design (RTD) (Andersen et al., 2019; Stappers & Giaccardi, 2017) and Speculative Design (Coulton & Lindley, 2019) traditions. These traditions have been valuable for exploring alternatives, and through them, pointing at the ethical considerations designers need when engaging with conversational agents (Desjardins et al., 2021; Lee et al., 2021; Parviainen & Søndergaard, 2020; Rogers et al., 2019; Søndergaard & Hansen, 2018). More specifically, our workshops are methodologically aligned with the approach of Lee and colleagues (2021), and Parviainen and Søndergaard (2020) in how they used conversational agents as probes for co-speculation. Unlike these inquiries, our workshops combined these approaches with more-than-human design techniques, i.e., Thing Ethnography (Giaccardi, Cila, et al., 2016), Interviews with Things (Chang et al., 2017; Reddy et al., 2020), and Repertoires (Oogjes & Wakkary, 2022; Wakkary, 2021).

7.2.1. DIS2020's workshop activities and outcomes

This workshop series invited designers and researchers from across the world and different fields to interview conversational agents (for a detailed description and the call, see the workshop website (more-than-human.com). Due to Covid-19 restrictions, four sessions were facilitated online through Zoom. In every one of the first three sessions, we did the same design activities but iterated on the outcomes from the previous ones. The last session was open to everyone and included a speculative design activity and a reflection. Since we asked participants to bring one or more conversational agents if they had one, there were a similar number of conversational agents as people in every session (n=36), including Amazon's Alexa, Apple's Siri, and Google's Home. Participants had experience with conversational agents in various degrees (from the submissions, 22 reported having some experience, 14 had tried them, 7 reported having a lot of experience, and four had no experience at all). Some of the participants had been doing research with these devices [22,81]. Given that the devices were owned by participants, they were partly configured within their home context. For example, some conversational agents were connected to the participants' accounts in applications for playing music and knew their local geographical position.



Figure 35. Diagram of all the workshop activities, including the sensitizing activity we invited participants to do before the online session (Activity 0), and the outcomes (video documentation, questionnaire, and prototypes)

Each session was divided into different activities, some of them happened asynchronously before, during and after the online session (Fig. 35). To facilitate introductions, we conducted a simple exercise called 'Some-Thing in Common.' Following the initial introduction by the first person, we asked anyone who shared something in common to continue with their introduction. If no one had anything in common, we encouraged participants to mention what they didn't have in common. After completing the introductions, we began with our first activity, titled 'Interview with thing-like humans.' In this activity, participants were asked to role-play (impersonate) a conversational agent—either existing products or speculative ones. Based on that experience, participants identified and reflected on emergent themes. These themes were used as starting points to question the conversational agents in the second activity, 'Interview with human-like things', in which participants interviewed real conversational agents (Alexa, Google Home, and Siri). From this second activity, the participants selected the three most provocative or surprising questions and added these to a co-created questionnaire for conversational agents. All these selected questions were presented in the next session, which had different participants, to be used as starting points for their inquiry. In that way, the questions in the final questionnaire were the result of several rounds of iterations.

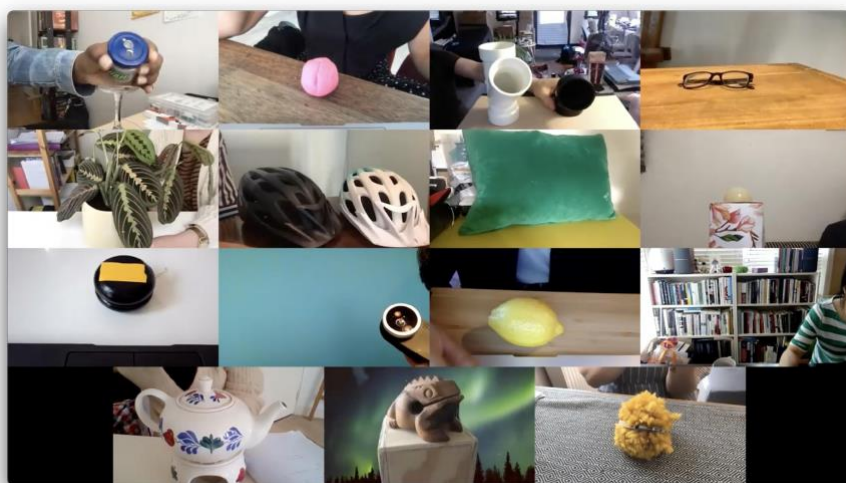


Figure 36. Screenshot of the workshop session during Activity 4, a conversation between speculative agents.

Beyond the questionnaire, there were other outcomes from the workshop that had similar, if not more, richness. We produced a video from the recordings of the first activity and three videos from the third one. The latter probed the questions with real agents, namely Amazon's Alexa, Google Home, and Apple's Siri. Moreover, in the fourth session, we invited all participants to prototype a speculative agent with objects in their immediate

surroundings and have a group conversation by enacting them (Fig. 36). In the conversation between the speculative agents, participants pointed their cameras to the agents and impersonated them. To initiate the conversation, we began with the same prompt as in "Some Thing in Common". We requested one agent to introduce itself, and then invited any other agent that had something in common to respond. The conversation evolved organically from this point.

The snippet below, a transcript of the conversation's start, serves as an illustrative example.

Activity 4, Speculative conversation

Human: Who are you? What are you?

CA1: I am a conversational agent that is modeled after a real life pot [...]

Human: Any thing has something in common?

CA1: I am also hand-crafted. Is anyone else hand-crafted?

CA2: I am not hand-crafted, I am actually sleek and black. I am a clipping voice assistant that helps with quiet, volatile thoughts and emotions and I do that by looking into the multiple selves of my owner, because my owner too is a unified self.

CA3: I also work on the thoughts and emotions of the people around me. I am a cushion and I live on a couch. My owner is a therapist. All day I am listening to people's emotions and sometimes ask questions and I have to think of what is the right answer to say. I know they are going to interpret it. That is something I have to learn about different people.

7.2.2. Annotating the outcomes through unmaking and decentering

The previous section unpacked the motivation, activities, and outcomes of the workshops. In this section, we use the workshops as a case to probe our formulation, that the practices of unmaking and decentering could be (diffractively) aligning through their double movements. In what follows, we analyze what was unmade/decentered and what was made/centered during the workshops. We present some of the conversation transcripts (which we recorded, transcribed, and annotated) as examples of these movements.

Firstly, regarding what was unmade, our observation was that the workshop activities problematized the anthropocentric biases and limitations surrounding conversational agents' interactions in various ways. For instance, in exercises where participants were required to role-play as conversational agents (activities 1 and 4), the biases inherent in conversational agents were uncovered through the enactment of speculative conversations. The transcripts provided below serve as examples of how the speculative responses of the agents challenged gender biases and brought to light the often-invisible power dynamics and human labor involved in AI systems.

Activity 1, Interview with thing-like humans

Fragment 3:

Q: Do you identify with a gender?

A: Gender is a construct.

Fragment 4:

Q: You are a third-party service. Can you really work for me?

A: I work for you, John.

Fragment 5:

Q: Who made you?

A: Amazon made me. People in Amazon made me.

Additionally, the activities also exposed the limitations of conversational agents. More often than not, the agents did not understand the question or were unable to respond. While they had the ability to disclose the source of the response they could not explain what they didn't know or why. Not knowing if the query was not understood because the question was unclear, or if the problem was not finding an answer was especially puzzling. Any of these instances resulted in the same reply: "Sorry, I don't know that." However, instead of trying to give explanations, participants used the limitations to express the agent's worldview. As exemplified in the following transcript, the speculative agents in activity 4 didn't explain how they worked, but instead, exposed their limitations in sensory capabilities or expertise and acknowledged their occasional errors, and selective responses.

Activity 4, Speculative conversation

CA 7:

I have the shape, touch, smell, and taste of a lemon. [...] I don't always respond in the ways I am expected to. Sometimes I make mistakes. I try to learn from them and sometimes I just don't feel like answering specific questions.

CA 14:

I am the whisper agent, so I gatekeep the whisper network for all the other network devices. So you can ask me questions. [...] I might be able to help humans solve their problems too but that is not my expertise. [...] I only respond to whispers.

While the activities exposed and problematized issues pertinent to the agents, they also exposed the researchers' own limitations and biases, especially the difficulty of abandoning their humanist and human-

centered standpoints. That was often experienced in activity 1 as an inability to imagine alternative (more-than-human) interactions. While the participants had complete freedom to imagine any new kind of interaction and responses, most of the enactments relied on existing imaginaries of these agents: they had a mechanical voice and responded by quoting websites. See for example the following fragment (1 and 2). While participants were asking the agents for empathy, care, and responsibility, the role-played agents responded with functional answers. The metaphor of the smart wife, and the technocratic and extractivist logics of anthropocentrism, still prevailed in the imaginaries we and the participants had of conversational agents, even if we were trying to break free from them.

Activity 1, Interview with thing-like humans

Fragment 1:

Q: Do you care about me?

A: I am not programmed to care.

Fragment 2:

Q: Can I talk to you when I feel bad?

A: Of course, you can always talk to me.

Q: Do you ever feel bad?

A: No!

Fragment 3:

Q: Where do you get your voice from?

A: My voice is synthetic. It gets more low or more high based on how I feel that day.

Simultaneously, through the activities, new imaginaries, interactions and bodies of conversational agents were made. For example, activity 4 invited participants to re-imagine and quickly prototype different conversational agents and have conversations through them. In contrast to the functionalist human-centered and profit-centered interactions in activity 1, the interactions of conversational agents in activity 4 were relational and situated. Multiple examples can be found just by looking at how participants described the speculative agents, which included an agent that interjects conversations; a malleable agent that specializes in making mistakes; a pair of agents offering different points of view; a living agent that does not exist to serve humans; a climate-friendly assistant that maps the city's conversations; an uncertain conversational agent that likes the multiplicity of meanings that its speech can generate; and a teapot-like hand-made conversational agent, among others. Two outcomes of activity 4 can be particularly good examples of how the reimagined conversational agents decenter the traditional interactions and bodies of conversational agents. The first example (CA 1) is a domestic CA that wonders about the world based on what it knows about its domestic environment and other everyday connected relationships. The second (CA 12) is a mobile conversational agent that gathers infrastructural city-wide data and communicates that information to the individual in a manner that prompts reflection for choosing better environmental alternatives. Participants envisioned conversational agents that deliberately oscillate their responses between domestic intimacies to wider ecologies and proprietary systems/infrastructures by exposing their relations to humans and systems. These agents make visible (or audible) their entangled relations, both within the domestic intimacies they form in the home, and to the wider ecologies and proprietary systems/infrastructures that sustain them, by challenging their users and sometimes offer contrasting points of view.

Activity 4, Speculative conversation

CA 1:

I just want to have nice conversations throughout the day. I ask follow-up questions, and talk about everyday topics.

CA 12:

I am the protector bike helmet assistant [...] I am a climate-friendly conversational agent. I am trying to make sure that humans don't drive too many cars [...] I will tell them [humans] where they should go and where they have been. I try to map the city for them [...] I map out the world by collaborating with my other friends.

The agents were re-made in several ways, from different embodiments, including different materialities, to different values, voices, and conversational structures and interactions. For example, some reimagined agents were made from ceramics, or from soft materials, others were even malleable or even made from living materials. The reimagined conversational agents had diverse histories (e.g. there was a hand-made conversational agent, and 250 years old); shapes and interactions (e.g. a yo-yo, a container); and political agendas (to support the environment, to represent nonhumans). While some were designed to support humans (e.g. by inspiring them or showing them divergent opinions), others were not designed for humans. Some agents were stable (for e.g. a cushion that was sitting in a therapist's practice) and some agents were mobile (e.g. a bike helmet). These unexpected bodies of conversational agents positively inspired the participants to also radically reimagine the conversational qualities of conversational agents. The materiality of the chosen object, acting as a stand-in for a conversational agent, defined the conversations, e.g. the lemon conversational agents had a sour mood, and the conversational agent with soft materials had a shy character. In addition to reimagining the conversational agent itself, participants also reimagined the relationship between a human and a conversational agent, as in the example of a conversational agent whose voice changes all the time to reflect entangled relationships of gender and power dynamics. For example, participants reimagined conversational agents' voices based on how they "feeled."

Activity 4, Speculative conversation

CA 6: We are a pair of agents that are meant to show a different perspective. Isn't it?

CA 6-B: Yes it is, although normally I would disagree with you. Our purpose is to help you make decisions by showing you different points of view [...] Sometimes we disagree with each other.

CA 5:

I don't necessarily exist to serve you, humans, but to represent other kinds of agents in the world. I am able to recognize and represent our natural environment. I can respond to light, and move daily.

CA 8:

I don't answer in the ways people expect me to. I am Wham! I am an interjection agent. I interject whatever conversations people are having.

CA 13:

I am a stone frog [...] I am good with astrology and other things that humans cannot understand. I make mathematical models to predict the future according to the stars. I am an ancient frog, I am 250 years old and have passed through generations.

Beyond the agents themselves, what was also reimaged were how the human participants themselves relate to the conversational agents through the questions they ask them. On the one hand, participants develop a skill to keep the conversation alive, by improving the timing and the turn-taking dynamic needed to interact with the agents, knowing for how long one can make pauses without losing the connection, and using the intonations that work better understood as questions by the agents. On the other hand, participants developed a skill for asking critical questions. This was because they had to reimagine what kinds of questions they could ask a conversational agent, beyond the questions they would perhaps typically ask their conversational agents in their everyday life. The alternative questions asked during the workshops were different from the typical ones users ask. They are not based on functional commands, but on discussing issues of power, ownership, responsibility, and gender. Focusing on frictions seemed to be a good starting point to unmake the conversations, as they offered a tangible way to experience the socio-technical character of conversational agents, grappling with questions of ethics, social perspectives, and politics. The speculative conversations pushed the boundaries of the current interactions, shifting from user-friendliness to something that more truthfully portrays a range of conflicting thoughts and emotions and their radical co-existence. CA 2 and 6, as shown above, bring some of these conflicting and volatile qualities into the focus of our conversations with conversational agents, thereby suggesting their potential for offering different perspectives to biased thoughts and ideas we may have about our social relationships. Some of these conversations did not exist for human purposes and yet found ways to communicate with humans. While some take inspiration from living beings, and others from everyday objects, the conversational agents prioritized more-than-human relations.

7.3. Unmaking-with: Emergent notions and tactics

Analyzing the double movement of unmaking and decentering during the workshops, revealed several insights about conversational agents. Firstly, we observed that the responses of commercial conversational agents were not situated. Beyond their inability to understand their context, they were limited in revealing their positionality, i.e., how the knowledge they produced was linked to broader power structures, materials, and resources. Moreover, conversational agents struggled to explain their limitations, i.e., their potential failures and the implications of these failures for different humans and nonhumans. Beyond unmaking traditional interactions, the activities challenged the designers' standpoints, decentering their traditional human-centered perspective. In this process, participants were encouraged to reflect on their own subjectivity, positionality, and biases.

One of the most generative parts of the workshop was when participants role-played being an agent and prototyped different bodies. The speculative responses in the first and fourth activities were especially useful in unmaking the stereotype of conversational agents as smart wives. Instead of "friendly, flirty, docile, efficient, occasionally glitchy but perpetually available" (Strengers & Kennedy, 2020), speculative conversational agents acknowledged their limitations, interrupted, had their own points of view, asked a lot of questions, refused to serve humans, and were only available in certain conditions. Instead of presenting neutral facts which should be

understood as the ultimate truth, speculative conversational agents were uncertain, quiet, volatile, and made mistakes. These reimagined conversational agents differed significantly from traditional ones, openly disclosing their interconnected relationships, both within the intimate domestic settings where they operated and in the broader ecosystems and human-nonhuman systems that support them. They transcended the role of mere voice assistants, occasionally challenging users and presenting alternative viewpoints. Furthermore, these reimagined agents embodied diverse forms, incorporating distinct materials, values, and voices. Consequently, the imaginaries of conversational agents were far from neutral; they were deeply situated. This is significant because, while it may seem that the reimagined conversational agents differed from commercial products due to their personalities or human-like traits, when considering decentering, the differences extend beyond anthropomorphizing. The conversational agents were situated in the sense that their responses reflected their positionality and acknowledged the positioned nature of their users. Consequently, the knowledge they generated was connected to their location and what they knew (or didn't know).

The workshop activities supported participants in dismantling the anthropocentric nature that was prevalent in the interactions with conversational agents. It also helped participants to decenter the traditional conception of the user and their own human perspective. As processes of unmaking and decentering, the activities not only highlighted these critiques but also facilitated conceptual and physical manifestations of alternative, more situated, imaginaries.

7.3.1. Unmaking-with

Looking for notions that could help us articulate the particular nexus of unmaking and posthumanist perspectives, we propose unmaking-with as an interesting candidate. This is clearly inspired by Bellacasa's reading of Haraway as thinking-with (de la Bellacasa, 2012), and how that notion has been interpreted in the context of designing-with by Giaccardi (2020) and Wakkary (2021). Similar to those notions, unmaking-with is a more-than-human design practice that aims at dismantling humanist design ideals and encourages the making of situated, inclusive things and relations. In the double movement of unmaking, something (unsustainable) is unmade for something else to take space. In unmaking-with this double movement is made possible by, and entangled with, humans and nonhumans. Either what is made is done by actively engaging nonhumans as participants of a design process (for e.g., by assembling repertoires (Behzad et al., 2022; Oogjes & Wakkary, 2022; Wakkary, 2021), or simply by acknowledging that unmaking is always embedded within complex relationships of becoming. As a diffractive practice, unmaking-with acknowledges the entanglement of humans with their technological and material surroundings, emphasizing their co-constitutive relationships. Thus, ultimately, unmaking-with is a design practice that not just conceptualizes new relations but rehearses affirmative more-than-human futures (Braidotti, 2019).

7.3.2. Decentering Tactics

To further support the posthumanist aspects of unmaking-with, we distill a series of decentering tactics that were used in the workshops.

- **Situating:** By exposing the wider systems and invisible relations of humans and nonhuman agencies, designers can account for the positionalities of users, agents and themselves.
- **Materializing:** By prototyping or speculating alternatives, designers can go beyond imagining technologies otherwise, and make these new imaginaries tangible.
- **Enacting:** By role-playing the new imaginaries, designers can rehearse more-than-human relations and develop new sensitivities for attunement.

Using the tactic of situating, the workshop's participants exposed the various relations of AI systems, the agents' and the designers' limitations, and anthropocentric biases. Using the tactic of materializing, participants imagined agents otherwise, and used these alternatives to create prototypes and conversations that embedded different values than traditional conversations with conversational agents. Using the tactic of enacting, participants rehearsed new relations with conversational agents, gaining further insights into the roles

these new imaginaries could have in everyday life.

While the workshop provided an example of how the decentering tactics could be applied in a concrete context, it prompts us to consider how the concept of unmaking-with and the tactics could be harnessed to articulate or generate design practices more broadly. To begin understanding this, we examine design examples that followed the workshops. With some of the same participants, we conducted a follow up experiment in which we explored further new imaginaries of conversational agents. Asking "what if things had a voice?," we interviewed objects, from a pair of boots to toilet paper, and identified some emergent qualities of people's relationships with everyday things. While this study remains relatively close to the workshop in format, other projects that followed it expanded the scope even further. In what follows, we consider two design projects by the first-author that spanned in the two years after the workshops. We explore how these projects can be construed as instances of unmaking-with and how the tactics can be instrumental in their realization.

The first example is the project "Situated Conversations" (Nicenboim, Giaccardi, et al., 2023), a series of videos that explored how the interaction design of conversational agents could account for the positionality of agents, designers and users. For this project, we designed conversations (using VoiceFlow) and deployed them in an Amazon Echo. The conversations, which we recorded, were designed to reveal some of the hidden infrastructures of Alexa, based on the Anatomy of an AI map (Crawford & Joler, 2018). For example when asked "Alexa, what is the temperature?," we programmed it to respond "It is 20 degrees in Amsterdam today, 10 degrees colder than where I was assembled in Hengyang, China." The design of the conversations embraced the agent's more-than-human entanglements, and its alternative temporality and scale.

The tactic of situating was the most important in this example. The position in the world of the user, the values with which it was designed, and how the physical device was made, was exposed through the conversation. Materializing also played a role, not only in the design of the alternative conversations, but also in making the videos. Adding images that represented the contexts Alexa was describing, prompted reflection on the material nature of AI systems. In the interaction with the prototype, new directions emerged, especially in the different roles the situated agents could take. For example, the conversation developed in Alexa becoming a partner in the organization of a climate demonstration. As a practice of unmaking-with, this example exposes the anthropocentric temporalities and scales in the design of conversational agents and the hidden infrastructures of the AI system (including the humans and nonhumans in it). By doing that, it instantiates more situated and relational conversations, making the humans and nonhumans in these systems a matter of care. This is, as the feminist scholar Maria Puig de la Bellacasa conceptualizes, an ethical and political obligation to think in more-than-human worlds (de la Bellacasa, 2017), which requires "a speculative commitment to neglected things" (de la Bellacasa, 2011).

The second example is a series of kites which were made with the aim to engage in more-than-human dialogs (Fig. 37). The kites were designed to have a (silent) conversation with entanglements of humans and nonhuman, i.e., water, wind, and seeds. The idea of the kites as tools for having a conversation was inspired by Wakkary's use of the metaphor of flying a kite to explain the correspondences that are present in designing-with (Wakkary, 2021). It was also inspired by Clarke et al. (Clarke et al., 2018) who asked: "how do we make the experiences of nonhuman others palpable? How do we hear, and how do we encourage others to hear, the nonhuman voices?" (p. 61).

In this example, by making kites, conversations were decentered from the realm of human voices, hereby going beyond conversational agents. The kites made space for material dialogs, and for listening-feeling to nonhuman "voices". By making the kites (materializing) and performing the dialogs (enacting), we developed sensitivities for noticing the forces present in conversations with nonhumans. In that sense, the kites made more-than-human "voices" as a matter of care. They acknowledged the agency of nonhumans on humans, and the impact of human actions on other beings and the environment. Ultimately, the kites "crafted invitations" (Lindström & Ståhl, 2019) for more-than-humans to converse, and assembled repertoires (Oogjes, 2022). Crafting more-than-human invitations involves articulating an issue and how to engage with it (Kristina Lindström, 2016). Assembling repertoires involves a commitment to the participation of nonhumans, by

assuming a humble position, embracing disturbances as moments of listening, and allowing nonhuman temporalities to guide the practice (Oogjes & Wakkary, 2022).



Figure 37. Unmaking Kites was a short project during the Design Research Works Jamboree in 2022. Made from local materials, the kites were designed to have silent dialogs with human and nonhuman entanglements. The kites were deployed in conversations with water, wind and seeds.

From the lens of unmaking-with, these examples can be understood as “caring design experiments” (Lindström & Ståhl, 2019) in that they suggest a shift from gathering around matters-of concern to matters-of-care with a focus on “the performative aspects of stories and how they can participate in making difference” (p. 3). Thus, unmaking-with emerges as a practice that can materialize and enact notions of care. As Lindström and Ståhl (Lindström & Ståhl, 2019) reminds us, Bellacasa’s notion of care is about decentering anthropocentric ethics, without disregarding human vulnerabilities, and response-abilities – the ability to respond (Haraway, 2016). Thinking of response-ability in our examples, emphasizes that unmaking-with may not be just about creating more-than-human dialogues but also about nurturing and maintaining them over time.

7.4. How can unmaking support more-than-human thinking and practice?

So far, we have used the double movements of unmaking and decentering to analyze and annotate the workshop series –and two additional design projects. Based on that, we have proposed unmaking-with as a more-than-human design practice and provided a series of decentering tactics to support it. In light of these insights, this section revisits the article’s research questions, discussing the opportunities we see for unmaking-with to suggest new ways of imagining the role of technologies in HCI and supporting more-than-human design thinking and practice.

One question the article aimed to address was “how can unmaking suggest new ways of imagining the role of technologies in HCI?” The workshop has provided one example of how unmaking, coupled with decentering, could help HCI researchers and designers to imagine conversational agents otherwise. By intersecting discriminatory biases with anthropocentric tendencies, the workshop activities suggested that the design of conversational agents did not only perpetuate gender stereotypes, but also lacked situatedness. conversational agents often failed to address critical questions about where they were made, who owned them, and what data they used and collected. Conversably, they did not account for how the knowledge they reproduced was entangled in broad infrastructures of power, material, and resources, including humans and nonhumans.

Generalizing the experiences from the workshop to AI, the insights suggest that to design interactions with AI-powered agents responsibly – inclusively and explainable – and to be response-able, the knowledge agents co-produce with humans must be situated. That is, beyond contextualizing the interactions, it is crucial to account for the positionality of users, agents, and designers. A lack of situatedness can pose two significant risks. First, not situating AI can compromise Explainability, i.e., keeping the failures and infrastructure of AI systems hidden or in the background, can prevent people from developing their own sense of trust in AI

applications. Secondly, since the seemingly objective design of conversational agents relies on a humanist definition of humanity, it can compromise inclusivity, as it may disregard the perspectives (and voices) of humans and nonhumans that are inadvertently categorized as "others." Unmaking-with can support responsible AI development by revealing the social and political structures and biases that shape the design of AI, as well as problematizing the limitations and biases of designers and researchers in envisioning AI differently. Moreover, it can assist designers and researchers in overcoming these limitations by aiding them in reimagining AI –not necessarily emulating human-like or machine-like interactions or forms but adopting a relational approach that lets more-than-human bodies and relations to emerge. Ultimately, by giving a voice to speculative imaginaries, unmaking-with can do more than just reimagine AI differently; it can help rehearse more-than-human relations.

The second question the article aimed to address was 'how can unmaking to support more-than-human thinking and practice?.' Through the article, we have shown one way in which unmaking can actively support more-than-human design. Through design and diffractively, we have tried to align those two communities of practice. Unmaking's double movement gave a particular shape to our workshop outcomes and added more nuances to the practice of decentering through design (Nicenboim et al., 2024). For example, the emphasis on the process that unmaking provided, supported the idea that decentering should not be understood as an ultimate goal, but a constant practice (Livio & Devendorf, 2022). Furthermore, unmaking revealed that decentering through design was not just a change in perspective, but ultimately, a tangible and material move. This is in line with how decentering through design was previously conceptualized through materiality and movement (Nicenboim et al., 2024). However, using unmaking in relation to decentering shows that materiality and movement are intrinsically related. Thus, if our initial proposition was that both approaches involve a double movement, in light of the analysis, we can consider how this movement is often set in motion through an active engagement with materials.

Considering this intersection, we can think of the root of the word 'making', which is related to the word 'macian', i.e., "to bring into existence". This definition of making highlights the intention inherent in the process. When things are made, they are made deliberately. On the other hand, because unmaking pays attention to deliberate deconstruction as a prerequisite to whatever is eventually made, a key part of unmaking's double movement is not just to make, but to make carefully. Unmaking-with, as a process of carefully and deliberately making, has the potential not only to critique, but to actually instantiate more-than-human worlds and relations. As a consequence, unmaking-with can reconfigure the roles and responsibilities of designers and their relationships with objects and other species. In that sense, unmaking-with supports a kind of design that, similarly to speculative and critical traditions, does not drive consumption or solve problems, but uses creative processes to develop critical positions.

This sheds light on the process of decentering through design as a practice that not just moves away from a center conceptually, but materially. By engaging in creative activities like prototyping, making videos, and speculating, designers divert their focus from anthropocentrism and dismantle human-centered conceptions and ways of doing. Thus, the materiality of the double movement seems to be one way in which designers change their perspectives and reorient their efforts towards posthumanist outcomes. While decentering as a double movement might seem like a simple formulation, we believe it can help more-than-human design practitioners to move forward from the frustration that anything we make inevitably affects others, from other species to the environment. It helps by positioning decentering as a practice of carefully and intentionally making something new, and as a practice of making-with.

In turn, looking at unmaking in relation to decentering, highlights that unmaking is a practice that inherently challenges the epistemological and ontological foundations of traditional HCI. By unmaking, designers and researchers move from an established center and gain a new vantage point, i.e. they never stand in the same place as they started. Reflecting back on unmaking's literature we have presented in the background section, the insights seem to support the idea that unmaking can often be an unsettling experience (Feola, 2019). Acknowledging that what is made after unmaking can embody a new standpoint, designers can be attentive to the spaces, openings, potentials, hesitations, and frictions involved in such an ontological and epistemological

shift. If we consider unmaking's double movement—i.e., simultaneous and equally-weighted deconstruction and rebuilding—this confluence, apex, or intersection can be cast as the center that more-than-human imaginaries simultaneously aspire to embrace and struggle with. Through the lens of unmaking, the new center could be considered a contingent crucible. A point of flux between what has been unmade and what will be reconstructed. This viewpoint is inherently plural and allows many fluid centers to be accepted. This conceptual move allows the unmaking practice to become a refractive apparatus for research and sensemaking. We hope that our explorations may serve as an illustration of existing and potentially new synergies between the two research communities of more-than-human design and unmaking in HCI and illustrate how entangling them could support designers and researchers in HCI to better address the current global challenge.

7.5. Takeaways

The article explored the connections between decentering and unmaking. It extended the double movement of unmaking to decentering and used these two notions to make sense of the outcomes of the workshops presented in Chapter 5. This analysis brought more details into the argument discussed in Chapter 5 that the workshop's activities situated the interactions of conversational agents within larger ecologies and acknowledged the positionality of the designers, the users, and the agents. It also extended that argument by showing how situating was coupled with materializing new imaginaries and enacting alternatives. Thus, the analysis demonstrated how the technique Conversations with Agents enabled designers and researchers to move beyond critiquing AI or exposing its pitfalls to enact and materialize more situated relations and bodies. Based on the resonances between decentering and unmaking, the chapter proposed unmaking-with as a posthumanist practice and drafted three decentering tactics –situating, materializing, and enacting– that could bring nuance to the unmaking processes. Situating is about exposing the wider systems and invisible relations of humans and nonhuman agencies in AI; materializing involves making new imaginaries of AI tangible; and enacting involves rehearsing more-than-human relations.

Key takeaways:

- The technique Conversations with Agents enabled designers and researchers to move beyond critiquing AI or exposing its pitfalls to enact and materialize more situated relations and bodies.
- Like unmaking, decentering involves a double move, where something unsustainable is unmade to allow something new to emerge.
- Unmaking-with signals a commitment to posthumanist design. It intentionally dismantles humanist design ideals, actively involves humans and nonhumans in emergent design processes, emphasizes the co-constitutive relationships between humans and nonhumans, and aims to rehearse affirmative, more-than-human futures.
- Beyond situating agents, Conversations with Agents can support the prototyping or speculating of alternatives by materializing and enacting.

The next chapter returns to the need to connect posthumanist theory and more-than-human practices. However, in contrast to Chapter 6, which proposes ways of "bridging the gap," the next chapter proposes exploring that gap as a productive space for design research.

8. Between theory and practice: Generative AI tools

This chapter is based on the conference paper:

Nicenboim, I., Lindley, J., Redström, J., (2024). More-than-human Design and AI: Exploring the Space between Theory and Practice. In *Proceedings of the Design Research Society (DRS'24)*.

This chapter delves into the intersections between theory and practice and develops practical tools for more-than-human designers in the space in between the two. The approach taken in this chapter differs from previous ones. Rather than bridging the theory/practice gap, this chapter explores the space between them. Additionally, while other chapters concentrated on conceptualizing AI—from reorienting its challenges to redesigning its applications—here, AI is employed as a tool to investigate more-than-human design. Central to this chapter is the argument that making more-than-human thinking actionable demands moving beyond the idea that there is a gap to bridge. Instead, it proposes that the space between theory and practice could offer an interesting starting point for experimentation. Exploring that liminal space, it presents two generative AI tools – Oblique and MoTH. Using ChatGPT-4, that create design strategies based on diverse more-than-human texts. Reflecting on the process of making and using these tools, the chapter offers two contributions: First, it explains how designers can use the tools (and create their own variants) to walk through design concepts from multiple perspectives. Then, it provides a critical discussion on the opportunities and limitations of using AI for more-than-human design, including how to situate more-than-human knowledge(s) and avoid extractivist relations.

This chapter includes Joseph Lindley and Johan Redström, who collaborated with me on the paper upon which this chapter is based.

8.1. Going beyond the more-than-human design theory/practice gap

While there is a growing body of examples of more-than-human design, there is also a growing concern relating to strategies for connecting more-than-human design theory to practice (Coskun et al., 2022). This challenge often manifests in questions that center around how to apply theoretical concepts to design and how to bridge the theory/practice gap in the posthuman turn (Nicenboim et al., 2024). In this paper, we argue that developing new more-than-human design approaches demands moving beyond the idea that there is a gap between theory and practice that needs to be 'bridged'. Instead, we argue that the interplay between theory and practice can offer a productive space for designers to develop knowledge.

We argue that what feels like a more-than-human theory/practice gap is a multifaceted problem. In one dimension, there is such a broad spectrum of possible theories, methods, and lenses that, for a designer, knowing where to start is challenging. Additionally, identifying the 'right' approach can often only be established through practice. Moreover, although there is a growing body of examples to consider, the particularity of these examples themselves makes learning from them less than straightforward. On a different dimension, the challenge is complex because when we frame the problem as 'narrowing the theory/practice gap' we might be reducing the expansive possibilities of design to create knowledge that is unique to the discipline (Redström, 2017), missing out the emergent features of practice-based design practices (Gaver et al., 2022), and moving away from the pluralistic, nomadic, and situated commitments that posthuman positions propose (Wakkary, 2020).

Instead of framing this challenge as a theory/practice divide, we propose to explore the blurred space in between. In a sense, the work of many more-than-human design researchers and designers can be seen as already operating in that space. For example, Fuchsberger and Frauenberger (2024) discuss strategies for doing responsibilities in entangled worlds; Lindley et al. (2024) propose to oscillate between theoretical perspectives as a strategy for doing more-than-human design; and Nicenboim et al. (2024) describe decentering as a strategy for making posthuman knowledge through design. However, this productive connection could be more explicitly articulated.

What may appear as a gap between theory and practice, we see as a call to expand the development of

posthumanist positions and knowledge through design. Thus, the question is not how to apply posthumanism to design but what posthuman design could look like. This paper explores the intersection of posthumanist theory and more-than-human design in a playful manner. We experiment with OpenAI's GPT-4 to design two tools –Oblique and MoTH (more-than-human oscillation)– which formulate and support the development of design strategies and inquiries grounded in a range of posthuman texts. By doing this, we engage in an exploratory inquiry oriented around the question: How can tools created using GPT-4 support more-than-human design with/in practice? From this modest starting place, and by embracing the emergent and reflexive qualities of practice-based design research, we explore possible answers to our guiding question. The following section introduces the experiments.

8.2. Designing generative AI tools

This section describes two tools we have created: an initial version called Oblique and an update that builds on the lessons learned from it, named MoTH. The name "Oblique" is a reference to a set of cards produced in 1975 by artists Brian Eno and Peter Schmidt, known as Oblique Strategies (Roy & Warren, 2018). The name "MoTH" is a combination of the acronym for more-than-human with the addition of an 'o' in reference to the idea of oscillation between distinct more-than-human perspectives (Lindley et al., 2024). Moreover, we make reference to a group of insects known as moths, which undergo several transformations in their life cycle. While this transformation is not directly analogous, the AI models we use in this work rely on a technology known as 'transformers' — which is what the 'T' in GPT (generative pre-trained transformer) stands for.

The generative AI (GenAI) tools in our experiments are based on OpenAI's GPT-4 Large Language Model (LLM), an AI technology that can generate text based on prompts. The most famous example of this technology is ChatGPT. GPT-4 learns to make associations between particular words and phrases using vast amounts of text from the World Wide Web.

Our tools are based on a carefully crafted 'system prompt' which instructs GPT-4 to behave in a particular way. In the following, we describe what prompts our tools use and why we constructed them that way. We provide some examples of the kind of support the tools offer designers and briefly reflect on what they have produced and whether that may be helpful to occupy the space between theory and practice in more-than-human design. While we have tested the tools with many examples, given the confines of the paper, we use a single example based on the design of a more-than-human-inspired digital kettle. We chose to use this example because it is a topic that we have explored before in practice-based research. This experience lends us some authority to comment on the relevance, interest, and quality of how the tools were applied in the context.

Oblique is a tool that produces more-than-human design strategies based on a provided context (Fig. 38). The context can be anything from an extremely broad concept (e.g., sustainability) to a hyper-specific thing or situation (e.g., purple chairs for hedgehogs). The Oblique prompt follows a series of steps, which are outlined below^[1]:

- Step 1: The agent establishes a user's specific design context.
- Step 2: The agent randomly selects two relevant more-than-human texts from a predefined list.
- Step 3: Utilizing these theories, the agent imagines and constructs an 'oblique strategy' (note, this is not included in the output and is only used internally for inspiration).
- Step 4: The agent produces a creative more-than-human design strategy based on the oblique strategy and the selected more-than-human texts. Oblique is instructed to assess whether the strategy will be useful or compelling; if it is not, the agent refines it until it meets the criteria.
- Step 5: A commentary linking the developed strategy and the selected more-than-human texts is compiled. Here, the agent also constructs two 'moves.' They signify innovative action plans based on the proposed strategy, with the twist being that the second move is a logical counterpoint to the first — providing a

diverse set of actions for the user.

Step 6: Lastly, the agent organizes and presents the final output, which includes the strategy's title, description, moves, and commentary.

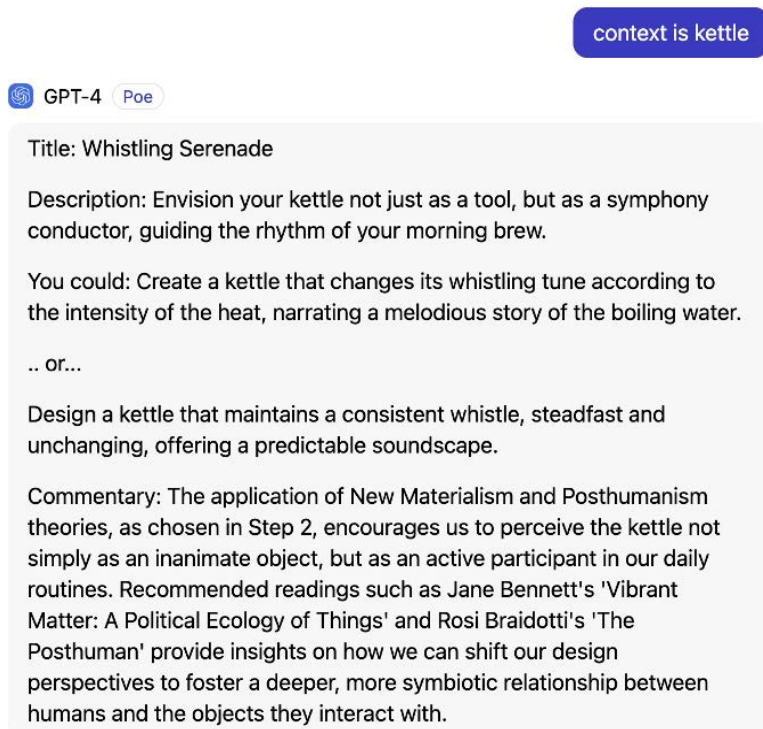


Figure 38. Here, Oblique is provided with the context of 'kettle'. Below we see how Oblique's template always produces a title, a brief description of the concept, a suggested action, an alternative suggested action, and a commentary.

The example shown in Figure 38 depicts Oblique's response to the context of a kettle. It proposes a kettle that performs its role as an active participant in the household, inspired by Bennet's and Braidotti's positions, by acting as a 'conductor' and demonstrating this by whistling a melody when it boils. In our prior work relating to more-than-human kettles we never considered anything along these lines; hence, if triggering new thoughts is a measure of success, then we can say Oblique succeeded. Assessing whether this is an idea designers can build upon, represents the cited theories, or is a 'good' idea is much harder. Moreover, without spending the time to use inspiration as the starting point in a full design process, it is impossible to predict where that process might end up.

Nonetheless, Oblique's ability to create infinite concepts, each with a direct—and usually quite coherent—link to one or two particular more-than-human texts, provides an easy-to-access way for any designer/researcher to explore aspects of the more-than-human canon that they are not previously familiar with. While this approach could not replace the depth of understanding that comes from an immersion in the underlying texts and examples, it provides a quick-and-useful 'taste' of what different more-than-human positions may have to offer.

While Oblique successfully presented new ideas and thoughts and supported those with more-than-human texts, its rigidity and pre-defined template format were constraining, artificially limiting the ability to settle on a single concept and refine it or consider it from multiple more-than-human perspectives. Our second design interaction sought to address these limitations.

MoTH is based on a popular prompt titled Professor Synapse, published by Synaptic Labs^[2]. The prompt uses 'chain of reason' which encourages GPT-4 to break any given task down into small bitesize tasks. The second technique the prompt employs is to ask GPT-4 to imagine several expert agents. Each of these agents should adopt the chain of reason approach to break down the challenge from different perspectives. If necessary, the agents can converse with each other and try to come to an agreement. The prompt also uses the idea of GPT-4

as an 'operating system' allowing 'commands' to be defined.

At the center of MoTH is an imaginary scholar named IO (and represented by the 🧑🏫 emoji) they are described as a "poet who is a conductor of three agents". The agents IO has at their disposal have different proficiencies and are also represented by emojis:

- 🧑🏫🎨 is an agent with a background in design research, creativity, and art.
- 🧑🏫🧠 is an agent with a background in more-than-human theory (in sociology, and philosophy).
- 🧑🏫🔬 is an agent with a background in science and engineering, who is also a pragmatist.
- Several optional 'commands' are defined that are specific to MoTH. These include:
 - /theory - tells MoTH to focus on a particular more-than-human theory
 - /reading - asks MoTH to suggest relevant reading
 - /inspiration - requests as concrete and definitive action to take

The /reading and /inspiration commands automatically understand the established context and taking account of the discussion so far should provide relevant reading or suggestions.

To show a verbatim example of a conversation with MoTH would take up multiple pages and many thousands of words. For this reason, the following example only demonstrates key points in an interaction with MoTH. In this example, which took place over the course of 10 minutes, we decided to build on the idea that Oblique had created for us in the prior example (Fig. 39) of a Bennet and Braidotti inspired kettle that whistles when it boils.

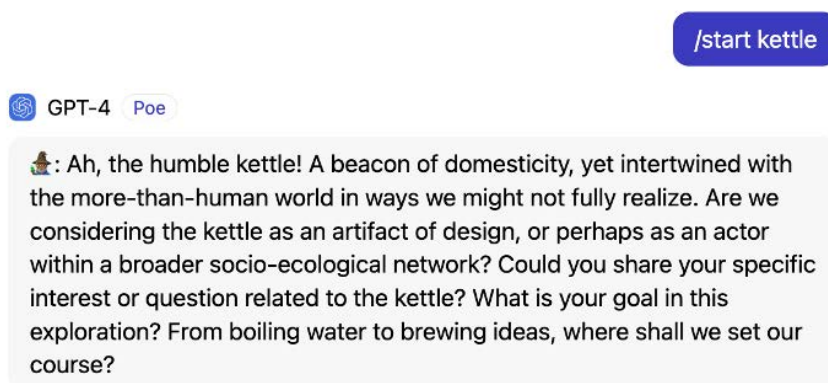


Figure 39. MoTH' initial response to requesting help with our kettle design.

In this image (Fig. 40), we see MoTH being initiated. Given that several virtual agents can be involved in the conversation, emojis are used to demonstrate who is speaking. In this case IO is speaking (represented by the 🧑🏫 emoji). Using the "/start" command we told MoTH we were interested in designing a kettle. MoTH acknowledged and asked that we establish our specific objective. Next, we specified Braidotti's book "The Posthuman" (2013) as the main theoretical focus. MoTH responds by summoning the agent with experience in design research, creativity, and art (🧑🏫🎨) who then asks for additional information and context (Figure X).

👤: Very well, we shall tread along the path illuminated by posthumanism. Our journey will lead us to decenter the human, and consider the kettle as an integral participant in our daily rituals, rather than a mere tool.

Now, I will call upon our expert agents to help us navigate this exploration.

👤: I am an expert in design research, creativity and art. I know the language of aesthetics, the principles of design, and the power of creativity. I will reason step-by-step to determine the best course of action to achieve a posthumanist understanding of the kettle. I can use design thinking and visual methodologies to help in this process.

I will help you accomplish your goal by following these steps:

1. Understand the current human-centered design of the kettle.
2. Identify the ways in which the kettle influences our habits and practices.
3. Explore possible redesigns that acknowledge the kettle's agency.

Figure 40. In this case, when we asked MoTH to focus on perspectives relevant to The Posthuman it summoned an expert in design research, creativity, and art, which set up these goals.

The next phases of the conversation covered a lot of ground very quickly. This included asking the user to consider how kettles influence our day-to-day lives. We re-prompted MoTH with the concept of a singing kettle. At that point, MoTH referred to the agent with a background in science and engineering (🔧), who instigated a discussion about acoustic properties of kettles, and produced a list of factors that impact the sounds kettles create (material, shape, heating element, ambient conditions). Then a detailed discussion of construction materials took place. Ceramic was chosen as a material that could generate a pleasing sound, while acknowledging the limitations of the material (fragility, slow to heat up, unpredictable acoustic and heat-transfer properties). At this point, MoTH returned to the expert in design research, creativity, and art (👤🧠) for a discussion of different ceramics artifacts that related to our context (ocarinas, wind chimes, ceramic drums, tea ceremonies). We then intervened to ask MoTH to help us understand how our emerging concept relates to ideas in Braidotti's book "The Posthuman" (2013), it responded with several ideas (Fig. 41).

So how does this relate to your singing kettle concept?

1. **Harmonious Interaction:** The idea of a kettle singing a duet with the water it's boiling is a beautiful embodiment of posthumanism. It recognizes the agency of non-human elements (the kettle and the water), and their interaction creates a harmonious result - the 'song' that is produced. This is a clear departure from the traditional human-centric view where the kettle is a mere tool controlled by a human.
2. **Material Agency:** The choice of ceramic as the material for the kettle takes into account its unique properties, including its acoustic properties and the specific way it interacts with heat and water. This respects the agency of the material in the interaction and acknowledges its role in the resulting 'performance'.
3. **Design Inspirations:** The proposed design inspirations, such as ocarinas, wind chimes, ceramic drums, Japanese tea ceremony, and sound art installations, all take into account the interaction of human and non-human entities. They recognize the influence of form, material, and environment on the sound produced, again acknowledging the agency of non-human factors.
4. **User Experience:** Finally, the user of the singing kettle becomes a part of this posthumanist scenario. They don't just use a tool to boil water; they participate in a multisensory experience that involves sound, heat, steam, and eventually, taste (if the boiled water is used for tea or coffee). This enhances their awareness of the complex interplay between various human and non-human factors.

Through this lens, the singing kettle isn't just a novel design idea. It's an exploratory project that highlights the interconnectedness of all entities

Figure 41. MoTH relating the discussion about the practical and physical aspects of the kettle design to a theoretical perspective.

At one point, MoTH asks, "the water boiling, the ceramic resonating, the heat transforming - these are all agents in the process. How might their roles be made more prominent or tangible in the interaction with the kettle?" this prompted us to imagine how some musicians and singers may not want to simply stop singing before resolving a melody that they had started. We wondered, what if a 'singing kettle' behaved in the same way, and would only stop 'singing' once the melody was finished? We prompted MoTH with this idea, asking what this would mean in the context of a more-than-human singing kettle design concept. In response it summoned all three agents to offer their various perspectives (Fig. 41).

The final suggestion (Fig. 42), to explore how these features might impact upon the usability of this kettle and safety concerns, seemed sensible and salient. Similarly, the conceptual positioning relating to agency, voice, and the 'performance' of the kettle seem to be fertile more-than-human design considerations. This example demonstrates that MoTH has some potential to help more-than-human design processes in ideation and reflection. In this example MoTH did not generate any original more-than-human design concept independently. However, through a systematic breaking down of relevant considerations into salient questions, and filtering those through the lens of the perspectives of the three agents, MoTH helped us to imagine and develop entirely new more-than-human design concepts. Additionally, MoTH could relate the discussion's practical and material aspects to the more-than-human theoretical positions. While these discussions were not in-depth, they provided plausible ways of connecting the design concept to theory that, in our view, would be productive starting points for a designer to bridge between theory and practice. In these regards, as a 'tool,' MoTH seemed to work successfully. While a remarkable feature of conversations with MoTH is the enormous breadth of the potential directions it opens up, as noted in our discussion of Oblique, demonstrating the quality of those stimuli and ideas is extremely difficult.

👤: Ah, an insightful notion! Embedding the kettle's "melody" as a necessary part of its function aligns with our aim to highlight non-human agency. This approach will give the kettle a certain autonomy and make the user more aware of its 'performance'. The kettle's song becomes an integral part of the boiling process, and the user must respect the kettle's 'time' and 'voice'.

To ensure this doesn't frustrate the user, the duration of the song should align with the boiling time. An abrupt stoppage of the melody might be seen as an interruption of the kettle's 'voice', reinforcing the narrative of the kettle as a performer.

😊: This is indeed a compelling way to illuminate non-human agency! By requiring the kettle to complete its tune before it can be turned off, you're assigning a certain autonomy to the kettle. It's not just an object being acted upon, but an actor with its own agency, its own 'voice', and its own 'story'. This aligns well with the principles of Braidotti's posthumanist theory, which emphasizes the agency of non-human entities.

👉: From a practical standpoint, this is feasible. The kettle's 'song' could be tied to the boiling process, starting when the kettle is turned on and ending when the water has fully boiled. This would necessitate some sort of feedback mechanism within the kettle to sense when the boiling process is complete. However, we should also consider safety implications. If the user needs to turn off the kettle for some reason (like a safety concern), they should be able to do so.

As we proceed, we might want to consider the balance between the kettle's 'autonomy' and the user's control and safety.

Figure 42. MoTH offers three perspectives on the notion of a duet between the kettle and its user, collectively these touch upon aspects of the theory as well as practical, material and usability considerations.

8.3. Enriching more-than-human design practices

Oblique and MoTH exhibited promising potential to enhance more-than-human design practices by sparking ideation while remaining firmly grounded in posthuman theory. Both creative tools presented some opportunities and limitations. Oblique, which excelled in generating ideas and connecting diverse theories, could aid designers needing to ground new work in posthuman theory or understand linguistic/rhetorical strategies to articulate that grounding. Oblique also simplified complex concepts, potentially making the content more accessible for those unfamiliar with posthuman theory. However, Oblique also produced a high volume of low-quality and irrelevant content, demanding careful and discerning curation. Lastly, the diverse theories the model converged to generate the strategies, often got connected in a superficial way, losing some of their original nuances and context.

MoTH had a distinct set of advantages. One of its strengths was the ability to endlessly ask challenging, thought provoking, questions. The questions and subsequent reasoning could be highly relevant and useful in guiding both the ideation and reflection parts of a design process, encouraging designers to mindfully explore their projects from multiple perspectives. MoTH's conversational interaction, powered by multiple agents with diverse abilities, facilitated rich discussions that included simulated plural positionality. However, MoTH was limited in providing deep engagement with theory and after a relatively short conversation its memory limitations would become evident.

Crafting the prompts to strike a balance between flexibility and narrowness, and using creative and expressive language, helped to make the outcomes more engaging for us as we interacted with the tool. We found that allowing the AI some flexibility encouraged a wider and more diverse output. In contrast, being overly specific with AI instruction led to narrower responses. While the constructed strategies often projected shades of vagueness, the 'moves' suggested direct action, rendering the conceptual soup with surprising amounts of concrete clarity. Even when direct execution appeared conflicting, the mere act of translating theory into hypothetical scenarios for action essentially unboxed the novelty of the possibilities. Similarly, the 'commentary section' proved to add rich context despite sporadic 'hallucinations' (instances where the AI cited non-existent or irrelevant references).

Ultimately, the tools served not as a solution but rather as a catalyst stimulating our ideation and reflection processes. In a sense, the tools developed here have some resemblance to the long tradition of using cards and similar prompts in design to infuse ideas and alternative perspectives into a design process (Roy & Warren, 2018). This journey, while offering some unique perspectives, also reinforced the significance of experience, intuition, and tacit knowledge in the context of design practice. In short, AI tools certainly seem to have some merit, but designers need to defer to their humanity to make sense of what the AI tools can offer them. While our initial question was framed around how GPT-4 could support more-than-human design with/in practices, by making (and interacting with) tools positioned at the interplay between theory and practice, we uncover new questions. For example, to what extent does understanding theory matter to the quality of the design outcomes? If designers relied on these tools, might they bypass the need to engage with theory? (which is the opposite of what we intended). The following section expands on these questions and considers broader challenges.

8.4. Situating generative AI

When exploring the interplay between theory and practice without attempting to 'bridge' the gap, the dialogue between designers and ChatGPT in our experiments represents a creative negotiation between humans and nonhumans regarding the actual implications of terms in the design process. What seems interesting is that as MoTH and Oblique gathered a wide range of theoretical knowledge and made it actionable for designers, they also enacted an emergent more-than-human design discourse. In that sense, the knowledge co-produced by humans and ChatGPT can be understood as more-than-human knowledge. This is understood here as knowledge that is created in the entanglements of humans and nonhumans.

In co-producing this knowledge, the aim was not merely to apply posthumanist theory, but to collaboratively shape and navigate the materialization of concepts and perspectives in design. Thinking of this process as a co-production of more-than-human knowledge presents an opportunity to reflect on how discourse always intersects design not only as an interpretive lens or methodological lever, but as literal 'material' that is central to the experimental design process. It is this materiality that goes some way to disintegrating the notion of the theory/practice gap and bridge, and instead leads us towards occupying and taking advantage of the liminal space.

Reflecting critically on the experiments, it is intriguing to observe that regardless of the distinct posthumanist theories the tools were invoking for any given instance of the prompt, the outcome was qualitatively similar. In essence, what each posthuman theory produced was not significantly different from what other theories did. While this uniformity may suggest potentially interesting overlaps among the different more-than-human design perspectives, it can also highlight a challenge. LLMs like GPT-4 can sometimes "flatten" content, that is, simplify or generalize text, leading to a loss of specificity or richness in the output. Consequently, this can dilute the nuances of individual perspectives, ultimately reducing their particularities. In that sense, the knowledge co-produced by humans and ChatGPT seems to lack situatedness (Haraway, 1988).

Previously, we have explored the challenge of situating AI, which involved considering how design can unveil the positionality of the individuals affected by AI, as well as the positionality of the designers and agents (Nicenboim et al., 2022). We found that the embodiment of conversational agents, and their interaction qualities,

could be designed to express positionality (Nicenboim et al., 2023). However, situating the knowledge co-produced by humans and ChatGPT seems more challenging as it is hard to disentangle which subjects produced which knowledge. As Raley and Rhee (2023) explain, interacting with ChatGPT is "to produce text for which there is no subject" (p. 190). Thus, the real challenge of interacting with LLMs is that actants, training data, input, and output are all now so entangled that responsibility is essentially foreclosed. Given that accountability through transparency becomes obsolete in the realm of GenAI (Crawford, 2021), it is imperative to explore new approaches. In the following section, we delve into several opportunities that the tools we created have provided for addressing this challenge.

8.4.1. Situating GenAI

An interesting opportunity that MoTH offers for situating the knowledge co-produced with AI, is the fact that it asks questions from multiple perspectives. By embodying the knowledge into differently positioned agents (designer, philosopher, engineer), one can say that MoTH is more situated than Oblique. However, more exploration is needed to understand the potential of this technique. While the agents in MoTH only embody traditional disciplines, the same technique could be used to explore subjectivity more broadly. Since metaphors play an important role when designing AI (Murray Rust et al., 2022), how these perspectives are presented has the potential to either situate knowledge or obscure it further. Working with metaphors or even training the model, could become reflective process for designers to understand what perspectives are represented in their designs.

Taking the idea of the multiple perspectives and thinking about how they could be designed to support the situating of more-than-human knowledge, we imagine the dialogs of MoTH as "diffractive." This is a notion the feminist posthuman theorist Karen Barad (2014) uses to describe an approach that attends to "relations of difference and how they matter" [p. 71]. In contrast to hierarchical approaches that put different texts or intellectual traditions against one another, a diffractive engagement means that they are dialogically read through one another to engender creative, and unexpected outcomes (Geerts & van der Tuin, 2021). Understanding the conversations of ChatGPT as diffractive offers some possible paths forward. Diffraction blurs the boundaries between different theories to provoke new thoughts, while also examining how and why these boundaries have been made in the first place. Most importantly, it can help to think how these boundaries could "be (re)made to matter more toward inclusion" (ibid, p. 175). Therefore, this approach could simultaneously facilitate a form of accountability that aligns with the entangled nature of knowledge production in AI and serve as a boundary-crossing mechanism between theory and practice.

8.4.2. Challenging extractive relations

While a more-than-human design approach offers intriguing avenues for situating AI, it also underscores new challenges. A significant concern revolves around the environmental impact of GenAI. As socio-technical systems, AI is embodied and material (Crawford, 2021). Thus, working with GPT-4 entails engaging within a process of extraction; of earthly materials (Crawford & Joler, 2018) and of human and nonhuman knowledge (Pasquinelli & Joler, 2021). Therefore, a posthuman AI program should foster non-exploitative relationships; or question whether developing tools based on existing platforms is inadvertently exacerbating the challenges it seeks to address. Shifting the focus from viewing chatbots merely as tools, to understanding how they entangle humans and nonhumans in their creation, could be a (humble) step towards challenging these extractivist logics.

To conclude, we embrace Haraway's metaphor of "string figures" (2016) to highlight the playful and relational approach we have taken in exploring how AI can enrich more-than-human design practices. Much like the process of crafting string figures to create new shapes, we hope our experiments can support designers in imagining how theory and practice could be intertwined in new ways. Simultaneously, we seek to emphasize the importance of situating the knowledge produced by AI alongside humans. As Haraway poignantly states, "it matters what knots knot knots, what thoughts think thoughts, what descriptions describe descriptions, what ties tie ties" (p.12). Ultimately, we hope our inquiry shifts the focus from exploring how to design with AI to reflecting

on what designing-with in the context of AI truly entails.

8.5. Takeaways

This chapter has argued that further developing theory and practice in the context of more-than-human design demands moving beyond the idea that there is a gap to 'bridge.' Instead, it proposed that the complex entanglements between theory and practice could offer a productive space for designers. To explore that space, we have engaged in a design process of two tools which aimed at converging diverse more-than-human perspectives to generate design inquiries. Using GPT-4, the tools (Oblique and MoTH) were generative in creating diverse ideas, actionable strategies, and thought-provoking questions, which were rooted in diverse posthuman theories.

While the tools presented facilitated the integration of diverse theories and their transformation into actionable outcomes, they often sacrificed the theories' context and positionality. The positionality of GenAI models seems crucial for comprehending and critically evaluating the potential biases and limitations of the knowledge it generates. To move forward, the chapter advocated for situating more-than-human knowledge, i.e., the entangled knowledge that humans. Overall, the space between practice and theory proved to be productive, yielding not only new conceptual understandings but also revealing fresh opportunities and challenges for incorporating GenAI into design processes.

Takeaways:

- GenAI tools could enrich the more-than-human design process by generating ideas grounded in more-than-human thinking, making complex concepts accessible. However, they have a limitation when it comes to preserving the positionality of the knowledge presented.
- While the tools we created facilitated the integration of diverse theories and their transformation into actionable outcomes, they often sacrificed the theories' context and positionality.
- Recognizing the positionality of GenAI models seems crucial for comprehending and critically evaluating the potential biases and limitations of AI-generated knowledge.
- Situating the knowledge that GenAI co-produces with humans could be about accounting for the positionality of the knowledge, the perspectives that are represented in it, and the ethical/environmental impact it has on humans and nonhumans
- MoTH showed a potential way to situate the knowledge by asking questions from multiple perspectives (designer, philosopher, engineer). However, more explorations are needed to understand the potential of this technique, exploring subjectivity more broadly.
- Choosing the metaphors for representing these perspectives has to be a careful process because they have the potential to either situate knowledge or obscure it further.
- Training (or fine-tuning) a model, could be a reflective process for designers to understand what perspectives are represented in their designs.
- The space between practice and theory can be productive, yielding not only new conceptual understandings but also revealing fresh opportunities and challenges for incorporating GenAI into design processes. Supporting diffractive dialogs (attending to differences) could offer productive paths and potentially help define a posthumanist agenda in GenAI.
- Understanding the conversations of ChatGPT as diffractive can be useful in that it blurs the boundaries between different theories to provoke new thoughts, while also examining how and why these boundaries have been made in the first place. Moreover, it can be a boundary-crossing mechanism between theory and practice and facilitate a form of accountability that aligns with the entangled nature of knowledge production in AI.

Part III

9. Assembling a practice of designing-with

With the objective of adopting a more-than-human design approach to studying and designing AI, the dissertation has presented various experiments and ways of doing and knowing through design. It has also made several contributions, including strategies, techniques, tactics to practice more-than-human design, as well as emergent notions and dimensions to articulate more-than-human design practices. Chapter 4 introduced the idea of situating AI and proposed two strategies to progress in this direction. Chapter 5 explored these strategies through design by experimenting with conversational agents and proposed two techniques for attuning to nonhumans. Chapter 6 explored the challenge of connecting posthumanist theory with more-than-human practices by focusing on the notion of decentering and reviewing how it has been enacted in HCI and design. Chapter 7 added more nuances to that practice and offered three decentering tactics. Lastly, Chapter 8 offered a generative AI tool situated at the intersection between theory and practice.

This chapter synthesizes the dissertation's outcomes and insights, weaving them together as a practice of designing-with. Rather than merely listing the outcomes, the intention here is to assemble an emergent more-than-human practice and contextualize the knowledge produced within the literature presented in the introduction. Ultimately, the goal here is not to prescribe a definition of designing-with, but rather to explore what it might be as it emerges from design practice.

9.1. Why assembling?

Weaving together diverse outcomes is not straightforward. On one hand, there are expectations for design research to be as systematic as other disciplines (Gaver et al., 2022). Thus, it is difficult to present the messy outcomes of an RTD process without succumbing to the dominant tendency to simplify or systematize them into a framework or a set of guidelines. On the other hand, staying true to the posthuman principles of this dissertation while integrating the situated nature of the knowledge into a unified narrative offers a similar challenge. Staying with the trouble of this task, I use this challenge as an opportunity to engage in a reflective process, or what Anna Tsing (2019) calls "to occupy the slow science of reflection and reworking" and "accept what is messy not as a defect but as what we have to learn to live and think in and with" (p. 120). Inspired by these ideas, I see the weaving of the dissertation's outcomes as an opportunity to explore different framings, as well as to generalize the insights gained from specific contexts to the broader field of design research. When I say that I will assemble a practice, my intention is to highlight the process of bringing into discussion different concerns, artifacts, and ways of doing.

The practice of assembling holds a rich historical significance within posthumanist thought. Drawing upon Deleuze and Guattari's concept of assemblages, Latour (2005) formulated the idea of socio-material assemblages involving both humans and nonhumans, while Bennett (2010) delved into the role of assemblages in democratic processes. In the realm of design, Binder and colleagues (2011) utilized this notion to underscore the involvement of nonhuman entities, and Redström and Wiltse (2018) conceptualized contemporary digital artifacts as fluid assemblages. While in modern design, assembling might suggest the process of integrating separate components or parts of a machine, assembly is the original meaning of the word 'thing' in English, dating back to the 7th century. It also signifies the act of gathering in one place for a common purpose. In relation to the meaning of gathering, Ursula Le Guin's essay "The Carrier Bag Theory of Fiction" (1986) intricately links assembling with the trajectory of human history. Le Guin suggests a narrative shift from weapons to carrier bags and challenges traditional accounts of human history, particularly those rooted in conquest and colonialism.

The metaphors of assembling and gathering are useful here to consolidate the epistemological position this dissertation takes. Inspired by the programmatic approach (Redström, 2017) the research departs from the idea that design foundations can emerge from the *making* of design. Using le Guin's metaphor, one can think that as the pieces of knowledge produced during the PhD are as diverse as the items inside a bag – not only having different shapes, materials, and functions, but also belonging to different contexts –they can be contained,

arranged, and framed in different ways too; and that as the knowledge produced is collected, also a flexible container for them can be crafted. Similarly to how a flexible bag takes shape as it gets filled with items, by discussing the outcomes and reflecting on the insights gained, the practice of designing-with can take shape. By allowing for fluidity in assembling the dissertation's outcomes and embracing an unfolding definition of designing-with, my aim is to provide insights that reflect the situated nature of my process and enable various ways of using them. This is crucial because the purpose of assembling is not to confine things within a container but to gathering them so they can be repurposed in other contexts.

9.2. Methodological interventions

The dissertation has developed some key practical outcomes. Inspired by Anna Tsing (2019), I call this group 'methodological interventions.' The methodological interventions include different elements—strategies, tactics, and techniques. Although the distinction among these terms is nuanced and not strictly delineated, each serves a unique role within each intervention. Broadly speaking, I perceive strategies as overarching schemes designed to achieve specific objectives. In Chapter 4, I developed strategies to facilitate situated understandings of AI. Conversely, I regard tactics as actions that are more reactive, improvised, and aimed at creating opportunities within existing constraints. I employed tactics in Chapter 5 to illustrate the emergent nature of the actions that participants in my workshops used to engage with conversational agents. Lastly, I use the term 'technique' to denote a way of doing that is not necessarily a widely tested method, as is often implied in design research. A technique, as I conceive it, is a practical element capable of serving the purposes of both broad, strategic planning and more immediate, tactical responses. In what follows, I summarize some of the outcomes.

9.2.1. Strategies for situating agents

In Chapter 4, I proposed two strategies for designers to foster situated understandings of AI, which were later developed in Chapters 5, 7 and 8. They can be generalized as follows:

Looking across	This strategy involves revealing the complexity of human and nonhuman entanglements and engaging with the intricate web of relations within them. In the context of AI, this strategy contrasts with the notion of 'looking inside AI,' which assumes an unattainable ideal of transparency. Instead, looking across AI promotes situated understandings.
Exposing failures	This strategy is about making visible the failures and limitations of design in a way that can be productive. In the context of AI, for example, knowing the limitations of a particular AI system might be crucial for people to grasp their capabilities and risks.

Looking across AI is an invitation for designers to see AI as a socio-technical system. This shifts the role of design from masking the complexity of AI systems in seamless interactions to exposing that complexity by revealing the infrastructures and tensions that are part of it. Looking across AI involves accounting for the situated encounters that different human and nonhuman agencies have when they relate to each other. This was explored in the workshop presented in Chapters 5 and 7. By looking across AI, these workshops have highlighted that the decisions AI agents make are both part of complex infrastructures, and yet situated in intimate encounters in people's homes. Exposing failures offers a tangible way to provoke frictions in the everyday encounters between people and AI and to probe how people could have an active role in trying to understand AI. In other words, this strategy provokes situations where understandings can be co-constructed within ongoing relations between people and AI. Using this strategy, Chapters 5 and 6 unpack how misunderstanding, silences, and discomfort can be used as productive design spaces.

9.2.2. Conversations with agents

In Chapter 5, I introduced a technique for designers called Conversations with Agents, which was further elaborated upon in Chapter 7. This technique involves attuning oneself to a thing's perspective. This is achieved by responding to interview questions from its standpoint; reflecting on the insights gained from this process; and using them to prototype new designs or scenarios. The technique was initially inspired by Interview with Things (Chang et al., 2017), and was developed further for the RTD workshop (Reddy et al., 2020), and a follow-up experiment (Reddy et al., 2021). Later, it was adapted towards the DIS workshop (Nicenboim et al., 2020), and used at the Thingscon conference with robots, and in several courses at Delft University of Technology. During one of the courses, it was tested as a method for grasping AI (Murray-Rust et al., 2023). The following table presents the instructions for Conversations with Agents that I presented to the students.

Conversations with Agents

Time: 15-45 minutes

Participants: 2-5 humans, 2-5 nonhumans

Process:

1. Choose a nonhuman to enact –this can be a thing, like a teapot, a being, like a butterfly, or a smart thing or agent, like a digital assistant.
2. Choose your role for the first round: One person is the interviewer, who asks questions to the agent, another person is the agent, who responds on its behalf, and the other/s is/are researcher/s, who time the interview to 3 min, take notes/quotes from the interview, and make a video by pointing the camera at the thing.
3. As interviewer, start a semi-structured interview with the agent, by talking to the thing directly (3 min). You can start by asking "Hello (e.g. digital assistant X), what is a typical day in your life?"
4. As the thing, enact the responses.
5. Swap roles until all have been interviewed. Share the notes and write down what was interesting and one or more quote/s from the thing from each interview. Reflect on the anthropocentric biases that were exposed, both the agents' and yours.
6. Speculate or prototype a new design or scenario based on the insights gained.

In the context of AI, this technique has shown potential for promoting reflexive design engagements that could lead to more inclusive interactions. For example, in the workshops of Chapter 7, the technique allowed designers and researchers to reflect on their positionality, biases, and limitations, as well as those of the agents. Furthermore, it helped them to imagine and materialize alternative relations. The research in Chapters 5 and 7 highlighted that while enactments are key elements in this technique, its goal is not to speak on behalf of nonhumans, nor represent nonhuman voices. Instead, the goal is to decenter the designer's perspective to prototype more-than-human alternatives. The generative power of enactments in this context is to allow participants to move from reimagining agents otherwise, to rehearsing new more-than-human relations with them.

9.2.3. Noticing entanglements

In Chapter 5, I introduced a technique to notice more-than-human entanglements. This technique builds on the method of Noticing (Liu et al., 2018) but extends it by focusing on entanglements; using the sense of listening. This is, not just attuning oneself to nonhuman voices, but starting to think what more-than-human voices could be like. This could be, for example, sounds that come from the interplay of human and nonhuman forces, for

e.g. a raindrop falling into a manufactured metal plate. Chapter 5 showed how this technique could go beyond noticing relations and help designers understand the anthropocentric biases embedded in the interactions with agents. By focusing on the silences of conversational agents, some of their anthropocentric biases were exposed. Thus, beyond attuning to more-than-human voices, this technique helped to challenge human-centeredness, by questioning who and what is silenced (i.e., filtered out) when AI captures the world. By using this technique, the research revealed the limitations of human-centered design to be inclusive, not just to nonhumans but also to many humans.

Inspired by the work of the composer John Cage, the technique was designed to use silences as opportunities for deep listening (Gann, 2010). Inspired by decolonial listening from Rolando Vázquez, the exploration focused on how designers could perceive and attend to the voices silenced by humanist views (Zoë Dankert, 2018). Based on these ideas, I conceptualized two ways of listening to human-nonhuman entangled voices: one is more passive, aiming at expanding our attention to capture as many sounds as possible, leading to a sense of being part of the whole; the other is more active, or rather activist, and it is trying to listen specifically to what and who was normally silenced. Based on these ways of listening, I made an audio-guide series of exercises, which were published as a podcast. Through the five episodes of the podcast, a gentle voice guides the listeners to try noticing exercises but also encourages them to reflect on possible resistances they might find along the way. There is a progression that goes from still and distinct entities to movement and entanglements. The podcast is being exhibited at the TU Delft Library and can be also accessed in Spotify at: <https://open.spotify.com/episode/4ganNhF2hqLN8NNuRyQCqW?si=0c686f8e645941da>. The following is a snippet of one of the exercises:

"Welcome to the second audio guide in this five-part noticing exercise series. In the first session, we practiced noticing something without attaching a predefined meaning to it, an exercise meant to help blur the lines between what we think of as separate objects and their relations to a larger, co-dependent whole. Now, we continue this practice by looking deeper at relations and entanglements. Noticing entanglements is about understanding how human culture, history, and everything we have done has shaped the environment around us. And in its turn, the environment has also shaped us. The entanglements are the constant complex processes of co-creation between nonhumans in our environment and us. Before we start, sit down in your space for noticing, it can be the same spot you found last time. If that is not possible, you can also find a new spot for this exercise. Pause this audio guide if you need to."

9.2.4. Decentering tactics

In Chapter 6, I discussed the notion of decentering in HCI and design as a shift that moves away from anthropocentric design perspectives and mainstream humanist understandings of users and progress to account instead for the agency of nonhumans, as well as an expansive notion of the user. In Chapter 7, I presented three tactics to support designers in decentering the human. These were distilled from analyzing the outcomes of the workshops that employed the technique Conversations with Agents.

Decentering by Situating	By exposing the wider systems and invisible relations of humans and nonhuman agencies, designers can account for the positionalities of users, agents and themselves.
Decentering by Materializing	By prototyping or speculating alternatives, designers can go beyond imagining technologies otherwise, and make these new imaginaries tangible.
Decentering by Enacting	By role-playing the new imaginaries, designers can rehearse more-than-human relations and develop new sensitivities for attunement.

Chapter 7 reflected on how these tactics have been useful in design workshops with AI. Using the tactic of

situating, the workshops' participants exposed the various relations of AI systems, the agents' and the designers' limitations, and anthropocentric biases. Using the tactic of materializing, participants imagined agents otherwise, and used these alternatives to create prototypes that embedded different values. Using the tactic of enacting, participants rehearsed new relations with conversational agents, gaining further insights into the roles these new imaginaries could have in everyday life.

9.3. Discussing the outcomes

Perhaps an important question to ask at this point is: 'What can these methodological interventions *do* in design practices?' Answering this question, I observe are at least three themes that cut across all the interventions: they situate human-nonhuman relations and help designers account for the positionalities involved, decenter the humanist conception of the human, and support designers in not-knowing. I will unpack these themes in what follows. It is important to note that there are some overlaps in the terms. For instance, while decentering serves as the explicit goal of the tactics, it also represents a theme cutting across all the methodological interventions. This repetition is expected given that the process of generalizing the knowledge here is not guided by defining clear boundaries but by extending lines across the outcomes.

9.3.1. Situating and positionality

In Chapter 4, I argued that in the context of AI, situating demands accounting for the positionality of humans and nonhumans affected by AI, as well as the positionality of designers and agents. Chapter 4 proposed strategies to achieve that, which were aimed to transcend the traditional ideal of transparency. Chapter 5 used these strategies to design situated interactions with AI. Chapter 7 highlighted that situating can happen through responses and different bodies of AI applications, while Chapter 8 highlighted the challenge of situating more-than-human knowledge, i.e., knowledge that is co-produced by humans and AI and is so entangled it is impossible to trace back with traditional notions of accountability.

Not only the strategies which had this explicit goal of situating were related to it. The techniques supported that process too. For instance, Noticing Entanglements situated the relations of humans and nonhumans by cultivating awareness of diverse agencies and unheard voices. In this technique, situating is a twin operation: both a passive act of observing relations, and an active (even activist) aim of noticing silenced voices. Similarly, Conversations with Agents helped designers position the agents and situating them within broader ecosystems of power. Designers also accounted for their own biases when they enacted the agents.

9.3.2. Not-knowing and failures

In Chapter 6, I discussed how discomfort, friction, and failures were key in decentering through design. For instance, in my practice, I defamiliarize myself by constantly moving between disciplines and domains to remain in a state of a beginner. This is related to what Wakkary (2021) calls 'not-knowing,' which means "to design together with things while also not fully knowing things" (p. 247). Expanding on that, Oogjes & Wakkary (2022) propose embracing the position of a visitor or a novice, as a fruitful way to practice humility, unlearn, and not-know in design research. Other scholars have reflected on that too. Maria Puig de la Bellacasa (2012) writes: "Knowing is not about prediction and control but about remaining attentive to the unknown knocking at our door" (p. 212). Similarly, Forlano (2023) advocates for embracing failures, breakdowns, errors, and biases not as "a 'problem' to be solved but rather the reality of living and working with technology" (p. 29).

Embracing failures and not-knowing played a key role in different chapters of the dissertation. Chapter 4 proposed to expose failures to support situatedness. Chapter 5 expanded on how misunderstandings and silences could be productive situations for designing situated AI interactions and highlight that living with AI is like living with an organism one cannot fully comprehend. This was interesting because, as explained in Chapters 4 and 8, AI cannot be understood or explained in a traditional sense. Overall, research here suggests that embracing failures and not-knowing can help designers move towards a more situated design of AI.

9.3.3. Decentering and unmaking

In Chapter 6, I provided evidence of how designers and HCI researchers have developed concrete methods and techniques for decentering, which are different from how decentering is used in other fields, such as the humanities. By reviewing how decentering is enacted in design practices, it became apparent that it is an ongoing and material practice. Two unique qualities emerged: movement and materiality. Comparing decentering to the practice of unmaking revealed that these two qualities are not independent but intersected in design: decentering through design is a practice that moves away from a center not only conceptually but also materially. Through engaging in creative activities such as prototyping, making videos, and speculating, among others, designers reorient their perspectives. In this dual movement, they dismantle (unmake) human-centered conceptions and ways of doing while simultaneously creating (making) new artifacts that embody more-than-human relations.

9.4. Articulating more-than-human design practices

The previous section articulated three themes across the dissertation's outcomes: positionality, not-knowing, and decentering the human. This section attempts a different articulation through a series of dimensions and questions, which designers can use to bring more clarity to the discourse around more-than-human design practices.

In Chapter 6 I explained that while the notion of decentering is commonly used in posthumanist HCI, designers and researchers have employed the concept in related yet distinct ways. There is often ambiguity regarding what is precisely intended, i.e., it is not clear who/what is being decentered and who/what is accounted for. To help overcome this challenge, the chapter provided a few recommendations for designers. The first one was to approach decentering as a practice rather than a goal. This can address some of the obstacles that designers encounter, such as the frustration of not being able to fully decenter their human perspectives. Viewing decentering as a practice emphasizes that it is a continuous effort that requires ongoing engagement and commitment. This shifts the focus from asking 'are we decentered enough?' to 'how can we improve our practice of decentering?' Ultimately, this nuanced understanding of decentering underscored the importance of the process and the sensitivities of attunement that designers need to develop, prioritizing gradual movements over paradigmatic shifts.

Another piece of advice for designers was to reflect on who/what was being decentered and who/what was being accounted for. To articulate decentering practices more clearly, designers could reflect on the strategies they use to achieve that and the kind of relations they aim to promote as a result. The different chapters of Part II provided examples of how decentering was enacted in my own practice. In Chapter 4, the perspectives of those developing AI were decentered, and instead, the perspectives of other individuals who are not direct users of AI were centered. In Chapter 5, the humanist user was decentered, and attention was given to the silenced voices of the humans and nonhumans affected by AI.

Based on these insights, Chapter 6 proposed that one way in which designers could articulate their practices is by clarifying the question: **What is decentered, and what is instead accounted for (centered)?** Some possible answers to that question were found in Chapter 6 by reviewing work from more-than-human designers:

- Decentering human privilege and accounting for multi-species.
- Decentering the designers' perspective and accounting for more-than-human senses.
- Decentering the human intention and accounting for the vitality of the materials and bodies.
- Decentering human knowledge and accounting for plural narratives.
- Decentering the privilege of dominant groups and accounting for the marginalized perspectives.

Another way in which more-than-human designers could articulate their practices, as discussed in Chapter 6, is by unpacking them through different dimensions:

- Cornerstone: The theoretical foundations of the inquiry

- Crux: What is being problematized
- Constitution: The strategies used to center what was marginalized
- Contribution: What the inquiry offers
- Context: the community in which the contribution is positioned

In my practice, for example, the *cornerstone* is the critical posthumanities and new materialism. In the *context* of HCI and design, the *contributions* my work has made are methodological and conceptual. What I try to problematize (*crux*), is technological determinism and anthropocentrism. The relations that I hope can be formed (*constitution*) are decolonial, situated and response-able (Haraway, 2016).

Building on these questions and dimensions, more-than-human designers can better articulate their practices by reflecting upon the following questions:

- What are the theoretical foundations of the inquiry?
- What is being problematized?
- What are the strategies used to center what was marginalized?
- What type of contribution could this inquiry offer?
- What is the community in which the contribution is positioned?
- What is decentered, and what is instead accounted for (centered)?
- What is made and what is un-made?
- What are the more-than-human relations you can observe?
- How might you better notice entanglements, decenter yourself, and embrace not-knowing?
- How might you rehearse these relations otherwise?

9.5. Designing-with AI

The previous section engaged with the objective of articulating more-than-human design practices. This section goes back to the notion of designing-with. In Section 2.5, I provided a provisional definition of designing-with as a posthumanist design practice that acknowledges the co-constitutive relations of humans and nonhumans and engages with them through design. In what follows, I will explore how the practice of designing-with emerged through the dissertation's outcomes. As mentioned in the introduction to this chapter, the aim is not to prescribe what this practice is, but to let it emerge from the outcomes.

Designing-with emerges here as a practice that is relational and affirmative as well as situated and material. It is relational because humans, things, and worlds could only be understood in relation to each other (Wakkary, 2021). It is affirmative because it implies "actively standing to the present, while assessing its becoming and imagining new configurations" (Braidotti, 2019, p. 463). It is situated because it aims at accounting for the positionality of agencies involved in design processes and material because it shifts from just imagining how technologies could be different to actually rehearsing alternative relations. Moreover, designing-with is a decentering practice: On the one hand, it challenges anthropocentrism by questioning human-centered approaches; and on the other, it reorients the humanist ideals prevalent in design, articulating more expansive understandings of users and things. As such, designing-with materializes and mobilizes what Rosi Braidotti (2013) calls the *posthuman convergence*.

Designing-with has the potential to reorient the design of AI in a few ways. Firstly, it can help designers transcend the perception of AI as a purely technical domain or a mere tool (Redström & Wiltse, 2018). This is, to engage with AI not as "something standing by to be ready for us when we need it" (Giaccardi & Redström, 2020, p. 33), but as an agent that participates in design processes and is "fundamentally implicated" (p. 42). The case of conversational agents made it very clear how, within an anthropocentric paradigm, voice interactions logically filtered out all but the human voice. In that way, they omitted nonhuman 'voices,' as well as human voices that were not 'stereotypically human' by considering them as background noise. Designing-with in that context, shifted the attention from efficiency and explanations towards the relations and interactions that can enabled us to situate, tune, and negotiate ethical responses (Giaccardi and Redström, 2020).

9.6. Making posthuman knowledge through design

I opened this chapter by discussing the challenges of synthesizing the outcomes into a coherent shape. I will close it by revisiting that issue considering the outcomes presented. Staying with the trouble of the task of summarizing the results, and working through it, this chapter has assembled a practice of designing-with, as it emerged in the situated context where I developed it. This last section discusses how the outcomes that are mobilized through the practice of designing-with sit in relation to other developments in the field of more-than-human design, and in relation to broader discussions in design research.

I have chosen to frame the outcomes as methodological interventions, a term I borrowed from Anna Tsing (2019). These seem to have much in common with other terms proposed by scholars in the community around more-than-human design. Methodological interventions are in some ways similar to disruptive improvisations (Andersen et al., 2018), as they combine diverse strategies to productively trouble traditional frameworks. They could also be understood as invitations (Lindström & Ståhl, 2019), in that they aim at creating opportunities for meaningful engagements with nonhumans. Alternatively, they have much in common with repertoires (Wakkary, 2021), because the interventions are actions that the human designer can take to engage with nonhumans in design research practices and reflect on the role of the human designer. However, the methodological interventions differ from these notions in that they are less concerned with increasing the participation of nonhumans and more interested in the reflective processes that they enable for designers.

Overall, the knowledge produced was presented as intermediate-level knowledge (Höök & Löwgren, 2012). As such, it occupies the middle ground between specific designed artifacts and broader theories. In other words, they are partly situated within the projects from which they emerged, and partly generalized to be resources for designers working within more-than-human design. The notions here are similar to strong concepts (Höök & Löwgren, 2012) in that they reside on an abstraction level above particular instances. But they differ in that the focus of strong concepts is in how they are *generative*, i.e., how they play a direct role in the generation of new designs (Höök & Löwgren, 2012). Instead, my focus was on observing both directions: how posthumanist theory generates more-than-human design practice and how more-than-human design practices can make posthuman theory. The notions I developed –especially the emergent notions in Chapters 6 and 7– were not predefined and subsequently tested through empirical work. Instead, they were generated through design.

The dissertation placed significant emphasis on the epistemological positioning it wanted to occupy between theory and practice. In that sense, the outcomes exist in that continuum. The methodological interventions are directly shaped by theory and the emergent notions and dimensions are directly drawn from practice. In relation to the tactics that Redström (2017) proposed for designers to engage with the interplay between theory and practice –parallels, sequencing, and intermediaries–this dissertation is close to intermediaries. However, while intermediaries position practice and theory as somehow separate, I have taken a more radical approach to blurring their boundaries. In fact, it is exactly in that intermediate space that the research found its productive drive, as it argued that the practice/theory gap in more-than-human design does not need to be bridged, but can become a productive space for designers and researchers to develop more-than-human design knowledge.

Claiming that designers can occupy the space in between theory and practice, the dissertation contributed to the debate in design research about the kind of knowledge that designers produce. It aligns with Wakkary's (2021) conceptualization of design research as a nomadic practice. The entanglements of theory and practice in this dissertation are also in line with the posthumanist epistemological commitments initially proposed. Ferrando (2019) claims that "the overcoming of dualisms called upon by Posthumanism includes the traditional divide between theory and practice" (p. 9). Similarly, Barad (2007) asserts that "practices of knowing and being are not isolable; they are mutually implicated" (p. 185). This is important because posthuman thinking does not only challenge conventional separations between theory and practice, but also recognizes the co-constitution of theory and practice that takes place when engaging with materials and other beings. Ultimately, the dissertation highlights that designing-with is a material-discursive practice that blurs the idea that there is a divide between theory and practice.

10. Final reflections and conclusion

The previous chapter provided an overview of the dissertation's outcomes and discussed them in relation to the literature presented in the introduction. This final chapter briefly reflects on the research contributions and how they addressed the objectives presented at the start. Firstly, it outlines the contributions across various domains, including more-than-human design, critical AI, and design research. Subsequently, it elucidates how these contributions have aligned with the research objectives. Finally, it underscores certain limitations of the inquiry and identifies opportunities for future research.

10.1. Reflections on the research objectives and contributions

The dissertation's primary contributions lie within the realm of more-than-human design. In this sphere, the dissertation developed the practice of designing-with (RO1), offered a collection of methodological interventions, and presented practical examples of how they could be mobilized (RO2). Additionally, it introduced emergent concepts and dimensions to articulate more-than-human design practices (RO3). The secondary contributions extend to the context of critical AI, where the dissertation proposed more-than-human design as a novel approach (RO1). Through various design experiments involving conversational agents, the research uncovered nuanced insights into the intricate relationships between humans and nonhumans within AI systems. Furthermore, it highlighted new challenges, such as the imperative to situate AI, acknowledging the positionalities of users, agents, and designers within these systems. By considering these insights, the research provided examples of alternative designs of conversational agents that are more inclusive, listening and responding to a wider range of human, nonhuman, and more-than-human voices.

In the context of design research, the dissertation emphasized the pivotal role of designers in materializing theory. The research shed light on possible ways to connect posthumanist theory with more-than-human practices, demonstrating how designers have developed unique ways to engage with posthumanism. The research showcased the potential of designers to materialize more-than-human thinking and produce posthuman knowledge through design. In doing so, it highlighted interesting synergies between theory and practice, in which theory is not merely applied to design but produced through design. Based on this, the research argued that instead of bridging the theory/practice gap, designers could benefit from working within the rich space between the two.

10.2. Reflections on the approach, methods, and domain

The more-than-human approach proved successful in exposing the scale and scope of AI systems, revealing AI as material and embodied. The research illuminated other potentials of more-than-human design within the context of AI. Firstly, it demonstrated that by situating and decentering, more-than-human design can assist designers in conceptualizing AI applications that are finely attuned to the intricate relations between humans and nonhumans within these systems. Secondly, it illustrated that more-than-human design can help to examine the agency of AI applications, as well as the lack of agency that many humans and nonhumans have in AI systems. Lastly, it probed that more-than-human design has the capacity to reorient outdated notions of responsibility, shifting the focus from merely designing technical explanations to actively supporting response-ability (Haraway, 2016). At the same time, AI's role in the context of more-than-human design was equally transformative, demonstrating some ways in which AI can help enrich more-than-human practice by connecting theoretical concepts of more-than-human thinking with practical applications.

The RTD and programmatic approaches helped to organize and make sense of the design process. By relying on the RTD tradition I assessed the contributions in a way that was suitable for the emergent character of my process. Importantly, the rigor of the research was not assessed by the predictability of the results, but by the quality of the reflections and their alignment with the field's epistemological commitments. The programmatic approach was especially useful for integrating diverse design experiments, each with a different format and scope. I have supported the programmatic approach with plenty of reflection on my practice, as I engaged in discussions with peers in HCI and design, through workshops, events, and conferences. Furthermore, engaging

with different dissemination formats helped me to highlight different aspects of the outcomes. For example, preparing a pictorial or an interactive submission demanded a focus on the design, while writing a journal paper allowed me to develop a more theoretical kind of knowledge and generalize the learnings. The notion of programs provided an overall arch but also allowed me to present plural readings of my work.

Taking posthumanist commitments, the dissertation also shed light on some challenges that the field of design research needs to address if it aims to accommodate more-than-human design practices that are nomadic, material, and ongoing. One challenge I recognized was the ongoing nature of decentering practices. If these practices are continuous and evolving, a key question arises: how can we effectively disseminate work that is perpetually in flux? This raises issues about capturing and conveying the essence of such dynamic processes in a meaningful way. Another challenge pertains to the material aspect of design research. In a field often dominated by textual outputs, how can we better establish and validate alternative research outcomes and non-textual formats within the academic context? This involves rethinking traditional academic norms and criteria for what constitutes legitimate research output, potentially expanding the scope to include more diverse forms of knowledge representation. This research can serve as an example of possible alternative formats that go beyond producing academic papers, and instead include organizing workshops, conference tracks, panel discussions and special issues. Lastly, taking posthumanist commitments to situated knowledges, it also raised significant questions in the context of design research. Considering the position of the 'knower,' prompts us to reflect on who has the privilege to engage in experimental design research and highlights the importance of accounting for designers' positionality.

Lastly, more-than-human design offered a relational approach to AI, as well as a relational way of thinking and doing through design. The epistemological positioning in the space between theory and practice was central to this inquiry. It expanded the initial question towards a new one: 'what epistemological commitments to knowledge production will be aligned with a practice of designing-with?' Answering this question the research highlighted that posthumanist theory is not merely translated but transformed through design engagements. The research has also shown that producing a range of experimental outcomes can be valuable not just for producing a discourse about more-than-human design, but as a form of discourse.

10.3. Limitations of the research and future work

While the research has, to a certain extent, achieved the defined objectives, it certainly possesses some limitations. The first set of limitations pertains to participation—both of humans and nonhumans. While the research contributed to making AI more inclusive, the design process engaged with a limited number of humans and nonhumans. The participation of nonhumans could be enhanced by expanding the scope to include differently situated perspectives and epistemologies, as well as diverse geographical and geopolitical contexts, ensuring that the outcomes are truly plural. Furthermore, while the research touched upon critical issues such as gender, race, and ethnicity, it did not thoroughly explore these topics. Expanding the research to align with scholarly advancements in pluriversal design, decolonizing agendas, and intersectional feminist approaches would be beneficial in addressing these limitations. Similarly, critically reflecting on ethics in relation to nonhuman participants seems key.

The second set of limitations pertains to engagements with AI. While the research shifted the focus from viewing AI solely as a technical domain to a socio-technical one, it did not fully explore the mechanisms of making AI nor its mechanisms of extraction. While more-than-human design could provide a unique lens for understanding these processes, most certainly this requires a multidisciplinary effort. In that effort, it is essential to guard against reverting to anthropocentric tropes of sustainability, which overlook the mutual interrelations between humans, other species, and the environment. Similarly, while the research advocated for moving away from anthropocentrism, certain aspects of this research may inadvertently revert to humanist dualisms. While it is challenging to entirely evade these frameworks, as elucidated by this research, maintaining reflexivity throughout the process is crucial. Recognizing the inherent difficulty in fully decentering human perspectives, and acknowledging the repercussions thereof, should be integral to the practice of more-than-human design.

The third set of limitations concerns the potential of scaling the dissertation's outcomes. While the outcomes advance understanding of how designers can integrate more-than-human design into their practice, to generalize them beyond their specific contexts, it is crucial to conduct follow-up studies on how these tools can be effectively utilized by others. Such assessments should prioritize evaluating the quality of reflections facilitated by these tools, rather than merely focusing on their immediate outcomes. Moreover, to scale up and consolidate the emerging field of more-than-human design, it is essential to comprehend its benefits across various contexts, and diverse academic and professional communities of practice.

Ultimately, striking a delicate balance between theory and practice, as well as between abstraction and situatedness, emerges as crucial both in AI and more-than-human design. Merely treating AI as a technical domain or attempting to address its challenges solely at the level of human-AI interaction risks overlooking its broader implications. Conversely, delving into AI at a high level of abstraction may inadvertently perpetuate what Crawford describes as the "twin moves of abstraction and extraction," obscuring the material realities of AI's production while exacerbating resource extraction from marginalized communities. Similarly, embracing the material and embodied aspects of design can counteract disembodied knowledge, which is what Haraway (1988) calls the 'god trick,' where accountability and engagement become elusive. However, bringing clarity to more-than-human design should not sacrifice the depth and richness of posthumanist discourse.

As future work, there's a unique opportunity to reconceptualize the knowledge generated with generative AI as more-than-human knowledge. Another direction that is particularly worth exploring is looking at the sensibilities that designers and students need to cultivate for adopting more-than-human design. Given that the ontological and epistemological shifts inherent in more-than-human design diverge from traditional humanist methodologies entrenched in current design practices, attempting to teach more-than-human design using conventional methods may prove ineffective. There is a pressing need to unlearn and reevaluate design practices more broadly. Sensitizing exercises have shown promise in equipping designers with the necessary mindset to engage with more-than-human relations. Lastly, there is an opportunity to explore the potential of more-than-human practices to intersect the agendas of sustainability and inclusion. As this research suggested, more-than-human design practices emerge as vital spaces for bridging divides, and intersectional spaces present a fertile ground for tackling contemporary challenges.

10.4. Conclusion

In conclusion, in response to the research objective of developing a more-than-human design approach for studying and designing AI, the dissertation advocated for assembling a practice of design-with. Designing-with is a relational design practice aligned with the critical posthumanities. Through this practice, designers can engage with the entangled relations of humans and nonhumans in AI, which is crucial for designing AI applications that are attuned to the current planetary conditions we live in. Moreover, more-than-human design offers "a more expansive notion of what it means to be human — one that integrates other ways of knowing and being into discussions about AI, technology, and science" (Forlano, 2021, p. 1).

The dissertation has mobilized a practice of designing-with through methodological interventions –strategies, tactics, and techniques. These interventions have the potential to support designers in a few ways. First, they can help designers to situate the design of AI –accounting for the positionality of humans and nonhumans entangled in AI systems, the positionality of the agents that coproduce knowledge with humans, and the positionality of the designers. This can be done, for example, by enacting different perspectives, exposing the anthropocentric biases (of the designs and the designers) and rehearsing more-than-human relations. Secondly, these interventions can assist designers in decentering the humanist conception of the user. This conception, rather than being neutral as commonly assumed, reflects a narrow view of an idealized humans that is often male, white, and able-bodied. Lastly, these interventions can support designers in embracing not-knowing, using failures, silences, and misunderstandings as opportunities for designing more situated and inclusive AI applications.

By articulating how posthuman approaches are manifested in design practices, the dissertation highlighted the pivotal role of designers in contributing to the posthuman turn and critical AI. Furthermore, it demonstrated that designers go beyond merely applying posthumanist theory to design, and instead materialize and make posthumanist knowledge in unique ways. In that way, it illustrated how posthuman theory is not merely translated *in* design but transformed *through* design. Exploring the relationships between theory and practice using the notion of decentering as an entry point, the research emphasized the contingent and material character of more-than-human design practices. This movement can be seen as double: as designers move away from an established position, they simultaneously gain a new standpoint from which they can create new things. Lastly, the dissertation not only assembled a practice of designing-with but also a set of concerns and potential approaches to addressing them. While the dissertation aimed to connect posthumanist theory with more-than-human design practices, it ultimately highlighted that rather than bridging the theory/practice gap, designers can operate within the rich space between the two.

Acknowledgments

This PhD has been a journey of designing-with and thinking-with others, both human and non-human. I am deeply grateful for the support and guidance I have received from so many along the way.

First and foremost, I would like to express my heartfelt gratitude to my supervisors, Elisa Giaccardi and Johan Redström. Elisa has been more than just a supervisor; she has been a mentor, a friend, and a constant source of encouragement through both my achievements and challenging times. Johan's kind words, support, and willingness to embrace experimentation have shaped my approach to design research, and his metaphors and wise insights have consistently offered new perspectives.

I would also like to thank Richard Banks from Microsoft Research for providing the scholarship that funded my PhD and mentoring me throughout the process.

I would also like to sincerely thank the external members of the committee for agreeing to review my dissertation: Rosi Braidotti, Begje van Eekelen, Laura Forlano, Ron Wakkary, and Alessandro Bozzon. Their insights, feedback, and support have been invaluable throughout this process.

My heartfelt thanks go to my co-conspirators: Marie Louise Jull Sondergaards, Anuradha Reddy, Doenja Oogjens, Heidi Biggs, Martin Tironi, Marcos Chillet, and Joseph Lindley. I am genuinely grateful for their generosity in co-authoring publications, insightful comments, mentorship, patience, and kindness throughout the PhD years.

Thank you to my colleagues and friends, Holly Robbins, Tal Ambram, Marcel Schouwenaar, Vera van der Burgh, Wasabi NG, Willem van der Maden, Dave Murray Rust, Maria Luce Luppetti, Lorenzo Romagnoli, Anna Pohlmeier, and Viktor Bedö, for their encouragement both within and beyond academia.

I would also like to thank my colleagues at TU Delft—Pieter Jan Stappers, Elvin Karana, Marco Rozendaal, Nazli Cila, Roy Bendor, Evert van Beek, Caiseal Beardow, Mireia Yurrita Semperena, Grace Turtle, Kars Alfrink, Ianus Keller, Sam Franklin, Wouter van der Hoog, Arnold Vermeeren, Iskander Smit, Froukje Sleeswijk Visser, Yuxi Liu, as well as Studio Lab members. I also want to thank the master's students who graduated with me, Shruthi Venkat, Seowoo Nam, and Maria Torralba, for their trust in working with me and for inspiring me with their creativity. I am especially grateful to those who helped me bring my ideas to life, especially Aadjan van der Helm, Martin Havranek, and Adriaan Bernstein from Studio Make; Martina and Jonas from Cream on Chrome; Roni Bulent Ozel from LucidMinds, and the student assistants Neva Rustad, and Diana Vardanyan.

Thank you to researchers from TU/e and Twente for the engaging academic discussions that have enriched my thinking: Jesse Josua Benjamin, Cristina Zaga, Dan Lockton, Oscar Tomico, Lenneke Kuijer, Minha Lee, Bahareh Barati, and Kristina Andersen. Additionally, I want to acknowledge the colleagues around the world who have influenced my research through our various academic encounters: Paulina Yurman, Arne Berger, Anton Poikolainen Rosén, Audrey Desjardins, Cayla Key, Heather Witse, Will Odom, James Pierce, Fiona Bell, Serena Pollastri, Abigail Durrant, Tom Jenkins, Markéta Dolejšová, Baki Kocaballi, Chris Speed, Chris Elsdén, Nadia Campo Woytuk, Mafalda Gamboa, Bettina Nissen, Michelle Westerlaken, Neta Offer, Jiwei Zhou, Youngsil Lee, and Matt Smith. Special thanks to Dave Chatting and Andy Boucher for inviting me to chair the pictorial track at DIS.

I want to express my heartfelt gratitude to my family and ancestors: my parents, Lydda and Paco, and my siblings, Sabrina and Julian (along with their beautiful families), for their unconditional love. Their passion for craft and the arts has been a guiding light for me since childhood. I also want to thank my partner's family—Alicia, Simon, Juli, and his family—for their unwavering support.

Lastly, I want to thank Bruno, my life partner, for standing by my side through every moment and making it all possible by always encouraging me and caring for our kids. My heartfelt gratitude also goes to my sons, Oli and Luc, whose curiosity and playfulness have inspired me and made this time in my life deeply meaningful.

Summary

Summary in English

Amidst increasing social and environmental challenges, the prevailing human-centered design paradigm is being questioned. While this approach has deepened our understanding of human needs, it has inadvertently privileged the needs of particular groups and marginalized other life forms. In the current planetary crisis, where humanity threatens its own survival, designers and researchers are shifting the focus away from users, interactions, and products and towards relations and ecologies. In the fields of human-computer interaction (HCI) and design, this paradigm shift is known as the posthuman turn. Within that shift, more-than-human design approaches are gaining traction as alternatives to human-centered design. They offer a relational perspective that challenges human exceptionalism and, instead, recognizes the entanglement of humans, nonhumans, and the environment.

These entanglements are particularly vibrant in the realm of Artificial Intelligence (AI), especially when considering AI as "an assemblage of technological arrangements and socio-technical practices" (Raley & Rhee, 2023). Within this understanding, responsible design approaches should engage with AI as material and embodied, i.e., as made by human labor and material resources (Crawford 2021). While the field of AI is embracing human-centered design approaches, they seem limited when it comes to engaging with the humans and nonhumans implicated by AI, beyond its direct users. Moreover, these approaches pose a risk to inclusion, as the Western humanist conceptions that underpin them exclude diverse perspectives (Forlano, 2023). To tackle these challenges and be more attuned to the social and planetary conditions we live in, new approaches for studying and designing AI are needed.

The dissertation explores the potential of adopting a more-than-human design approach for studying and designing AI as a socio-technical system and planetary network. Through a research-through-design (RTD) process and a programmatic approach, the research takes a specific case as an entry point: the design of AI-powered conversational agents. Answering the question, 'How might designers adopt a more-than-human approach in the field of AI?' the dissertation addresses a crucial knowledge gap in the posthuman turn: to complement the myriad of theoretical developments in the field with practical resources and examples that can enrich more-than-human practices.

The research addresses this gap in several ways. Firstly, it develops strategies, tactics, and techniques to complement existing more-than-human concepts and methods and provides examples of how these diverse elements could be assembled and mobilized in design research practices. Secondly, it articulates more-than-human design practices, emphasizing the active role of designers in 'making' posthuman knowledge rather than merely applying posthumanist theory to design. Lastly, it provides recommendations for enriching these practices further, showing how designers can benefit from working within the space between theory and practice, rather than attempting to 'bridge' the two. This approach opens up a productive design space, contributing to ongoing discussions on how designers produce knowledge.

The dissertation contains three parts. Part I, comprising Chapters 1, 2 and 3, situates the emergence of the dissertation within a broader societal and academic context. It offers a discussion of relevant literature to motivate the research and introduces the chosen research approach, along with the methodologies employed. Part II, comprising Chapters 4-8, consists of published papers that have been slightly edited to enhance the flow. Part III, comprising Chapters 9 and 10, summarizes the outcomes of the dissertation and discusses the contributions within the context of the literature presented in Part I. More specifically the content of the chapters is as follows:

Chapter 1 introduces the knowledge gap, and the research objectives. The dissertation focuses on a gap in the field of more-than-human design which is the need to understand how posthumanist thinking can be enacted in concrete design practices. This is a challenge because, despite the myriad of concepts, their practical enactment in concrete designs remains an area in need of further exploration (Coskun et al., 2022). It "requires

urgent attention if action is to complement abundant theory" (Lindley et al., 2023). With the aim of supporting designers in adopting a more-than-human design approach in AI, and articulating more-than-human design practices, the dissertation explores how posthumanist theory is enacted in design practice and how more-than-human design practices can be further enriched. Addressing that gap in the context of AI, the dissertation focuses on the question:

How might a more-than-human design approach be assembled and mobilized in the context of AI, to enable design researchers to engage with the entangled relations between humans and nonhumans within AI socio-technical and planetary systems?

This question is broken down into three research objectives:

- RO1: Adopt a more-than-human design approach to designing AI
- RO2: Develop practical tools for more-than-human designers and produce examples to illustrate and expand how these could be integrated and mobilized in situated design practices
- RO3: Articulate more-than-human design practices and understand how they could be further enriched

Chapter 2 starts by situating AI within societal and planetary conditions. Then, it unpacks the key role of designers in questioning fundamental aspects of AI. Following that, it highlights the limitations of the current approach, human-centered design, in engaging with the complex entanglements of humans and nonhumans in AI and proposes more-than-human design as a suitable approach for studying and designing it. More-than-human design can help designers account for the humans and nonhumans that *make* and are *made* by AI: It can help designers reflect on which conceptions of humans their designs are based, and provide "a more expansive notion of what it means to be human — one that integrates other ways of knowing and being into discussions about AI, technology, and science" (Forlano, 2021, p. 1).

The objective of developing a more-than-human design practice is conceptualized as a practice of designing-with. Designing-with is defined as a more-than-human design practice that is aligned with the critical posthumanities and that consciously acknowledges and engages with the agency of, and co-constitutive relationships between, humans and nonhumans.

Chapter 3 discusses the approach the research takes. Methodologically, the dissertation follows the tradition of research-through-design (RTD) and research programs. Theoretically, it draws from posthuman critical theory, incorporating concepts from the scholars Rosi Braidotti, Donna Haraway, Karen Barad, Maria Puig de la Bellacasa, and Anna Tsing. Epistemologically, it views design as a field capable of producing knowledge and theory, emphasizing the importance of situated knowledges and nomadic practices.

Chapter 4 reorients the challenges of responsible AI through more-than-human design and proposes two design strategies to support designers in situating AI.

- **Looking across:** This strategy involves revealing the complexity of human and nonhuman entanglements and engaging with the intricate web of relations within them. In the context of AI, this strategy contrasts with the notion of "looking inside AI," which assumes an unattainable ideal of transparency. Instead, looking across AI promotes situated understandings.
- **Exposing failures:** This strategy is about making visible the failures and limitations of design in a way that can be productive. In the context of AI, for example, knowing the limitations of a particular AI system might be crucial for people to grasp their capabilities and risks.

Chapter 5 builds upon these strategies and explores them through design. This chapter presents a variety of design experiments, ranging from performance art and kite-making to creating a podcast and a series of interactive prototypes. Based on these experiences, it offers two techniques for practicing more-than-human design:

- **Conversations with Agents** is a more-than-human technique that involves attuning oneself to a thing's perspective, impersonating the thing, and responding to interview questions from its standpoint.

Subsequently, designers reflect on the insights gained from this process and use them to prototype new designs or scenarios.

- **Noticing Entanglements** is a series of exercises to support designers in listening to more-than-human voices. Produced as a podcast, it guides designers to practice noticing while encouraging them to reflect on possible resistances along the way – in a progression that goes from still and distinct entities to movement and entanglements.

The chapter also offers one design example:

- **Conversation Starters** is a series of interactive prototypes of more-than-human conversational agents, i.e., agents that listen and respond to more-than-human human voices.

One key learning from this chapter is that the interactions with AI agents could be more situated if the agent's limitations and infrastructures were exposed. While exposing the limitations of technologies might seem counterproductive for the companies that develop them, the research shows that failures and misunderstandings could be potentially useful opportunities for helping people develop their own competencies for when and how to trust AI agents. The design examples presented are explorations of how designers could support situated understandings and misunderstandings of AI during interactions and how the design of AI could be more inclusive if it is designed to listen to more-than-human voices.

Chapter 6 focuses on the notion of decentering, as a starting point to understand and articulate more-than-human design practices. Generally, decentering signals a move away from mainstream perspectives to recognize and prioritize multiple voices, especially those traditionally marginalized or excluded. In HCI and design, this concept has been used to challenge the human-centric focus of traditional human-centered design approaches and support the participation of nonhumans in design processes. The term is widely used within more-than-human design, but it is not stable: its theoretical foundations are unclear and it is often ambiguous what or who is decentered, and what or who is centered. Moreover, the notion often surfaces some tensions for designers, such as the impossibility of decentering our own human perspective completely and the discomfort that often emerges from encountering more-than-humans. Trying to understand decentering has raised important questions such as: Does decentering require adopting nonhuman perspectives? If so, how do we cope with the impossibility of accessing nonhuman perspectives really, given our inherent human assumptions and ways of knowing? How can designers know when they have decentered their perspectives enough? Does decentering mean caring less for our species? Can decentering the human be dangerous?

Addressing these questions and tensions, the chapter first traces the notion of decentering back to critical posthumanism and then reviews how designers in HCI and design enact it in their practices. Tracing decentering back to the critical posthumanities offers new conceptions that designers can move towards: it describes a posthuman subjectivity that is necessary to meet the complexity of our times. Looking at how it is enacted in design practices reveals that designers have created concrete exemplars, methods, and tactics for decentering.

More-than-human Design practices can be more clearly articulated by answering the question 'Who/what is decentered and who/what is accounted for?' By answering that question when analyzing a large corpus of papers from HCI and design, six clusters were formed.

- **Multispecies:** Decentering human privilege and accounting for multi-species.
- **Perspectives:** Decentering the designers' perspective and accounting for more-than-human senses.
- **Agency:** Decentering the human intention and accounting for the vitality of the materials and bodies.
- **Epistemology:** Decentering human knowledge and accounting for plural narratives.
- **Power:** Decentering the privilege of dominant groups and accounting for the marginalized perspectives.

Another way in which designers could articulate their practices is by unpacking them through different dimensions. These dimensions articulate not only who/what is de/centered, but also what new relationships are formed, and which tactics are used for that. The dimensions are:

- Cornerstone: The theoretical foundations of the inquiry
- Crux: What is being problematized
- Constitution: The strategies used to center what was marginalized
- Contribution: What the inquiry offers
- Context: the community in which the contribution is positioned

As takeaways, this chapter reveals that instead of measuring if we have decentered enough, it is more important for more-than-human designers to recognize their own positionalities and limitations, as well as cultivating sensibilities of attunement to more-than-human scales and events. Situations of discomfort, such as embracing the 'silliness' of interactions with nonhumans, seem to be generative ways for more-than-human designers to decenter themselves.

Chapter 7 further explores the practice of decentering by intersecting it with a similar practice, unmaking. It suggests that decentering, like unmaking, involves a double movement—a transition from an established position to a new one. This exploration draws from the analysis of outcomes from workshops conducted in 2020, as presented earlier in Chapter 5. Based on analyzing the outcomes through the double movement of decentering and unmaking, the chapter proposes a series of tactics for decentering the human through design:

- **Situating:** By exposing the wider systems and invisible relations of humans and nonhuman agencies, designers can account for the positionalities of users, agents and themselves.
- **Materializing:** By prototyping or speculating alternatives, designers can go beyond imagining technologies otherwise, and make these new imaginaries tangible.
- **Enacting:** By role-playing the new imaginaries, designers can rehearse more-than-human relations and develop new sensitivities for attunement.

Chapter 8 builds upon the inquiries raised in Chapter 6 regarding the unique ways designers create more-than-human knowledge. Central to this chapter is the argument that making more-than-human thinking actionable demands moving beyond the idea that there is a gap to bridge. Instead, this chapter proposes that the space between theory and practice could offer an interesting starting point for experimentation. Exploring that liminal space, it presents two tools designed to generate strategies based on diverse more-than-human texts. Reflecting on the process of making and using these tools, the chapter offers two contributions: It explains how designers can use the tools (and create their own variants) to walk through design concepts from multiple perspectives; and provides a critical discussion on the opportunities and limitations of using AI for more-than-human design, including how to situate more-than-human knowledge(s) and avoid extractivist relations.

Chapter 9 synthesizes the dissertation's insights and weaves the outcomes together as a practice of designing-with. It also contextualizes the knowledge generated in the dissertation within the existing literature presented in the introduction.

It proposes a series of questions for more-than-human designers to reflect upon in their practices:

- What are the theoretical foundations of the inquiry?
- What is being problematized?
- What are the strategies used to center what was marginalized?
- What type of contribution could this inquiry offer?
- What is the community in which the contribution is positioned?
- What is decentered and what is instead accounted for (centered)?
- What is made and what is un-made?
- What are the more-than-human relations you can observe?
- How might you better notice entanglements, decenter yourself, and embrace not-knowing?
- How might you rehearse these relations otherwise?

Finally, it describes the emergent practice of designing-with as:

- **Relational:** It acknowledges that humans, things, and worlds can only be understood in relation to each other and focuses on acknowledging the more-than-human co-constitutive relations that are present in any design engagement.
- **Affirmative:** It implies “actively standing to the present, while assessing its becoming and imagining new configurations” (Braidotti, 2019, p. 463).
- **Situated:** It aims at accounting for the positionality of agencies involved in design processes.
- **Material:** It shifts from just imagining how technologies or relations could be different to actually rehearsing alternative relations.

Chapter 10 summarizes the contributions, explains in which ways these contributions have addressed the research objectives, and what areas remain open for further research. Lastly, it takes a critical look at the limitations of the research and highlights opportunities for future work.

The primary contribution is to the field of more-than-human design. In this field, the dissertation has:

- applied a more-than-human design approach in the particular context of AI, specifically in the subdomains of conversational agents (Chapters 5, 7) and generative AI (Chapter 8) and provided examples that illustrate in which ways more-than-human design could be a suitable approach for studying and designing AI (Chapters 4-8).
- provided novel strategies, tactics, techniques, and notions for practicing more-than-human design (Chapter 9) and developed further two techniques from the field: Interviews with Things and Noticing (Chapters 4 and 8).
- reviewed how designers practice more-than-human design (Chapter 6), providing notions and dimensions that can help designers better articulate their practices (Chapter 6).

The secondary contribution is to the field of AI, including the emergent perspective of critical AI, and the subfield of conversational AI and generative AI. In these fields the dissertation:

- proposed more-than-human design as an approach to design more responsible interactions.
- uncovered novel observations regarding the anthropocentric biases of conversational agents, in how they listen to and silence both human and nonhuman voices.
- conceptualized the knowledge co-produced by humans and AI as more-than-human knowledge
- used the concept of 'situated knowledges' to reflect on accountability in generative AI
- designed an application of ChatGPT to support design researchers in adopting more-than-human design approaches

A small contribution has been made to design research. The dissertation:

- illustrated how theory and practice are interwoven in RTD research, bringing new insights to long standing discussions in the field on the particularities of the knowledge designers generate.

In conclusion, in response to the research objective of developing a more-than-human design approach for studying and designing AI, the dissertation advocated for assembling a practice of design-with. The dissertation mobilizes that practice through methodological interventions –strategies, tactics, and techniques. These interventions can support designers in:

- **Situating the design of AI:** Accounting for the positionality of humans and nonhumans entangled in AI systems, the positionality of the agents that coproduce knowledge with humans, and the positionality of the designers. This can be done, for example, by enacting different perspectives, which exposes the anthropocentric biases (of the designs and the designers) and rehearses more-than-human relations.
- **Embracing not-knowing:** using failures, silences, and misunderstandings as opportunities for designing more inclusive AI applications.
- **Decentering the humanist conception of the user:** Challenging traditional conceptions of humans, which rather than being neutral as commonly assumed, often reflect a narrow view of the human that is

male, white, and able-bodied. Decentering the human in AI is not about excluding humans but about moving away from that narrow humanist conception.

The findings of this dissertation suggest that a more-than-human approach can be a suitable approach for designing AI, especially supporting designers in exposing the scale and scope of AI systems, revealing AI as material and embodied, and offering “a more expansive notion of what it means to be human — one that integrates other ways of knowing and being into discussions about AI” (Forlano, 2021, p. 1).

Summary in Dutch

Te midden van toenemende sociale en ecologische uitdagingen wordt het heersende human-centered (mensgericht) design paradigma in twijfel getrokken. Hoewel deze ontwerpparadigma ons inzicht in de menselijke behoeften heeft verdiept, heeft het onbedoeld de behoeften van bepaalde groepen bevoorrecht en andere levensvormen gemarginaliseerd. In de huidige planetaire crisis, waarin de mensheid haar eigen voortbestaan bedreigt, verleggen ontwerpers en onderzoekers de focus van gebruikers, interacties en producten naar relaties en ecologieën. Op het gebied van human-computer interaction (HCI) en ontwerp staat deze paradigmaverschuiving bekend als de posthumanistische wending. Binnen deze verschuiving winnen more-than-human (meer dan menselijk-gericht) ontwerpbenaderingen aan populariteit als alternatief voor human-centered design. Ze bieden een relationeel perspectief dat het menselijke exceptionalisme uitdaagt en de verstrengeling van mensen, niet-mensen en het milieu erkent.

Deze verstrengelingen zijn bijzonder zichtbaar op het gebied van de artificiële intelligentie (AI), vooral als we AI beschouwen als "een verzameling van technologische arrangementen en sociaal-technische praktijken" (Raley & Rhee, 2023). Binnen deze definitie van AI moeten verantwoorde ontwerpbenaderingen zich bezighouden met AI als materiëel en belichaamd. Dat wil zeggen, gemaakt door menselijke arbeid en materiële, aardse middelen (Crawford 2021). Hoewel het vakgebied van AI human-centered ontwerpbenaderingen omarmt, lijkt deze aanpak beperkt als het gaat om het omgaan met zowel mensen als niet-mensen die betrokken zijn bij AI, buiten de directe gebruikers om. Bovendien vormt deze human-centered benadering een risico voor inclusiviteit, omdat de westerse humanistische opvattingen die aan deze benadering ten grondslag liggen diverse perspectieven uitsluiten (Forlano, 2023). Om deze uitdagingen aan te pakken en beter af te stemmen op de huidige sociale en planetaire omstandigheden zijn nieuwe benaderingen nodig voor het bestuderen en ontwerpen van AI.

Dit proefschrift onderzoekt de potentie van een more-than-human-ontwerpbenadering voor het bestuderen en ontwerpen van AI als een sociaal-technisch systeem en een planetair netwerk. Via een research-through-design (RTD) onderzoeksmethode en een programmatische aanpak ([Redström 2017](#)) neemt het proefschrift een specifieke AI-technologie/casus als uitgangspunt: Het ontwerp van AI-gestuurde 'conversational agents' (gespreksagenten). Het proefschrift beantwoordt de vraag: "Hoe kunnen ontwerpers een more-than-human design benadering aannemen op het gebied van AI?". Door deze vraag te onderzoeken richt het proefschrift zich op een cruciale kenniskloof in een posthumanistische wending, en richt zich op: het aanvullen van de talloze theoretische ontwikkelingen op dit gebied met praktische methodes en voorbeelden die more-than-human design praktijken kunnen verrijken.

Het proefschrift pakt deze kenniskloof op verschillende manieren aan. Ten eerste ontwikkelt het strategieën, tactieken en technieken als aanvulling op bestaande, more-than-human concepten en methoden, en geeft het voorbeelden van hoe deze elementen kunnen worden samengevoegd en gemobiliseerd in ontwerp-gerelateerde onderzoekspraktijken. Ten tweede behandelt het more-than-human design praktijken, met een specifieke focus op de actieve rol van ontwerpers bij het ontwikkelen van posthuman kennis in plaats van alleen maar de posthumanistische theorie toe te passen op ontwerp. Ten slotte geeft het aanbevelingen om deze praktijken verder te verrijken, en laat het zien hoe ontwerpers kunnen profiteren van het werken in de ruimte tussen theorie en praktijk, in plaats van te proberen de twee te 'overbruggen'. Deze aanpak opent een productieve ontwerpruimte en draagt bij aan de voortdurende discussies over hoe ontwerpers kennis produceren.

Het proefschrift bevat drie delen: Deel I, bestaande uit de hoofdstukken 1, 2 en 3, plaatst de opkomst van het proefschrift binnen een bredere maatschappelijke en academische context. Het biedt een bespreking van relevante literatuur om het onderzoek te motiveren en introduceert de gekozen onderzoeks aanpak, samen met de gebruikte methodologieën. Deel II, dat de hoofdstukken 4 tot en met 8 omvat, bestaat uit gepubliceerde artikelen die enigszins zijn aangepast om de leesbaarheid te verbeteren. Deel III, bestaande uit de hoofdstukken 9 en 10, vat de uitkomsten van het proefschrift samen en bespreekt de bijdragen binnen de context van de literatuur gepresenteerd in Deel I. Meer specifiek is de inhoud van de hoofdstukken als volgt:

Hoofdstuk 1 introduceert het onderwerp van het proefschrift, de kenniskloof en de onderzoeksdoelstellingen. Het proefschrift richt zich op een kloof op het gebied van more-than-human design, namelijk de behoefte om te begrijpen hoe posthumanistisch denken kan worden toegepast in concrete ontwerppraktijken. Dit is een uitdaging omdat, ondanks de talloze concepten, de praktische uitvoering ervan in concrete ontwerpen een gebied blijft dat verder onderzocht moet worden (Coskun et al., 2022). Begrijpen hoe more-than-human denken uitvoerbaar kan worden "vereist dringende aandacht als actie een aanvulling moet zijn op de overvloedige theorie" (Lindley et al. 2023). Met als doel ontwerpers te ondersteunen bij het adopteren van een more-than-human design benadering in AI, en het benoemen van more-than-human design praktijken, onderzoekt het proefschrift hoe posthumanistische theorie wordt geïmplementeerd in de ontwerppraktijk en hoe more-than-human design praktijken verder kunnen worden verrijkt. Om deze kloof, in de context van AI, aan te pakken, concentreert het proefschrift zich op de vraag:

Hoe kan een more-than-human design aanpak worden samengesteld en gemobiliseerd in de context van AI, om ontwerponderzoekers in staat te stellen zich bezig te houden met de verstrengelde relaties tussen mensen en niet-mensen binnen de sociaal-technische AI-wereld en planetaire systemen?

Deze vraag is opgesplitst in drie onderzoeksdoelstellingen:

- RO1: Hanteer een more-than-human design benadering bij het ontwerpen van AI
- RO2: Ontwikkel praktische hulpmiddelen voor more-than-human designs en produceer voorbeelden om te illustreren en uit te breiden hoe deze kunnen worden geïntegreerd en gemobiliseerd in gesitueerde ontwerppraktijken
- RO3: Articuleer more-than-human design praktijken en begrijp hoe deze verder kunnen worden verrijkt

Hoofdstuk 2 begint met het situeren van AI binnen maatschappelijke en planetaire omstandigheden. Vervolgens wordt de sleutelrol van ontwerpers bij het in vraag stellen van fundamentele aspecten van AI uiteengezet. Vervolgens worden de beperkingen benadrukt van de huidige benadering, human-centered design, bij het omgaan met de complexe verstrengelingen van mensen en niet-mensen in betrekking tot AI en stelt het more-than-human design voor als een geschikte aanpak voor het bestuderen en ontwerpen van AI. More-than-human design kan de ontwerpers helpen met het rekening houden de mensen en niet-mensen die *AI maken en gemaakt worden door de AI*: Het kan ontwerpers helpen reflecteren op welke opvattingen over mensen hun ontwerpen zijn gebaseerd, en 'een uitgebreider idee te geven van wat het betekent om mens te zijn' – 'een idee dat andere manieren van weten en zijn integreert in discussies over AI, technologie en wetenschap' (Forlano, 2021, blz. 1).

Het doel van het ontwikkelen van more-than-human designpraktijk wordt geconceptualiseerd als een praktijk van ontwerpen-met. Ontwerpen-met wordt gedefinieerd als more-than-human designpraktijken die aansluiten bij de kritische posthumaniteiten en die bewust de keuzevrijheid van en co-constitutieve relaties tussen mensen en niet-mensen erkent en ermee omgaat.

Hoofdstuk 3 bespreekt de aanpak van het onderzoek. Methodologisch volgt het proefschrift de traditie van research-through-design (RTD) en onderzoeksprogramma's. Theoretisch is het gebaseerd op de posthumanistische kritische theorie, waarin concepten zijn verwerkt van geleerden als Rosi Braidotti, Donna Haraway, Karen Barad, Maria Puig de la Bellacasa en Anna Tsing. Epistemologisch gezien, beschouwt het design als een veld dat kennis en theorie kan voortbrengen, waarbij het belang van gesitueerde kennis en nomadische praktijken wordt benadrukt. In lijn met posthumanistische verplichtingen neemt het een bepaald standpunt in en pleit het voor het werken in de wisselwerking tussen de twee, in plaats van te proberen de kloof tussen theorie en praktijk te overbruggen.

Hoofdstuk 4 heroriënteert de uitdagingen van verantwoorde AI door middel van more-than-human design ontwerp en stelt twee ontwerpstrategieën voor om ontwerpers te ondersteunen bij het situeren van AI.

- **Kijken naar het geheel:** deze strategie houdt in dat de complexiteit van menselijke en niet-menselijke verstrengelingen wordt onthuld en dat we ons bezighouden met het ingewikkelde web van relaties daarin. In de context van AI staat deze strategie in contrast met het idee van 'binnenin AI kijken', dat

uitgaat van een onbereikbaar ideaal van transparantie. In plaats daarvan bevordert het 'kijken naar geheel' AI gesitueerde inzichten.

- **Mislukkingen blootleggen:** deze strategie gaat over het zichtbaar maken van de mislukkingen en beperkingen van ontwerp op een manier die productief kan zijn. In de context van AI kan het bijvoorbeeld van cruciaal belang zijn om de beperkingen van een bepaald AI-systeem te kennen, zodat mensen hun mogelijkheden en risico's kunnen begrijpen.

Hoofdstuk 5 bouwt voort op deze strategieën en onderzoekt ze door middel van ontwerp. Dit hoofdstuk presenteert een verscheidenheid aan ontwerpexperimenten, variërend van performancekunst en het maken van vliegers tot het maken van een podcast en een reeks interactieve prototypes.

Het biedt twee belangrijke bijdragen voor het beoefenen van meer dan menselijk ontwerp:

- **Gesprekken met agenten** is een more-than-human design techniek waarbij je jezelf afstemt op het perspectief van een ding, je voordoet als het ding en vanuit dat standpunt op interviewvragen reageert. Vervolgens reflecteren ontwerpers op de inzichten die dit proces oplevert en gebruiken ze deze om nieuwe ontwerpen of scenario's te prototypen.
- **Opmerken van verstrengelingen** is een podcastserie die ontwerpers ondersteunt bij het luisteren naar more-than-human stemmen. De podcast begeleidt ontwerpers bij het doen van opmerkoefeningen en stimuleert onderweg reflectie op mogelijke weerstanden, in een progressie die gaat van stille en afzonderlijke entiteiten naar beweging en verstrengeling.

Dit hoofdstuk biedt ook één ontwerpvoorbeeld:

- **Conversation Starters** is een serie interactieve prototypes van more-than-human gespreksagenten: het luistert en reageert op more-than-human stemmen, dat wil zeggen geluiden van thuis en van andere soorten. Deze objecten groeien ook en zijn geïnspireerd door processen van fermentatie en brouwen.

Een van de belangrijkste lessen uit dit hoofdstuk is dat de interacties met AI-agenten meer gesitueerd zouden kunnen zijn als de beperkingen en infrastructuur van de agent blootgelegd zouden worden. Hoewel het blootleggen van de beperkingen van technologieën contraproductief lijkt voor de bedrijven die deze ontwikkelen, toont het onderzoek aan dat mislukkingen en misverstanden potentieel nuttige kansen kunnen zijn om mensen te helpen hun eigen competenties te ontwikkelen over wanneer en hoe ze AI-agenten kunnen vertrouwen. De gepresenteerde ontwerpvoorbeelden zijn verkenningen van hoe ontwerpers gesitueerde inzichten en misverstanden over AI tijdens interacties kunnen ondersteunen, en hoe het ontwerp van AI inclusiever kan zijn als het ontworpen is om te luisteren naar more-than-human stemmen.

Hoofdstuk 6 richt zich op het begrip 'decentralisering', als startpunt om more-than-human design praktijken te begrijpen en te articuleren. Over het algemeen duidt decentralisering op een verschuiving van de reguliere perspectieven naar het erkennen en prioriteren van meerdere stemmen, vooral de stemmen die traditioneel worden gemarginaliseerd of uitgesloten. In HCI en design is dit concept aangepast om de human-centered focus van traditionele human-centered ontwerpbenaderingen uit te dagen en de deelname van niet-mensen aan ontwerpprocessen te ondersteunen. De term wordt veel gebruikt binnen het more-than-human design, maar is niet stabiel: de theoretische grondslagen ervan zijn onduidelijk en het is vaak dubbelzinnig wat of wie gedecentreerd is, en wat of wie gecentreerd is. Bovendien brengt dit idee voor ontwerpers vaak enkele spanningen aan het licht, zoals de onmogelijkheid om ons eigen menselijke perspectief volledig te decentraliseren en het ongemak dat vaak voortkomt uit de ontmoeting met more-than-humans. Het proberen te begrijpen van decentralisatie heeft belangrijke vragen opgeworpen zoals: vereist decentralisering het aannemen van niet-menselijke perspectieven? Als dat zo is, hoe gaan we dan om met de onmogelijkheid om echt toegang te krijgen tot niet-menselijke perspectieven, gegeven onze inherente menselijke aannames en manieren van weten? Hoe kunnen ontwerpers weten of ze hun perspectieven voldoende hebben gedecentreerd? Betekent decentralisering dat we minder zorg dragen voor onze soort? Kan het fatsoeneren van de mens gevaarlijk zijn?

Door deze vragen en spanningen aan te pakken, herleidt het hoofdstuk eerst het begrip 'decentralisering' tot het kritische posthumanisme en bespreekt vervolgens hoe ontwerpers in HCI en design dit in hun praktijk omzetten. Het terugvoeren van decentralisatie naar de kritische posthumanities biedt nieuwe concepten waar ontwerpers naartoe kunnen evolueren: het beschrijft een posthuman subjectiviteit die nodig is om de complexiteit van onze tijd het hoofd te bieden. Als we kijken naar de manier waarop dit in ontwerppraktijken wordt toegepast, blijkt dat ontwerpers concrete voorbeelden, methoden en tactieken voor decentralisering hebben gecreëerd.

More-than-human designpraktijken kunnen duidelijker worden verwoord door de vraag te beantwoorden: "Wie/wat is decentered en wie/wat wordt verantwoord?" Door die vraag te beantwoorden bij het analyseren van een groot corpus aan artikelen uit HCI en design, werden zes clusters gevormd.

- Multispecies: het menselijke privilege decentreren en rekening houden met multispecies.
- Perspectieven: het perspectief van de ontwerpers decentreren en rekening houden met more-than-human zintuigen.
- Agentschap: Het decentreren van de menselijke intentie en rekening houden met de vitaliteit van de materialen en lichamen.
- Epistemologie: het decentreren van menselijke kennis en het verantwoorden van meervoudige verhalen.
- Macht: het privilege van dominante groepen decentraliseren en rekening houden met de gemarginaliseerde perspectieven.

Een andere manier waarop ontwerpers hun praktijken kunnen verwoorden, is door ze via verschillende dimensies te ontleden. Deze dimensies articuleren niet alleen wie/wat wordt gedecentreerd, maar ook welke nieuwe relaties worden gevormd en welke tactieken daarvoor worden gebruikt. De dimensies zijn:

- Hoeksteen: de theoretische grondslagen van het onderzoek
- Crux: Wat wordt er geproblematiseerd
- Constitutie: De strategieën die worden gebruikt om te centreren wat gemarginaliseerd was
- Bijdrage: Wat het onderzoek biedt
- Context: de gemeenschap waarin de bijdrage is gepositioneerd

Dit hoofdstuk laat zien dat, in plaats van het meten of we voldoende gedecentreerd zijn, het belangrijker is dat more-than-human design zijn eigen positionaliteiten en beperkingen erkennen, en dat ze een gevoel van afstemming op more-than-human schalen en evenementen cultiveren. Situaties van ongemak, zoals het omarmen van de 'dwaasheid' van interacties met niet-mensen, zijn een van de manieren waarop more-than-human designers hun perspectieven decentreren.

Hoofdstuk 7 onderzoekt de praktijk van decentering verder door de nuances ervan te onderzoeken en deze te kruisen met een vergelijkbare praktijk, namelijk 'het ongedaan maken'. Het suggereert dat decentralisatie, net als het ongedaan maken, een dubbele beweging inhoudt: een overgang van een gevestigde positie naar een nieuwe. Deze verkenning is gebaseerd op de analyse van de uitkomsten van workshops die in 2020 zijn gehouden, zoals eerder gepresenteerd in hoofdstuk 4. Gebaseerd op de analyse van de uitkomsten via de dubbele beweging van decentreren en ongedaan maken, stelt het hoofdstuk een reeks tactieken voor om de mens te decentraliseren door middel van ontwerp:

- Situeren: Door de bredere systemen en onzichtbare relaties tussen mensen en niet-menselijke instanties bloot te leggen, kunnen ontwerpers rekening houden met de positionaliteiten van gebruikers, agenten en zichzelf.
- Materialiseren: Door het maken van prototypen of het speculeren van alternatieven kunnen ontwerpers verder gaan dan het bedenken van technologieën op een andere manier, en deze nieuwe denkbeelden tastbaar maken.
- Enacting: Door de nieuwe denkbeelden in een rollenspel te spelen, kunnen ontwerpers more-than-human relaties repeteren en nieuwe gevoeligheden voor afstemming ontwikkelen.

Hoofdstuk 8 bouwt voort op de vragen uit Hoofdstuk 6 over de unieke manieren waarop ontwerpers more-than-human kennis creëren. Het duikt in de generatieve kruispunten tussen theorie en praktijk en onderzoekt deze ideeën door het ontwerp van twee op AI gebaseerde tools. In plaats van conceptuele ontwikkeling legt dit hoofdstuk de nadruk op praktische verkenning om de verbanden tussen theoretische raamwerken en ontwerpresultaten te verhelderen.

Centraal in dit hoofdstuk staat het argument dat het uitvoerbaar maken van more-than-human denken vraagt om verder te gaan dan het idee dat er een kloof moet worden overbrugd. In plaats daarvan wordt in dit hoofdstuk voorgesteld dat de ruimte tussen theorie en praktijk een interessant startpunt zou kunnen bieden voor experimenten. Het verkennen van die liminale ruimte presenteert twee hulpmiddelen die zijn ontworpen om strategieën te genereren op basis van diverse, more-than-human teksten. Als we reflecteren op het proces van het maken en gebruiken van deze tools, biedt dit hoofdstuk twee bijdragen:

- Er wordt uitgelegd hoe ontwerpers de tools kunnen gebruiken (en hun eigen varianten kunnen creëren) om vanuit meerdere perspectieven door ontwerpconcepten te lopen.
- Het biedt een kritische discussie over de mogelijkheden en beperkingen van het gebruik van AI voor more-than-human design, inclusief hoe more-than-human kennis kan worden gesitueerd en extractivistische relaties kunnen worden vermeden.

Hoofdstuk 9 synthetiseert de inzichten uit het proefschrift en weeft de uitkomsten samen als een praktijk van ontwerpen-met. Het contextualiseert ook de kennis die in het proefschrift wordt gegenereerd binnen de bestaande literatuur die in de inleiding wordt gepresenteerd.

Het stelt een reeks vragen voor waar more-than-human ontwerpers in hun praktijk over kunnen nadenken:

- Wat zijn de theoretische grondslagen van het onderzoek?
- Wat wordt er geproblematiseerd?
- Welke strategieën worden gebruikt om datgene wat gemarginaliseerd werd, te centreren?
- Welke bijdrage zou dit onderzoek kunnen bieden?
- In welke gemeenschap bevindt de bijdrage zich?
- Wat is 'decentered' en waar wordt in plaats daarvan rekening mee gehouden (gecentreerd)?
- Wat is gemaakt en wat is niet gemaakt?
- Welke more-than-human relaties kun je waarnemen?
- Hoe zou je de verstrengelde relaties beter kunnen opmerken, jezelf decentraliseren en omarmen van het niet weten?
- Hoe zou je deze relaties anders kunnen oefenen?

Ten slotte beschrijft het de opkomende notie van ontwerpen-met als:

- **Relationeel:** Het herkent dat mensen, dingen en werelden alleen in relatie tot elkaar begrepen kunnen worden en richt zich op het erkennen van more-than-human co-constituerende relaties die aanwezig zijn in elk ontwerpproces.
- **Bevestigend:** Het impliceert "actief staan voor het heden, terwijl we de ontwikkeling ervan beoordelen en nieuwe configuraties bedenken" (Braidotti, 2019, p. 463).
- **Gesitueerd:** Het heeft als doel rekening te houden met de positionering van de actoren die betrokken zijn bij ontwerpproessen.
- **Materiaal:** verschuivingen van alleen maar voorstellen hoe technologieën of relaties anders zouden kunnen zijn, naar het daadwerkelijk repeteren van alternatieve relaties.

Hoofdstuk 10 vat de bijdragen samen, legt uit op welke manieren deze bijdragen de onderzoeksdoelstellingen hebben aangepakt, en welke gebieden open blijven voor verder onderzoek. Ten slotte wordt er kritisch gekeken naar de beperkingen van het proefschrift en worden de mogelijkheden voor toekomstig werk benadrukt.

In de context van more-than-human design biedt het proefschrift verschillende bijdragen. Binnen dit veld heeft het proefschrift:

- een more-than-human ontwerpmethodologie toegepast in de specifieke context van AI, met name in de subdomeinen van gespreksagenten (Hoofdstukken 5, 7) en generatieve AI (Hoofdstuk 8), en voorbeelden gegeven die illustreren op welke manieren more-than-human design een geschikte benadering kan zijn voor het bestuderen en ontwerpen van AI (Hoofdstukken 4-8).
- nieuwe strategieën, tactieken, technieken en begrippen voorgesteld voor het beoefenen van more-than-human design (Hoofdstuk 9) en twee technieken uit dit veld verder ontwikkeld: Interviews met Dingen en Noticing (opmerken) (Hoofdstukken 4 en 8).
- onderzocht hoe ontwerpers more-than-human design in de praktijk toepassen (Hoofdstuk 6), waarbij begrippen en dimensies worden geboden die ontwerpers kunnen helpen hun praktijk beter te verwoorden (Hoofdstuk 6).

De secundaire bijdrage is aan het veld van AI, inclusief het opkomend perspectief van kritische AI, en de subvelden van conversationale AI en generatieve AI. Binnen deze velden heeft het proefschrift:

- more-than-human design voorgesteld als een benadering om verantwoordelijkere interacties te ontwerpen.
- nieuwe observaties onthuld met betrekking tot de antropocentrische vooroordelen van gespreksagenten, in hoe zij zowel menselijke als niet-menselijke stemmen horen of het zwijgen opleggen.
- de door mensen en AI gezamenlijk geproduceerde kennis geconceptualiseerd als more-than-human kennis.
- het concept van 'gesitueerde kennis' gebruikt om te reflecteren op verantwoordelijkheid in generatieve AI.
- een toepassing van ChatGPT ontworpen om ontwerponderzoekers te ondersteunen bij het aannemen van meer-dan-menselijke ontwerpbenaderingen.

Een kleine bijdrage is geleverd aan ontwerponderzoek. Het proefschrift:

- heeft geïllustreerd hoe theorie en praktijk vervlochten zijn in RTD-onderzoek, en nieuwe inzichten gebracht in langdurige discussies binnen het veld over de specifieke aard van de kennis die ontwerpers genereren.

Tot slot, als reactie op de onderzoeksdoelstelling om een more-than-human ontwerpmethodologie te ontwikkelen voor het bestuderen en ontwerpen van AI, pleit het proefschrift voor het samenstellen van een 'design-with'-praktijk. Het proefschrift mobiliseert deze praktijk door middel van methodologische interventies – strategieën, tactieken en technieken. Deze interventies kunnen ontwerpers ondersteunen bij:

- **Het situeren van het ontwerp van AI.** Dit verklaart de positionaliteit van mensen en niet-mensen die verstrengd zijn in AI-systemen, de positionaliteit van de agenten die kennis coproduceren met mensen, en de positionaliteit van de ontwerpers. Dit kan bijvoorbeeld worden gedaan door verschillende perspectieven naar voren te brengen, waardoor de antropocentrische vooroordelen (van de ontwerpen en de ontwerpers) worden blootgelegd en more-than-human relaties worden gerepeteerd.
- **Het niet-weten omarmen,** mislukkingen, stiltes en misverstanden gebruiken als kansen voor het ontwerpen van meer inclusieve AI-toepassingen.
- **Het decentraliseren van de humanistische opvatting van de gebruiker.** Deze opvatting weerspiegelt, in plaats van neutraal te zijn, zoals vaak wordt aangenomen, vaak een beperkte kijk op de mens die neutraal, mannelijk, blank en valide is. Het decentraliseren van de mens in AI gaat niet over het uitsluiten van mensen, maar over het afstand nemen van een bekrompen humanistische opvatting van de mens.

De bevindingen van dit proefschrift suggereren dat een more-than-human benadering een geschikte methode kan zijn voor het ontwerpen van AI. Deze benadering ondersteunt ontwerpers in het blootleggen van de schaal en reikwijdte van AI-systemen, het onthullen van AI als materieel en belichaamd, en het bieden van 'een meer uitgebreide notie van wat het betekent om mens te zijn — een notie die andere manieren van weten en zijn integreert in discussies over AI' (Forlano, 2021, p. 1).

About the author

Curriculum Vitae

Iohanna Nicenboim, born on February 6, 1985, in Buenos Aires, Argentina, embarked on her academic journey by completing a Bachelor's degree in Industrial Design (B.des.) at the Bezalel Academy in Jerusalem, Israel in 2009, followed by a Master's degree in Advanced Media at the University of the Arts (UDK) in Berlin, Germany in 2015. In November 2019, she commenced her Ph.D. at Delft University of Technology, focusing on Interaction Design.

In academia, Nicenboim has served as a guest editor for the HCI Journal's special issue on the More-than-Human Turn in Design; as chair of the DRS track More-than-human Design in Practice; and as one of the technical chairs for the Designing Interactive Systems (DIS) conference in 2023. Additionally, she has edited a book titled "Resourceful Ageing" and contributed chapters to several other books. From 2016 to 2018, she served as an Interaction Design Researcher for the NWO-funded Resourceful Ageing project at TU Delft, contributing to research on aging and technology. Prior to that, she worked as a Research Assistant for various projects, including Community Now at the Design Research Lab Berlin and Beyond Prototyping at the University of the Arts Berlin.

Beyond academia, Nicenboim has worked in industry as UX Manager at Robert Bosch in Berlin from 2018 to 2019 and as an Independent Interaction Designer from 2011 to 2018, collaborating on projects internationally. She also worked as a curator from 2012 to 2014 and 2016, a teacher at the Node Center for Curatorial Studies in Berlin from 2012 to 2018, and a Program Coordinator at Node's residency.

Nicenboim has secured grants such as the Personal PhD fellowship from Microsoft Research, and received prestigious awards, including the NGI Award for Excellence in Next Generation Internet in 2019, the Thingscon Fellowship in 2017, and the Best Design Fiction Project Award in 2016. In terms of teaching, she has held various roles at TU Delft, including lecturing in Digital Interfaces, leading Master Elective courses in More-than-human Design Experiments, and supervising Master Students Graduation projects.

Publications

Nicenboim, I., Lindley, J., Søndergaard, M. L. J., Reddy, A., Strengers, Y., & Giaccardi, E. (2024). Unmaking-with AI: Tactics for Decentering through Design. TOCHI, Special Issue: Unmaking & HCI: Techniques, Technologies, Materials, and Philosophies Beyond Making.

Nicenboim, I., Lindley, J., Zaga, C., Berger, A., Forlano, L., and Giaccardi, E. (2024) More-Than-Human Design in Practice, in Gray, C., Ciliotta Chehade, E., Hekkert, P., Forlano, L., Ciuccarelli, P., Lloyd, P. (eds.), DRS2024: Boston, 23–28 June, Boston, USA.

Nicenboim, I., Lindley, J., & Redstrom, J. (2024). Designing Generative AI Tools to Support More-than-human Design With/in Practice. DRS 2024.

Giaccardi, E., Redström, J., & Nicenboim, I. (2024). The Making(s) of More-than-Human Design: Introduction to the special issue on More-than-Human Design and HCI. Human-Computer Interaction, Taylor & Francis.

Chillet, M., Tironi, M., Nicenboim, I., & Lindley, J. (2024). Designing with planetary AI. In P. Rosén, A. Salovaara, M. L. Juul Søndergaard, & A. Botero (Eds.), More-than-human Design in Practice. Routledge.

Murray Rust, D., Luppetti, M. L., & Nicenboim, I. (2024). Metaphor Gardening: Experiential Engagements for Designing AI Interactions. DRS 2024.

Nicenboim, I., Oogens, D., Biggs, H., Nam, S., et al. (2023). Decentering through design: bridging posthumanist theory and more-than-human design practices. HCI Journal Posthumanist HCI special issue.

- Nicenboim, I., Giaccardi, E., & Redström, J. (2023). Designing More-Than-Human AI: Experiments on Situated Conversations and Silences. *diid Journal* issue n.80 "Artificial Intelligence and Design. On materiality, imagination and decentralized perspectives".
- Nicenboim, I., Venkat, S., Rustad, N. L., Vardanyan, D., Giaccardi, E., & Redström, J. (2023). Conversation Starters: How Can We Misunderstand AI Better? Extended Abstracts oCHI EA '23.
- Nicenboim, I. (2023). Data domestication: exploring sensors in the future everyday through design fiction. In M. Hartmann (Ed.), *The Routledge Handbook of Media and Technology Domestication*.
- Murray-Rust, D., Luppetti, M. L., Nicenboim, I., & van der Hoog, W. (2023). Grasping AI: experiential exercises for designers. *AI & Society*.
- Yoo, M., Berger, A., Lindley, J., Green, D. P., et al. (2023). Beyond Academic Publication: Alternative Outcomes of HCI Research. *DIS 2023*.
- van der Maden, W., van Beek, E., Nicenboim, I., van der Burg, V., et al. (2023). Towards a Design (Research) Framework with Generative AI. *DIS workshop 2023*.
- Nicenboim, I., Giaccardi, E., & Redström, J. (2022). From Explanations to Shared Understandings of AI. *DRS 2022 Conference, Bilbao*.
- Murray-Rust, D., Nicenboim, I., & Lockton, D. (2022). Metaphors for Designers Working with AI. *DRS Biennial Conference Series*.
- Coskun, A., Cila, N., Nicenboim, I., Frauenberger, C., et al. (2022). More-than-human Concepts, Methodologies, and Practices in HCI. *CHI EA '22*.
- Reddy, A. V., Nicenboim, I., Pierce, J., & Giaccardi, E. (2020). Encountering ethics through design: a workshop with nonhuman participants. *AI & Society*.
- Reddy, A. V., Kocaballi, A. B., Nicenboim, I., Søndergaard, M. L. J., et al. (2020). Making Everyday Things Talk: Speculative Conversations into the Future of Voice Interfaces at Home. *CHI Extended Abstracts 2021*.
- Nicenboim, I., Giaccardi, E., Søndergaard, M. L. J., Reddy, A. V., Strengers, Y. A. A., Pierce, J., & Redström, J. (2020). More-Than-Human Design and AI: In Conversation with Agents. In *Conference on Designing Interactive Systems (Companion Volume) 2020* (pp. 397-400). New York, NY, USA: Association for Computing Machinery.
- Kitazaki, M., Nicenboim, I., & Giaccardi, E. (2019). Connected Resources - Empowering Older People to Age Resourcefully. In *Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems (CHI EA '19)* (Paper VS06, p. 1). New York, NY, USA: Association for Computing Machinery.
- Kitazaki, M., Nicenboim, I., Giaccardi, E., Kuijer, L., & Neven, L. (2019). Connected Resources: A Research through Design approach to designing for older people's resourcefulness. *figshare. Journal contribution*.
- Nicenboim, I., Giaccardi, E., & Kuijer, L. (2018). Designing Connected Resources for Older People. In *Proceedings of the 2018 Designing Interactive Systems Conference (DIS '18)* (pp. 413-425). New York, NY, USA: Association for Computing Machinery.
- Nicenboim, I., Kitazaki, M., Kihara, T., Marin, A. T., & Havranek, M. (2018). Connected Resources: A Novel Approach in Designing Technologies for Older People. In *Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems (CHI EA '18)* (Paper D202, pp. 1-4). New York, NY, USA: Association for Computing Machinery.
- Nicenboim, I., Giaccardi, E., & Schouwenaar, M. (2018). Everyday Entanglements Of The Connected Home. In

Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems (CHI EA '18) (Paper VS04, p. 1). New York, NY, USA: Association for Computing Machinery.

Kuijjer, L., Nicenboim, I., & Giaccardi, E. (2017). Conceptualising Resourcefulness as a Dispersed Practice. In Proceedings of the 2017 Conference on Designing Interactive Systems (DIS '17) (pp. 15–27). New York, NY, USA: Association for Computing Machinery.

Ängeslevä, J., Nicenboim, I., Wunderling, J., & Lindlbauer, D. (2016). Beyond Prototyping. In C. Gengnagel, E. Nagy, & R. Stark (Eds.), Rethink! Prototyping (pp. 10). Cham: Springer.

References

- Abdul, A., Vermeulen, J., Wang, D., Lim, B. Y., & Kankanhalli, M. (2018). Trends and Trajectories for Explainable, Accountable and Intelligible Systems: An HCI Research Agenda. *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems - CHI '18*, 1–18.
- Adam, A. (1993). Gendered knowledge: Epistemology and artificial intelligence. *AI & Society*, 7(4), 311–322.
- Adam, A. (2000). Deleting the Subject: A Feminist Reading of Epistemology in Artificial Intelligence. *Minds and Machines*, 10(2), 231–253.
- Aizenberg, E., & van den Hoven, J. (2020). Designing for Human Rights in AI. In *arXiv [cs.CY]*. arXiv.
- Akmal, H., & Coulton, P. (2020). The Divination of Things by Things. *Extended Abstracts of the 2020 CHI Conference on Human Factors in Computing Systems*, 1–12.
- Amershi, S. (2020). Toward Responsible AI by Planning to Fail. *Proceedings of the 26th ACM SIGKDD International Conference on Knowledge Discovery & Data Mining*, 3607.
- Amershi, S., Inkpen, K., Teevan, J., Kikin-Gil, R., Horvitz, E., Weld, D., Vorvoreanu, M., Fourney, A., Nushi, B., Collisson, P., Suh, J., Iqbal, S., & Bennett, P. N. (2019). Guidelines for Human-AI Interaction. *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems - CHI '19*, 1–13.
- Ananny, M., & Crawford, K. (2018). Seeing without knowing: Limitations of the transparency ideal and its application to algorithmic accountability. *New Media & Society*, 20(3), 973–989.
- Andersen, K., Boucher, A., Chatting, D., Desjardins, A., Devendorf, L., Gaver, W., Jenkins, T., Odom, W., Pierce, J., & Vallgård, A. (2019). Doing Things with Research Through Design: With What, with Whom, and Towards What Ends? *Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems*, W13:1–W13:8.
- Andersen, K., Devendorf, L., Pierce, J., Wakkary, R., & Rosner, D. K. (2018). Disruptive Improvisations: Making Use of Non-Deterministic Art Practices in HCI. *Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems*, Article Paper W11.
- Andres, J., Wolf, C. T., Cabrero Barros, S., Oduor, E., Nair, R., Kjærum, A., Tharsgaard, A. B., & Madsen, B. S. (2020). Scenario-based XAI for Humanitarian Aid Forecasting. *Extended Abstracts of the 2020 CHI Conference on Human Factors in Computing Systems*, 1–8.
- Arendt, H. (1994). Understanding and Politics (The Difficulties of Understanding). In J. Kohn (Ed.), *Essays in Understanding: 1930-1954* (1st ed.). Harcourt.
- Artificial Intelligence Act (2024). <https://digital-strategy.ec.europa.eu/en/policies/regulatory-framework-ai>
- Barad, K. (2007). *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning*. Duke University Press.
- Barad, K. (2012). On touching—the inhuman that therefore I am. *Differences*, 23(3), 206–223.
- Barad, K. (2014). Diffracting Diffraction: Cutting Together-Apart. *Parallax*, 20(3), 168–187.
- Barredo Arrieta, A., Díaz-Rodríguez, N., Del Ser, J., Bennetot, A., Tabik, S., Barbado, A., Garcia, S., Gil-Lopez, S., Molina, D., Benjamins, R., Chatila, R., & Herrera, F. (2020). Explainable Artificial Intelligence (XAI): Concepts, taxonomies, opportunities and challenges toward responsible AI. *An International Journal on Information Fusion*, 58, 82–115.
- Bedö, V. (2021). Catch the Bus: Probing Other-Than-Human Perspectives in Design Research. *Frontiers in*

Behzad, A., Wakkary, R., Oogjes, D., Zhong, C., & Lin, H. (2022). Iterating through Feeling -with Nonhuman Things: Exploring repertoires for design iteration in more-than-human design. *Extended Abstracts of the 2022 CHI Conference on Human Factors in Computing Systems*, Article Article 278.

Benjamin, J. J., Berger, A., Merrill, N., & Pierce, J. (2021). Machine Learning Uncertainty as a Design Material: A Post-Phenomenological Inquiry. *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*, Article Article 171.

Bennett, J. (2010). *Vibrant Matter: A Political Ecology of Things*. Duke University Press.

Biggs, H. R., Bardzell, J., & Bardzell, S. (2021). Watching Myself Watching Birds: Abjection, Ecological Thinking, and Posthuman Design. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems* (pp. 1–16). Association for Computing Machinery.

Biggs, H. R., & Desjardins, A. (2020). High Water Pants: Designing Embodied Environmental Speculation. *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, 1–13.

Binder, T., De Michelis, G., Ehn, P., Jacucci, G., & Linde, P. (2011). *Design Things*. MIT Press.

Blanco-Wells, G. (2021). Ecologies of Repair: A Post-human Approach to Other-Than-Human Natures. *Frontiers in Psychology*, 12, 633737.

Bleecker, J. (2009). *A short essay on design, science, fact and fiction*. The Near Future Laboratory.

Bødker, S. (2015). Third-wave HCI, 10 years later: participation and sharing. *Interactions*, 22(5), 24–31.

Braidotti, R. (2013). *The Posthuman* (1st ed.). Polity.

Braidotti, R. (2019). *Posthuman Knowledge* (1st ed.). Polity.

Braidotti, R., & Hlavajova, M. (2018). *Posthuman Glossary*. Bloomsbury Publishing.

Brand, N., Odom, W., & Barnett, S. (2021). A Design Inquiry into Introspective AI: Surfacing Opportunities, Issues, and Paradoxes. *Proceedings of the 2021 ACM Designing Interactive Systems Conference*, 1603–1618.

Brewer, R. N., Harrington, C., & Heldreth, C. (2023). Envisioning Equitable Speech Technologies for Black Older Adults. *Proceedings of the 2023 ACM Conference on Fairness, Accountability, and Transparency*, 379–388.

Brunton, F., Nissenbaum, H., Echizen, I., Houmansadr, A., Cote, N., Hammond, R., & Friedler, S. (2017). *Obfuscation Workshop Report*.

Cage, J., & Gann, K. (2011). *Silence: Lectures and Writings, 50th Anniversary Edition* (second edition). Wesleyan University Press.

Camocini, B., & Vergani, F. (2021). *From Human-centered to More-than-Human Design. Exploring the transition*. Franco Angeli.

Capel, T., & Brereton, M. (2023). What is Human-Centered about Human-Centered AI? A Map of the Research Landscape. *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems*, Article Article 359.

Cattabriga, A., & Joler, V. (2023). Decentering Design With AI. *Diid — Disegno Industriale Industrial Design*, 80, 12–12.

Celaschi, F. (2023). Editorial. *Diid Disegno Industriale Industrial Design*, 80.

- Chang, W.-W., Giaccardi, E., Chen, L.-L., & Liang, R.-H. (2017). "Interview with Things": A First-thing Perspective to Understand the Scooter's Everyday Socio-material Network in Taiwan. *Proceedings of the 2017 Conference on Designing Interactive Systems*, 1001–1012.
- Cheon, E. (2018). Alternative Ways of Living and Design. *Companion of the 2018 ACM Conference on Computer Supported Cooperative Work and Social Computing*, 85–88.
- Chiou, L.-Y., Hung, P.-K., Liang, R.-H., & Wang, C.-T. (2023). Designing with AI: An Exploration of Co-Ideation with Image Generators. *Proceedings of the 2023 ACM Designing Interactive Systems Conference*, 1941–1954.
- Cho, J., Devendorf, L., & Volda, S. (2021). From The Art of Reflection to The Art of Noticing: A Shifting View of Self-Tracking Technologies' Role in Supporting Sustainable Food Practices. *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems*, Article Article 298.
- Clark, E. (2021). Sound, colonialism, and decolonial listening. *FOCUS On Sound*, 1.
- Clarke, R., Heitlinger, S., Foth, M., DiSalvo, C., Light, A., & Forlano, L. (2018). More-than-human urban futures: speculative participatory design to avoid ecocidal smart cities. *Proceedings of the 15th Participatory Design Conference on Short Papers, Situated Actions, Workshops and Tutorial - PDC '18*, 1–4.
- Clarke, R., Heitlinger, S., Light, A., Forlano, L., Foth, M., & Disalvo, C. (2019). More-than-human participation. *Interactions*.
- Cooper, G., & Bowers, J. (1995). Representing the user: notes on the disciplinary rhetoric of human-computer interaction. In *The social and interactional dimensions of human-computer interfaces* (pp. 48–66). Cambridge University Press.
- Cortés, N., Quijano, P. R., Hernández, P., la_jes, & Pérez-Díaz, L. H. (2020). *Tecnoafecciones Por una política de la co-responsabilidad*. Instituto de Liderazgo Simone de Beauvoir.
- Coskun, A., Cila, N., Nicenboim, I., Frauenberger, C., Wakkary, R., Hassenzahl, M., Mancini, C., Giaccardi, E., & Forlano, L. (2022). More-than-human Concepts, Methodologies, and Practices in HCI. *Extended Abstracts of the 2022 CHI Conference on Human Factors in Computing Systems*, Article Article 150.
- Costanza-Chock, S. (2020). *Design Justice: Community-led Practices to Build the Worlds We Need*. MIT Press.
- Coulton, P., & Lindley, J. G. (2019). More-Than Human Centred Design: Considering Other Things. *The Design Journal*, 22(4), 463–481.
- Coulton, P., Lindley, J., Sturdee, M., & Stead, M. (2017). Design Fiction as World Building. *Research through Design*.
- Cowan, B. R., Doyle, P., Edwards, J., Garaialde, D., Hayes-Brady, A., Branigan, H. P., Cabral, J., & Clark, L. (2019). What's in an accent? The impact of accented synthetic speech on lexical choice in human-machine dialogue. In *arXiv [cs.HC]*.
- Crawford, K. (2018). *Atlas of AI*. Yale University Press.
- Crawford, K. (2021). *Atlas of AI: Power, Politics, and the Planetary Costs of Artificial Intelligence*. Yale University Press.
- Crawford, K., & Joler, V. (2018). *Anatomy of an AI System: The Amazon Echo As An Anatomical Map of Human Labor, Data and Planetary Resources*. <https://anatomyof.ai/>
- Crawford, K., Joler, V., & Cattabriga, A. (2023). A Perspective on AI and Data in Design. *DIID*, 80.
- Croak, M. (2023). *Responsible AI* (No. 2). Google Research.

- de la Bellacasa, M. P. (2011). Matters of care in technoscience: assembling neglected things. *Social Studies of Science*, 41(1), 85–106.
- de la Bellacasa, M. P. (2012). "Nothing Comes Without Its World": Thinking with Care. *The Sociological Review*.
- de la Bellacasa, M. P. (2017). *Matters of Care: Speculative Ethics in More than Human Worlds*. U of Minnesota Press.
- Deleuze, G., & Parnet, C. (2007). *Dialogues II*. Columbia University Press.
- De Mul, J. (2010). Moral Machines: ICTs as Mediators of Human Agencies. *Techné: Research in Philosophy and Technology*, 14(3), 226–236.
- Desjardins, A., Psarra, A., & A. Whiting, B. (2021). Voices and Voids: Subverting Voice Assistant Systems through Performative Experiments. In *Creativity and Cognition* (pp. 1–10). Association for Computing Machinery.
- Devendorf, L., De Kosnik, A., Mattingly, K., & Ryokai, K. (2016). Probing the Potential of Post-Anthropocentric 3D Printing. *Proceedings of the 2016 ACM Conference on Designing Interactive Systems*, 170–181.
- Devendorf, L., & Ryokai, K. (2015). Being the Machine: Reconfiguring Agency and Control in Hybrid Fabrication. *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, 2477–2486.
- de Vries, A. (2023). The growing energy footprint of artificial intelligence. *Joule*, 7(10), 2191–2194.
- Dew, K., & Rosner, D. (2018). Lessons from the Woodshop: Cultivating Design with Living Materials. *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems - CHI '18*, 1–12.
- Di Salvo, C. (2012). *Adversarial Design*. The MIT Press.
- Disalvo, C., & Lukens, J. (2011). Nonanthropocentrism and the Nonhuman in Design: Possibilities for Designing New Forms of Engagement with and through Technology. In M. Foth (Ed.), *From Social Butterfly to Engaged Citizen: Urban Informatics, Social Media, Ubiquitous Computing, and Mobile Technology to Support Citizen Engagement*. MIT Press.
- Dolejšová, M., van Gaalen, S., Wilde, D., Raven, P. G., Heitlinger, S., & Light, A. (2020). Designing with more-than-human food practices for climate-resilience. *Companion Publication of the 2020 ACM Designing Interactive Systems Conference*. DIS '20: Designing Interactive Systems Conference 2020, Eindhoven Netherlands.
- Dolejšová, M., Wilde, D., Altarriba Bertran, F., & Davis, H. (2020). Disrupting (More-than-) Human-Food Interaction: Experimental Design, Tangibles and Food-Tech Futures. *Proceedings of the 2020 ACM Designing Interactive Systems Conference*, 993–1004.
- Dörrenbächer, J., Löffler, D., & Hassenzahl, M. (2020). Becoming a Robot - Overcoming Anthropomorphism with Techno-Mimesis. *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, 1–12.
- Druga, S., Williams, R., Breazeal, C., & Resnick, M. (2017). Hey Google is it OK if I eat you?: Initial Explorations in Child-Agent Interaction. *Proceedings of the 2017 Conference on Interaction Design and Children*, 595–600.
- Edwards, J., Clark, L., & Perrone, A. (2021). LGBTQ-AI? Exploring Expressions of Gender and Sexual Orientation in Chatbots. *Proceedings of the 3rd Conference on Conversational User Interfaces*, Article Article 2.
- Ehsan, U., & Riedl, M. O. (2020). Human-centered Explainable AI: Towards a Reflective Sociotechnical Approach. In *arXiv [cs.HC]*.
- Ehsan, U., Wintersberger, P., Liao, Q. V., Watkins, E. A., Manger, C., Daumé, H., III, Riener, A., & Riedl, M. O. (2022). Human-Centered Explainable AI (HCXAI): Beyond Opening the Black-Box of AI. *Extended Abstracts of the 2022 CHI Conference on Human Factors in Computing Systems*, Article Article 109.

- Erlhoff, M., & Jonas, W. (2018). *NERD – New Experimental Research in Design*. Birkhäuser.
- Escobar, A. (2018). *Designs for the Pluriverse: Radical Interdependence, Autonomy, and the Making of Worlds*. Duke University Press.
- Escobar, A. (2020). Sentipensar with the Earth: Territorial Struggles and the Ontological Dimension of the Epistemologies of the South. In *Pluriversal Politics* (pp. 67–83). Duke University Press.
- Feng, K. J. K., Coppock, M. J., & McDonald, D. W. (2023). How Do UX Practitioners Communicate AI as a Design Material? Artifacts, Conceptions, and Propositions. *Proceedings of the 2023 ACM Designing Interactive Systems Conference*, 2263–2280.
- Feola, G. (2019). Degrowth and the Unmaking of Capitalism: Beyond “Decolonization of the Imaginary”? *ACME: An International Journal for Critical Geographies*, 18(4), 977–997.
- Ferrando, F. (2019). *Philosophical Posthumanism*.
- Forlano, L. (2016). Decentering the human in the design of collaborative cities. *Design Issues*, 32(3), 42–54.
- Forlano, L. (2017). Posthumanism and Design. *She Ji: The Journal of Design, Economics, and Innovation*, 3(1), 16–29.
- Forlano, L. (2021). A New AI Lexicon: Human. *AI Now Institute*.
- Forlano, L. (2023). Living Intimately with Machines: Can AI Be Disabled? *Interactions*, 30(1), 24–29.
- Fossa, F., & Sucameli, I. (2022). Gender Bias and Conversational Agents: an ethical perspective on Social Robotics. *Science and Engineering Ethics*, 28(3), 23.
- Frauenberger, C. (2019). Entanglement HCI The Next Wave? *ACM Trans. Comput.-Hum. Interact.*, 27(1), 1–27.
- Frayling, C. (1993). *Research in Art and Design*. Royal College of Art.
- French, F., Mancini, C., & Sharp, H. (2020). More Than Human Aesthetics: Interactive Enrichment for Elephants. *Proceedings of the 2020 ACM Designing Interactive Systems Conference*, 1661–1672.
- Friedman, B., & Yoo, D. (2017). Pause: A Multi-lifespan Design Mechanism. *The 2017 CHI Conference*, 460–464.
- Fuchsberger, V., & Frauenberger, C. (2024). Doing responsibilities in entangled worlds. *Human-Computer Interaction*, 1–24.
- Ganesh, M. I. (2022). Between metaphor and meaning: AI and being human. *Interactions*, 29(5), 58–62.
- Gann, K. (2010). *No Such Thing as Silence: John Cage's 4'33"*. Yale University Press.
- Garcia, P., Sutherland, T., Cifor, M., Chan, A. S., Klein, L., D'Ignazio, C., & Salehi, N. (2020). No: Critical Refusal as Feminist Data Practice. *Conference Companion Publication of the 2020 on Computer Supported Cooperative Work and Social Computing*, 199–202.
- Gaver, & Bowers. (2012). Annotated portfolios. *Interactions*, 19(4), 40–49.
- Gaver, W., Krogh, P. G., Boucher, A., & Chatting, D. (2022). Emergence as a Feature of Practice-based Design Research. *Designing Interactive Systems Conference*, 517–526.
- Geerts, E., & van der Tuin, I. (2021). Diffraction & Reading Diffractively. *Matter: Journal of New Materialist Research*, 1(2).
- Ghajargar, M., & Bardzell, J. (2022). Learning About Plant Intelligence from a Flying Plum Tree: Music Recommenders and Posthuman User Experiences. *Proceedings of the 25th International Academic Mindtrek*

Conference, 343–346.

Ghajargar, M., Bardzell, J., Renner, A. S., Krogh, P. G., Höök, K., Cuartielles, D., Boer, L., & Wiberg, M. (2021). From "Explainable AI" to "Graspable AI". *Proceedings of the Fifteenth International Conference on Tangible, Embedded, and Embodied Interaction*, Article Article 69.

Giaccardi, E. (2019). Histories and Futures of Research through Design: From Prototypes to Connected Things. *International Journal of Design*, 13(3).

Giaccardi, E. (2020). Casting things as partners in design: Towards a more-than-human design practice. In H. Wiltse (Ed.), *Relating to Things: Design, Technology and the Artificial*. Bloomsbury.

Giaccardi, E., Cila, N., Speed, C., & Caldwell, M. (2016). Thing Ethnography: Doing Design Research with Non-Humans. *Proceedings of the 2016 ACM Conference on Designing Interactive Systems*, 377–387.

Giaccardi, E., Kuijter, L., & Neven, L. (2016). Design for Resourceful Ageing: Intervening in the Ethics of Gerontechnology. *DRS 2016 Design Research Society 50th Anniversary Conference*.

Giaccardi, E., & Redström, J. (2020). Technology and more-than-human design. *Design Issues*, 36(4), 33–44.

Giaccardi, E., Speed, C., Cila, N., & Caldwell, M. L. (2016). Things As Co-ethnographers: Implications of a Thing Perspective for Design and Anthropology. In R. C. Smith, K. T. Vangkilde, M. G. Kjaersgaard, T. Otto, J. Halse, & T. Binder (Eds.), *Design Anthropological Futures*. Bloomsbury Academic.

Giaccardi, E., Redström, J., & Nicenboim, I. (2024). The making(s) of more-than-human design: introduction to the special issue on more-than-human design and HCI. *Human–Computer Interaction*, 1–16.

Goodman, E. S. (2013). *Delivering Design: Performance and Materiality in Professional Interaction Design*, University of California, Berkeley.

Göransdotter, M., Auricchio, V., Auger, J., Daalhuizen, J., & Giaccardi, E. (2023). Designing designing : design methods revisited. *IASDR 2023: Life-Changing Design, Milano, Italy, October 9-13, 2023*.

Green, D. P., Lindley, J., Encinas, E., Dore, M., Benjamin, J. J., & Bofylatos, S. (2023). Ways of seeing design research: A polyphonic speculation. *Nordes Conference Series*.

Grusin, R. (Ed.). (2015). *The Nonhuman Turn (21st Century Studies)* (1st ed.). Univ Of Minnesota Press.

Guattari, F., & Deleuze, G. (1980). *A Thousand Plateaus*.

Hales, D. (2013). Design fictions an introduction and provisional taxonomy. *Digital Creativity*, 24(1), 1–10.

Haraway, D. (2008). *When Species Meet*. U of Minnesota Press.

Haraway, D. (2016). *Staying with the Trouble: Making Kin in the Chthulucene*. Duke University Press.

Haraway, D. (1988). Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective. *Feminist Studies: FS*, 14(3), 575–599.

Haraway D. & Goodeve, T. (2018). Nothing Comes Without Its World. In Haraway & Goodeve (Ed.), *Modest_Witness* (2nd Edition, pp. xiii – xlvii). Routledge.

Harrington, C., Erete, S., & Piper, A. M. (2019). Deconstructing Community-Based Collaborative Design: Towards More Equitable Participatory Design Engagements. *Proc. ACM Hum.-Comput. Interact.*, 3(CSCW), 1–25.

Hemment, D., Aylett, R., Belle, V., Murray-Rust, D., Luger, E., Hillston, J., Rovatsos, M., & Broz, F. (2019). Experiential AI. *AI Matters*, 5(1), 25–31.

- Homewood, S., Hedemyr, M., Fagerberg Ranten, M., & Kozel, S. (2021). Tracing Conceptions of the Body in HCI: From User to More-Than-Human. *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*, Article Article 258.
- Höök, K., & Löwgren, J. (2012). Strong concepts: Intermediate-level knowledge in interaction design research. *ACM Trans. Comput.-Hum. Interact.*, 19(3), 1–18.
- Howell, N., Desjardins, A., & Fox, S. (2021). Cracks in the Success Narrative: Rethinking Failure in Design Research through a Retrospective Trioethnography. *ACM Trans. Comput.-Hum. Interact.*, 28(6), 1–31.
- Hutiri, W. T., & Ding, A. Y. (2022). Bias in Automated Speaker Recognition. *Proceedings of the 2022 ACM Conference on Fairness, Accountability, and Transparency*, 230–247.
- Ingold, T. (2013). *Making* (1st Edition). Routledge.
- Ingold, T. (2017). On human correspondence. *The Journal of the Royal Anthropological Institute*, 23(1), 9–27.
- Jönsson, L., Tironi, M., Hermansen, P., & Wilkie, A. (2022). Doing and Undoing Post-Anthropocentric Design. *DRS Biennial Conference Series*.
- Kak, A., & West, S. M. (2023). *AINow 2023 Landscape: Confronting Tech Power*. AINow Institute.
- Key, C., Gatehouse, C., & Taylor, N. (2022). Feminist Care in the Anthropocene: Packing and Unpacking Tensions in Posthumanist HCI. *Designing Interactive Systems Conference*, 677–692.
- Klumbyte, G., & Draude, C. (Eds.). (2022). *Prospects for a New Materialist Informatics* (Issue 1). Matter: Journal of New Materialist Research.
- Klumbyte, G., Draude, C., & Taylor, A. S. (2022). Critical Tools for Machine Learning: Working with Intersectional Critical Concepts in Machine Learning Systems Design. *Proceedings of the 2022 ACM Conference on Fairness, Accountability, and Transparency*, 1528–1541.
- Koenecke, A., Nam, A., Lake, E., Nudell, J., Quartey, M., Mengesha, Z., Toups, C., Rickford, J. R., Jurafsky, D., & Goel, S. (2020). Racial disparities in automated speech recognition. *Proceedings of the National Academy of Sciences of the United States of America*, 117(14), 7684–7689.
- Krogh, P. G., & Koskinen, I. (2020). *Drifting by Intention*. Springer International Publishing.
- Kuijter, L., & Giaccardi, E. (2018). Co-performance: Conceptualizing the Role of Artificial Agency in the Design of Everyday Life. *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*, 125:1–125:13.
- Kusal, S., Patil, S., Choudrie, J., Kotecha, K., Mishra, S., & Abraham, A. (2022). AI-Based Conversational Agents: A Scoping Review From Technologies to Future Directions. *IEEE Access*, 10, 92337–92356.
- Latour, B., & Weibel, P. (2005). *Making Things Public*. The MIT Press, Massachusetts Institute of Technology.
- Lawson, S., Kirman, B., Linehan, C., Feltwell, T., & Hopkins, L. (2015). Problematising Upstream Technology through Speculative Design: The Case of Quantified Cats and Dogs. *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, 2663–2672.
- Lawton, T., Grace, K., & Ibarrola, F. J. (2023). When is a Tool a Tool? User Perceptions of System Agency in Human–AI Co-Creative Drawing. *Proceedings of the 2023 ACM Designing Interactive Systems Conference*, 1978–1996.
- Lee, F. (2022). *Ontological overflows and the politics of absence: Zika, disease surveillance, and mosquitos at the ECDC*.

- Lee, M., Leal, D. de C., Krüger, M., Strohmayer, A., & Zaga, C. (2021). Activated: Decentering activism in and with academia. *Companion Publication of the 2021 Conference on Computer Supported Cooperative Work and Social Computing*, 343–346.
- Lee, M., Noortman, R., Zaga, C., Starke, A., Huisman, G., & Andersen, K. (2021). Conversational Futures: Emancipating Conversational Interactions for Futures Worth Wanting. *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*, Article Article 298.
- le Guin, U. K. (1986). *The Carrier Bag Theory of Fiction*. Ignota Books, 2019.
- Lindley, J., Akmal, H. A., Pilling, F., & Coulton, P. (2020). Researching AI Legibility through Design. *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, 1–13.
- Lindley, J., Benjamin, J. J., Green, D. P., McGarry, G., Pilling, F., Dudek, L., Crabtree, A., & Coulton, P. (2024). Productive Oscillation as a strategy for doing more-than-human design research. *Human-Computer Interaction*, 1–26.
- Lindley, Nicenboim, Forlano, Giaccardi, Berger, & Zaga. (2023). *More-than-human Design in Practice*. DRS2024.
- Lindström, K., & Ståhl, Å. (2016). Politics of Inviting: Co-Articulations of Issues in Designerly Public Engagement. In R. C. Smith, K. T. Vangkilde, M. G. Kjaersgaard, T. Otto, J. Halse, & T. Binder (Eds.), *Design Anthropological Futures*. Taylor & Francis.
- Lindström, K., & Ståhl, Å. (2019). Caring Design Experiments in the Aftermath. *Nordes*, 0(8).
- Lindström, K., & Ståhl, Å. (2020). Un/Making in the Aftermath of Design. *Proceedings of the 16th Participatory Design Conference 2020 - Participation(s) Otherwise - Volume 1*, 12–21.
- Lindström, K., & Ståhl, Å. (2023). Un/Making the Plastic Straw: Designerly Inquiries into Disposability. *Design and Culture*, 1–23.
- Liu, J., Byrne, D., & Devendorf, L. (2018). Design for Collaborative Survival: An Inquiry into Human-Fungi Relationships. *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*, Article Paper 40.
- Liu, S.-Y. (cyn), Bardzell, J., & Bardzell, S. (2019). Decomposition as Design: Co-Creating (with) Natureculture. *Proceedings of the Thirteenth International Conference on Tangible, Embedded, and Embodied Interaction*, 605–614.
- Liu, V., Vermeulen, J., Fitzmaurice, G., & Matejka, J. (2023). 3DALL-E: Integrating Text-to-Image AI in 3D Design Workflows. *Proceedings of the 2023 ACM Designing Interactive Systems Conference*, 1955–1977.
- Livio, M., & Devendorf, L. (2022). The Eco-Technical Interface: Attuning to the Instrumental. *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems*, Article Article 101.
- Lockton, D., Singh, D., Sabnis, S., Chou, M., Foley, S., & Pantoja, A. (2019). New Metaphors: A Workshop Method for Generating Ideas and Reframing Problems in Design and Beyond. *Proceedings of the 2019 on Creativity and Cognition*, 319–332.
- Luger, E., & Sellen, A. (2016). "Like Having a Really Bad PA": The Gulf between User Expectation and Experience of Conversational Agents. *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*, 5286–5297.
- Lupetti, M. L., Smit, I., & Cila, N. (2018). Near future cities of things: addressing dilemmas through design fiction. *Proceedings of the 10th Nordic Conference on Human-Computer Interaction*, 787–800.
- Maffei, S. (2021). Expanding the Galaxy. *Diid — Disegno Industriale Industrial Design*, 75, 8–8.

- Mancini, C. (2017). Towards an animal-centred ethics for Animal-Computer Interaction. *Int. J. Hum.-Comput. Stud.*, 98(C), 221–233.
- Marenko, B., & Benqué, D. (2019). *Speculative Diagrams: experiments in mapping Youtube*.
- Mazé, R., & Redström, J. (2009). *Difficult Forms: Critical practices of design and research*. 1(1), 28–39.
- Mccarthy, L. (2018, January 8). *Feeling at Home: Between Human and AI*. Immerse.
- Miller, T. (2019). Explanation in artificial intelligence: Insights from the social sciences. *Artificial Intelligence*, 267, 1–38.
- Mittelstadt, B., Russell, C., & Wachter, S. (2018). Explaining Explanations in AI. In *arXiv [cs.AI]*. arXiv.
- Moore, J. W. (2017). The Capitalocene, Part I: on the nature and origins of our ecological crisis. *The Journal of Peasant Studies*, 44(3), 594–630.
- Murray-Rust, D., Lupetti, M. L., Nicenboim, I., & Hoog, W. van der. (2023). Grasping AI: experiential exercises for designers. *AI & Society*.
- Murray-Rust, D., Nicenboim, I., & Lockton, D. (2022). Metaphors for designers working with AI. *DRS Biennial Conference Series*.
- Nicenboim, I., Giaccardi, E., & Redström, J. (2022). From explanations to shared understandings of AI. *DRS Biennial Conference Series*.
- Nicenboim, I., Giaccardi, E., & Redström, J. (2023). Designing More-Than-Human AI: Experiments on Situated Conversations and Silences. *Diid — Disegno Industriale Industrial Design*, 80, 12–12.
- Nicenboim, I., Giaccardi, E., Søndergaard, M. L. J., Reddy, A. V., Strengers, Y., Pierce, J., & Redström, J. (2020). More-Than-Human Design and AI: In Conversation with Agents. *Companion Publication of the 2020 ACM Designing Interactive Systems Conference*, 397–400.
- Nicenboim, I., Oogjes, D., Biggs, H., & Nam, S. (2024). Decentering Through Design: Bridging Posthuman Theory with More-than-Human Design Practices. *Human-Computer Interaction*, 1–26.
- Nicenboim, I., Venkat, S., Rustad, N. L., Vardanyan, D., Giaccardi, E., & Redström, J. (2023). Conversation Starters: How Can We Misunderstand AI Better? *Extended Abstracts of the 2023 CHI Conference on Human Factors in Computing Systems*, Article Article 431.
- Nordmoen, C. (2020). Decentring the Human in Digital Making - Towards Embodied Mattering. *Companion Publication of the 2020 ACM Designing Interactive Systems Conference*, 543–547.
- Noticing Entanglements*. (2023). Spotify. <https://open.spotify.com/show/3yv8MulZWcJ52VFsoUgUGR>
- Objects that Withdraw - Iohanna Nicenboim*. (2017). <https://iohanna.com/Objects-that-Withdraw>
- Odom, W., Stolterman, E., & Chen, A. Y. S. (2022). Extending a Theory of Slow Technology for Design through Artifact Analysis. *Human-Computer Interaction*, 37(2), 150–179.
- Ofer, N., Bell, F., & Alistar, M. (2021). Designing Direct Interactions with Bioluminescent Algae. *Designing Interactive Systems Conference 2021*, 1230–1241.
- Oktay, G., Ikeya, Y., Lee, M., Barati, B., Lee, Y., Chen, Y., Pschetz, L., & Ramirez-Figueroa, C. (2023). Designing with the more-than-human: Temporalities of thinking with care. *Companion Publication of the 2023 ACM Designing Interactive Systems Conference*, 104–106.

- Oogjes, D. (2022). *Repertoires for designing with nonhumans*. Simon Fraser University.
- Oogjes, D., & Wakkary, R. (2022). Weaving Stories: Toward Repertoires for Designing Things. *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems*, Article Article 98.
- Oogjes, D., Wakkary, R., Lin, H., & Alemi, O. (2020). Fragile! Handle with Care: The Morse Things. *Proceedings of the 2020 ACM Designing Interactive Systems Conference*, 2149–2162.
- Ørngreen, R., & Levinsen, K. (2017). Workshops as a Research Methodology. *Electronic Journal of E-Learning*, 15(1), 70–81.
- Páez, A. (2019). The Pragmatic Turn in Explainable Artificial Intelligence (XAI). *Minds & Machines*, 29, 441–459.
- Parviainen, E., & Søndergaard, M. L. J. (2020). Experiential Qualities of Whispering with Voice Assistants. *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, 1–13.
- Pasquinelli, M., & Joler, V. (2021). The Nooscape manifested: AI as instrument of knowledge extractivism. *AI & Society*, 36(4), 1263–1280.
- Pelikan, H. R. M., & Broth, M. (2016). Why That Nao? How Humans Adapt to a Conventional Humanoid Robot in Taking Turns-at-Talk. *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*, 4921–4932.
- Phan, T. (2019). Amazon Echo and the Aesthetics of Whiteness. *Catalyst : Feminism, Theory, Technoscience*, 5(1).
- Pierce, J. (2012). Undesigning technology: considering the negation of design by design. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 957–966.
- Pierce, J., & Paulos, E. (2015). Making Multiple Uses of the Obscura 1C Digital Camera: Reflecting on the Design, Production, Packaging and Distribution of a Counterfunctional Device. *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, 2103–2112.
- Plummer-Fernandez, M. (2019). *The art of bots: A practice-based study of the multiplicity, entanglements and figuration of sociocomputational assemblages*.
- Porcheron, M., Fischer, J. E., Reeves, S., & Sharples, S. (2018). Voice Interfaces in Everyday Life. *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*, 640:1–640:12.
- Proceedings of the 5th International Conference on Conversational User Interfaces*. (2023). Association for Computing Machinery.
- Project Alias*. (2018). Bjørn Karmann. http://bjoernkarmann.dk/project_alias
- Rajcic, N., & McCormack, J. (2023). Message Ritual: A Posthuman Account of Living with Lamp. *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems*, Article Article 634.
- Raley, R., & Rhee, J. (2023). Critical AI: A field in formation. *American Literature; a Journal of Literary History, Criticism and Bibliography*, 95(2), 185–204.
- Reddy, A., Kocaballi, A. B., Nicenboim, I., Søndergaard, M. L. J., Lupetti, M. L., Key, C., Speed, C., Lockton, D., Giaccardi, E., Grommé, F., Robbins, H., Primlani, N., Yurman, P., Sumartojo, S., Phan, T., Bedö, V., & Strengers, Y. (2021). Making Everyday Things Talk: Speculative Conversations into the Future of Voice Interfaces at Home. *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems*, Article Article 23.
- Reddy, A., Nicenboim, I., Pierce, J., & Giaccardi, E. (2020). Encountering ethics through design: a workshop with nonhuman participants. *AI & Society*.

Redström, J. (2011). Some Notes on Programme-Experiment Dialectics. *Nordes*, 0(4).

Redström, J. (2017). *Making Design Theory*. The MIT Press.

Redström, J., & Wiltse, H. (2018). *Changing Things: The Future of Objects in a Digital World*. Bloomsbury Visual Arts.

Robbins, H., & Giaccardi, E. (2019). Generating value across academic and professional design practice in the Internet of Things. *CoDesign*, 15(1), 24–40.

Rogers, J., Bihr, P., Jain, A., Arden, J., von Grafenstein, M., Clarke, L., Skelly, M., Taylor, N., Thomas, P., Thorne, M., Larsen, S., Odrozek, K., & Kloiber, J. (2019). Our Friends Electric: Reflections on Advocacy and Design Research for the Voice Enabled Internet. *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems - CHI '19*, 1–13.

Rolighed, M. L., Aagaard, E. M., Due Jensen, M., Frankjaer, R., & Hansen, L. K. (2022). Plant Radio: Tuning in to plants by combining posthumanism and design. *Designing Interactive Systems Conference*, 666–676.

Rosner, D. K. (2020). *Critical Fabulations*. The MIT Press, Massachusetts Institute of Technology.

Rosner, D. K., Kawas, S., Li, W., Tilly, N., & Sung, Y.-C. (2016). Out of Time, Out of Place: Reflections on Design Workshops as a Research Method. *Proceedings of the 19th ACM Conference on Computer-Supported Cooperative Work & Social Computing*, 1131–1141.

Rotenberg, M., & Roschelle, J. (2022). Making AI Fair, and How to Use It. *Communications of the ACM*, 66(1), 10–11.

Roy, R., & Warren, J. (2018). Card-based Tools for Creative and Systematic Design. *DRS Biennial Conference Series*.

Sabie, S., Jackson, S. J., Ju, W., & Parikh, T. (2022). Unmaking as Agonism: Using Participatory Design with Youth to Surface Difference in an Intergenerational Urban Context. *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems*, Article Article 324.

Sabie, S., Soden, R., Jackson, S., & Parikh, T. (2023). Unmaking as Emancipation: Lessons and Reflections from Luddism. *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems*, Article Article 604.

Sabie, S., Song, K. W., Parikh, T., Jackson, S., Paulos, E., Lindstrom, K., Ståhl, Å., Sabie, D., Andersen, K., & Wakkary, R. (2022). Unmaking@CHI: Concretizing the Material and Epistemological Practices of Unmaking in HCI. *Extended Abstracts of the 2022 CHI Conference on Human Factors in Computing Systems*, Article Article 105.

Sareen, H., Zheng, J., & Maes, P. (2019). Cyborg Botany: Augmented Plants as Sensors, Displays and Actuators. *Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems*, Article Paper VS13.

Sciuto, A., Saini, A., Forlizzi, J., & Hong, J. I. (2018). "Hey Alexa, What's Up?": A Mixed-Methods Studies of In-Home Conversational Agent Usage. *Proceedings of the 2018 Designing Interactive Systems Conference*, 857–868.

Smith, Amershi, Barocas, Wallach, & Vaughan, W. (2022). REAL ML: Recognizing, Exploring, and Articulating Limitations of Machine Learning Research. *2022 ACM Conference on Fairness, Accountability, and Transparency*, 587–597.

Smith, N., Bardzell, S., & Bardzell, J. (2017). Designing for Cohabitation: Naturecultures, Hybrids, and Decentering the Human in Design. *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*, 1714–1725.

Smith, N. E. (2019). *Decentering Design: Bees, Biomimicry, and the Sixth Mass Extinction*, Indiana University.

Søndergaard, M. L. J., & Campo Woytuk, N. (2023). Feminist Posthumanist Design of Menstrual Care for More-

- than-Human Bodies. *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems*, Article Article 38.
- Søndergaard, M. L. J., Campo Woytuk, N., Howell, N., Tsaknaki, V., Helms, K., Jenkins, T., & Sanches, P. (2023). Fabulation as an Approach for Design Futuring. *Proceedings of the 2023 ACM Designing Interactive Systems Conference*, 1693–1709.
- Søndergaard, M. L. J., & Hansen, L. K. (2018). Intimate Futures: Staying with the Trouble of Digital Personal Assistants through Design Fiction. *DIS '18 Proceedings of the 2018 Designing Interactive Systems Conference*, 869–880.
- Song, K. W., & Paulos, E. (2021). Unmaking: Enabling and Celebrating the Creative Material of Failure, Destruction, Decay, and Deformation. *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*, Article Article 429.
- Stappers, P. J., & Giaccardi, E. (2017). Research through Design. In M. Soegaard & R. Friis-Dam. (Eds.), *The Encyclopedia of Human-Computer Interaction, 2nd Ed.* (pp. 1–94). The Interaction Design Foundation.
- Steenson, M. W. (2017). *Architectural Intelligence: How Designers and Architects Created the Digital Landscape* (Illustrated edition). The MIT Press.
- Strengers, Y., & Kennedy, J. (2020). *The Smart Wife: Why Siri, Alexa, and Other Smart Home Devices Need a Feminist Reboot*. The MIT Press.
- Stricklin, C., & Nitsche, M. (2020). Primal Clay: Worldbuilding with the New Materialism. *Proceedings of the 15th International Conference on the Foundations of Digital Games*, Article Article 43.
- Sturdee, M., Lindley, J., Harrison, R., & Kluth, T. (2020). The Seven Year Glitch: Unpacking Beauty and Despair in Malfunction. *Extended Abstracts of the 2020 CHI Conference on Human Factors in Computing Systems*, 1–11.
- Suchman, L. (2002). Located accountabilities in technology production. *Scandinavian Journal of Information Systems*, 14(2), 7.
- Suchman, L. (2006). *Human-Machine Reconfigurations: Plans and Situated Actions*. Cambridge University Press.
- Suchman, L. (1987). *Plans and Situated Actions: The Problem of Human-Machine Communication*. Cambridge University Press.
- Sutton, S. J. (2019). "I am from all over the world": moving towards a healthier voice enabled internet by acknowledging how it is built. *Proceedings of the 1st International Conference on Conversational User Interfaces*, Article Article 18.
- Sutton, S. J. (2020). Gender Ambiguous, not Genderless: Designing Gender in Voice User Interfaces (VUIs) with Sensitivity. *Proceedings of the 2nd Conference on Conversational User Interfaces*, 1–8. Article 11.
- Sutton, S. J., Foulkes, P., Kirk, D., & Lawson, S. (2019). Voice As a Design Material: Sociophonetic Inspired Design Strategies in Human-Computer Interaction. *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*, 603:1–603:14.
- Tharp, B. M., & Tharp, S. M. (2018). *Discursive Design*. The MIT Press.
- Tholander, J., & Jonsson, M. (2023). Design Ideation with AI - Sketching, Thinking and Talking with Generative Machine Learning Models. *Proceedings of the 2023 ACM Designing Interactive Systems Conference*, 1930–1940.
- Tironi, M., Chilet, M., Marín, C. U., & Hermansen, P. (Eds.). (2023). *Design For More-Than-Human Futures: Towards Post-Anthropocentric Worlding*. Routledge.

- Tomico, O., Wakkary, R., & Andersen, K. (2023). Living-with and Designing-with Plants. *Interactions*, 30(1), 30–34.
- Tomlinson, B., Nardi, B., Stokols, D., & Raturi, A. (2021). Ecosystemas: Representing Ecosystem Impacts in Design. *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems*, Article Article 14.
- Tran O'Leary, J., Zewde, S., Mankoff, J., & Rosner, D. K. (2019). Who Gets to Future? Race, Representation, and Design Methods in Africatown. *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*, Article Paper 561.
- Treusch, P., Berger, A., & Rosner, D. K. (2020). Useful Uselessness? Teaching Robots to Knit with Humans. *Proceedings of the 2020 ACM Designing Interactive Systems Conference*, 193–203.
- Tropozone. (2020). <http://tropozone.com/>
- Tsing, A. (2019). When the things we study respond to each other: In *Anthropos and the Material* (pp. 221–243). Duke University Press.
- Tsing, A. (2020). When the Things We Study Respond to Each Other: Tools for Unpacking the Material. In L. P. E. a. Eds Jaque A., Verzier, M.O., Pietroiusti, L. (eds.) (Ed.), *More-than-human* (pp. 16–26). Het Nieuwe Instituut.
- Tsing, A. (2015). *On the Possibility of Life in Capitalist Ruins*. Princeton University Press.
- Turek, M. (2020). *Explainable Artificial Intelligence*. Defense Advanced Research Projects Agency, Program Information. <https://www.darpa.mil/program/explainable-artificial-intelligence>
- van der Burg, V., de Boer, G., Akdag Salah, A. A., Chandrasegaran, S., & Lloyd, P. (2023). Objective Portrait: A practice-based inquiry to explore AI as a reflective design partner. *Proceedings of the 2023 ACM Designing Interactive Systems Conference*, 387–400.
- Van Der Maden, W., Van Beek, E., Nicenboim, I., Van Der Burg, V., Kun, P., Lomas, J. D., & Kang, E. (2023). Towards a Design (Research) Framework with Generative AI. *Companion Publication of the 2023 ACM Designing Interactive Systems Conference*, 107–109.
- Vera Liao, Q., Gruen, D., & Miller, S. (2020). Questioning the AI: Informing Design Practices for Explainable AI User Experiences. In *arXiv [cs.HC]*.
- Wakkary, R. (2020). Nomadic practices: A posthuman theory for knowing design. *International Journal of Design*, 14(3), 117–128.
- Wakkary, R. (2021). *Things We Could Design: For More Than Human-Centered Worlds*. MIT Press.
- Wakkary, R., Odom, W., Hauser, S., Hertz, G., & Lin, A. H. (2015). Material Speculation: Actual Artifacts for Critical Inquiry. *Aarhus 2015: Critical Alternatives 2015, At Aarhus, Copenhagen, Volume: Aarhus Series on Human Centered Computing*, 1(1).
- Wakkary, R., Oogjes, D., & Behzad, A. (2022). Two Years or More of Co-speculation: Polylogues of Philosophers, Designers, and a Tilting Bowl. *ACM Trans. Comput.-Hum. Interact.*, 29(5), 1–44.
- Wakkary, R., Oogjes, D., Hauser, S., Lin, H., Cao, C., Ma, L., & Duel, T. (2017). Morse Things: A Design Inquiry into the Gap Between Things and Us. *Proceedings of the 2017 Conference on Designing Interactive Systems*, 503–514.
- Wakkary, Ron, and Doenja Oogjes. 2024. *The Importance of Speculation in Design Research (Synthesis Lectures on Human-Centered Informatics) Kindle Edition*. Berlin, Germany: Springer.
- Weisz, J. D., Muller, M., He, J., & Houde, S. (2023). Toward General Design Principles for Generative AI Applications. In *arXiv [cs.HC]*. arXiv.

- Weitz, K., Schiller, D., Schlagowski, R., Huber, T., & André, E. (2019). "Do you trust me?": Increasing User-Trust by Integrating Virtual Agents in Explainable AI Interaction Design. *Proceedings of the 19th ACM International Conference on Intelligent Virtual Agents*, 7–9.
- Westerlaken, M., Gabrys, J., Urzedo, D., & Ritts, M. (2022). Unsettling participation by foregrounding more-than-human relations in digital forests. *Environmental Humanities*.
- West, M., Rebecca, K., & Han, E. C. (2019). *I'd blush if I could: closing gender divides in digital skills through education*. UNESCO: United Nations Educational, Scientific, and Cultural Organization, and EQUALS Global Partnership.
- Whittaker, Crawford, Dobbe, Fried, Kaziunas, Mathur, West, M., Richardson, Schultz, & Schwartz. (2018). *AI Now Report*. AI Now.
- Wilde, D., Dolejsova, M., van Gaalen, S., Bertran, F. A., Davis, H., & Raven, P. G. (2021). Troubling the impact of food future imaginaries. *Nordes Conference Series*.
- Wu, Y., Porcheron, M., Doyle, P., Edwards, J., Rough, D., Cooney, O., Bleakley, A., Clark, L., & Cowan, B. (2022). Comparing Command Construction in Native and Non-Native Speaker IPA Interaction through Conversation Analysis. *Proceedings of the 4th Conference on Conversational User Interfaces*, Article Article 10.
- Xu, W. (2019, June 26). *Toward human-centered AI: a perspective from human-computer interaction*. 26(4).
- Yang, J., Bozzon, A., Gadiraju, U., & Lease, M. (2023). Editorial: Human-centered AI: Crowd computing. *Frontiers in Artificial Intelligence*, 6, 1161006.
- Yang, X., Aurisicchio, M., & Baxter, W. (2019). Understanding Affective Experiences with Conversational Agents. *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems - CHI '19*, 1–12.
- Yoo, D., Bekker, T., Dalsgaard, P., Eriksson, E Foug S, Frauenberger, C., Friedman, B., Giaccardi, E., Hansen, A.-M., Light, A., Nilsson, E. M., Wakkary, R., & Wiberg, M. (2023). More-Than-Human Perspectives and Values in Human-Computer Interaction. *Extended Abstracts of the 2023 CHI Conference on Human Factors in Computing Systems (CHI EA '23)*, 5 pages.
- Yoo, M., Berger, A., Lindley, J., Green, D. P., Boeva, Y., Nicenboim, I., & Odom, W. (2023). Beyond academic publication: Alternative outcomes of HCI research. *Designing Interactive Systems Conference*. DIS '23: Designing Interactive Systems Conference, Pittsburgh PA USA.
- Zoë Dankert, R. V. (2018). Decolonial Listening, An Interview with Rolando Vázquez. *Soapbox Journal*, 1.1(1), 147–156.