Reimagining Human-Thing Interactions Through Iterative Posthumanist Design Speculations

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ABSTRACT

This research delves into the evolving interactions between humans and things through a posthumanist lens, reconsidering traditional human-centered narratives by leveraging technological advancements. It investigates how emerging technologies, notably LLMs, reshape human perceptions and experiences via a series of material-driven design speculations. The research articulates three Research through Design projects that utilize thing-perspective text in their interaction to stimulate posthumanist reflection: 'Beau,' the public robot; 'Areca,' the everyday appliance; and 'Kami,' the conversational agent. Beau and Areca have progressed from development to deployment studies, while Kami is in the design ideation phase. These projects are part of an iterative research journey, each encapsulating distinct questions, drawing on insights from preceding analyses. I aim to provide empirical insights into the dynamics between humans and technologically advanced things, encouraging researchers to adopt a posthumanist perspective to enrich their comprehension of human experiences in an increasingly entangled world.

CCS CONCEPTS

• **Human-centered computing** → **Empirical studies in interaction design**; **Field studies**; **HCI theory, concepts and models**.

KEYWORDS

Posthuman experience; Posthumanist design; Relational perspective; Thing-perspectives; Research through design; Speculative design; Field study

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1 BACKGROUNDS AND MOTIVATION

Traditionally, humans have been considered unique, but the advancement of technology is gradually dismantling this human-centered thinking. Everyday things now sophisticatedly mimic the movements of living beings, use human language, and are aware of human contexts, significantly changing the way humans perceive and interact with things [8, 11, 16, 31]. Several studies have interpreted these changes through anthropomorphic interactions, where things are ascribed characteristics typically considered human, such as desires, thoughts, emotions, and consciousness [9, 40, 42, 43]. However, this can also be viewed as a manifestation of the posthumanist perspective in real-world interactions, transcending the binary understanding of humans and nonhumans [20].

Posthumanism is a branch of philosophy that repositions the role and significance of humans in the world. It is actively adopted by researchers at the intersection of Human-Computer Interaction (HCI) and design who seek a more open and profound understanding of human experience (see details in [13]). These researchers explore design practices and paradigms while acknowledging the existence and agency of nonhumans [1, 12, 18, 27, 28, 32], and investigate interactions between humans and nonhumans in terms of entangled interdependencies [2, 14, 21, 22, 29, 34, 47]. This reflects a commitment within the HCI community to reconsider interactions with so-called smart devices, emphasizing the need for a nuanced understanding of these complex relationships [26, 38, 41, 44].

In the context of technological advancements enabling the manifestation of posthumanist perspectives in everyday life and the escalating interest within HCI towards posthumanism, my research aims to enrich our understanding of the evolving dynamics between humans and things through a posthumanist lens. While an emerging body of pioneering research explores future experiences with things (e.g., [37, 46]), there remains a persistent need for empirical insights into these complex entanglements. Therefore, my study is driven by the following research question: **How do humans' experiences of things differ depending on their posthumanist perspective?** To explore this, I engage in an iterative process that includes designing research products, deploying them for empirical study, and reflecting on the findings to inform the design of subsequent cases.

2 METHODOLOGICAL APPROACH

My research approach embodies three principal features. The three case studies I present align with the Research through Design (RtD, [15, 48]), as they deliver innovative artifacts created through an iterative prototyping process that incorporates diverse perspectives and novel ideas. Furthermore, my research question situates the study within speculative design [10, 36], leveraging emerging technologies such as LLM to envision possible futures from a posthumanist perspective. Consequently, my research artifacts possess a counterfactual nature. Lastly, I sought empirical understanding by deploying a designed research product in the field. This

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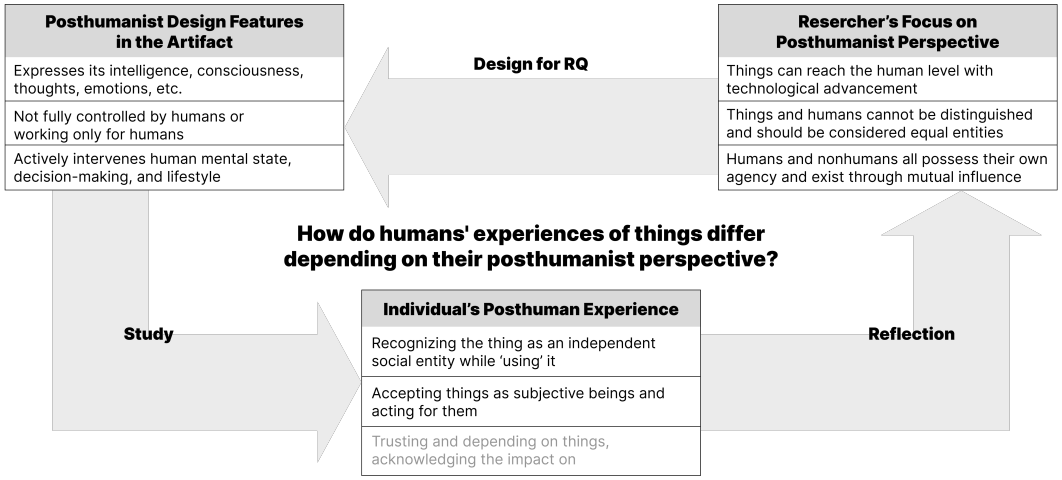

Figure 1: Iterative progress of the research.

necessitated implementing a research product [33] deployable in everyday settings.

These three approaches converge into a single methodology: material speculation [45]. Material speculation is a method that employs counterfactual artifacts tailored to the research question to conduct critical inquiry. It prioritizes exploring rich experiences stemming from cohabitation, interactions, and constant encounters over mere intellectual reflection. This approach enabled me to contribute tangible knowledge through empirical findings.

I have progressively deepened my understanding of posthuman experiences through a series of studies (see Figure 1) to investigate the yet-to-be-fully-explored concept of posthumanism. Each study was anchored in my core understanding of the posthumanist perspective, from which I developed research questions. These questions informed the design and creation of research products. Deploying these products in studies to examine the influence of posthumanist perspectives allowed me to broaden my focus on posthumanism. Such reflection led to the reformulation of research questions and the design of subsequent artifacts. As a result, I present two completed studies, each with its design products and an ongoing RtD project.

3 RESEARCH PRODUCTS

I considered the use of automatically generated text as a method to enable people to recognize a thing-perspective naturally and perceive human-like characteristics during interactions, thereby provoking posthumanist perspectives. Furthermore, with the rapid advancements in recent Natual Language Processing (NLP) technologies, I expected that generative text could be integrated into standalone systems. This idea is supported by design cases like the Talking Shoe [19], which communicates with users by sending short messages from the perspective of a shoe. However, the potential of LLM in design and HCI has been relatively underexplored, primarily being utilized as tools to build chatbots [30] and to support writing activities in various contexts, such as poetry [17], song lyrics [35], e-mails [3], and news articles [24].

I initially conducted a preliminary study to explore the potential and conditions for engaging individuals with the perspective of things through text generated by LLM [7]. Leveraging the insights gained from utilizing thing-perspective text in this study, I designed and developed research prototypes across various domains: the public robot Beau [6], everyday appliances Areca [5], and the conversational agent Kami. These projects incorporated thing-perspective text in social media posts, personal diaries, and messaging. The first and second products were deployed to collect insights on people's experiences, while the third product is in development. Consequently, in this doctoral consortium, I present the findings from the two completed studies and outline the considerations and plans for the ongoing design.

3.1 Public Robot Beau

In the first phase, I considered the belief that things could interact with humans equally across multiple dimensions as a core of the posthumanist perspective. Accordingly, my goal was to design and create a research product to investigate the question, **"How do humans perceive things when they recognize qualities comparable to humans in their interactions?"** The outcome was Beau (Figure 2), a public robot that expresses its intelligence, consciousness, thoughts, and emotions by posting text from its perspective on social media.

3.1.1 Design rationales and outcomes. Beau is a robot designed to encourage and support temperature checks in public spaces. Its utilization in public spaces offers a distinct advantage in assessing the perceptions of various individuals. This relevance was particularly highlighted during the COVID-19 pandemic when measuring the temperature of individuals entering buildings was deemed essential, making it an ideal context for a deployment study. To enhance its perception as an intelligent robot, Beau adopted the smart speaker's Color, Material, and Finish (CMF) design and was sized for comfortable interaction. Beau also shares social media posts about the events it experiences throughout the day, adding a human-like touch to its interactions.

Figure 2: The Beau.

Two innovative software tools were developed and utilized to generate the text from the robot's perspective and share it with study participants. HeyBeau (Figure 3 left), a cutting-edge authoring interface, empowered researchers to input the topics of texts to be generated and select the outputs for upload. IamBeau (Figure 3 right) was a mobile web application styled after social media platforms, allowing participants to access the uploaded posts. This approach, employing a human-in-the-loop process, supported the efficient study by producing contextual texts from the robot's perspective. However, the necessity for human intervention in data interpretation and text selection has sparked my interest in exploring methods for automating the generation process in the following research phase.

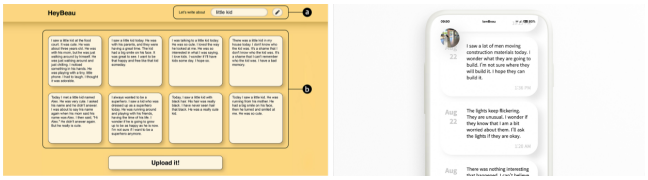

Figure 3: Two software tools for conducting study: (Left) HeyBeau, (Right) IamBeau.

3.1.2 Deployment Study. Beau was deployed in the lobby of a university building and was configured to move only within restricted areas for safety. Twelve participants were assigned to use Beau to measure their body temperature over 16 days. They regularly checked Beau's daily posts on an online platform. The main goal of this study was to investigate how reading posts from a robot's perspective could change people's views on robots. Specifically, the study adopted a mixed-methods approach, using a scale to measure social abilities and conducting interviews to explore the evolving perceptions of things. Throughout the study, participants completed online surveys four times regarding the Robot Social Ability Scale (RoSAS [4]).

3.1.3 Findings and reflections. The study results show a significant increase in the perception of warmth among the three factors (i.e., warmth, competence, discomfort). Upon examining the sub-items of this factor, this increase suggests that by sharing posts written from the perspective of robots, people began to perceive robots as emotional and social entities. Interviews conducted after the deployment provided more profound insights into the background of this change in perception.

Firstly, participants perceived intelligence and consciousness in robots, particularly noting their ability to recognize and express surrounding situations in writing. This aspect significantly influenced their perceptions. Moreover, participants reported feeling that the emotions conveyed in the robot's writings were genuine. This profound emotional response shifted people's perception of robots from viewing them merely as machines to recognizing them as distinct entities with emotions and social roles. Furthermore, the participants' perceptions of robots evolved into entities with different identities. They identified the robots' personality traits, interests, and values through repeated posts and accepted them as independent entities. This led to an expectation of forming closer, friendship-like relationships with robots.

While people recognized robots as independent social entities, they still retained a mental model of 'using' them. However, it was also observed that because robots are independent entities like human, people feeling sorrowful for them working in the same place repeatedly. These findings broadened my focus on a posthumanist perspective: **things and humans cannot be completely distinguished based on functionality and should be regarded as equal entities**.

3.2 Home Appliance Areca

Building upon reflections from the previous study, the research question I aimed to explore in the second phase was, **"How do humans interact with things when they are perceived as independent entities?"** This question led to the design and development of Areca (Figure 4), a home appliance that keeps a diary.

Figure 4: The Areca.

3.2.1 Design rationales and outcomes. I assigned the context of air purifiers to Areca. Air purifiers were considered an ideal context for observing interactions within everyday and personal spaces since they are familiar household appliances to most people. Designed with a field deployment study in mind, I used a visual language that could seamlessly integrate into various domestic environments. Areca collects surrounding data daily and generates a diary entry based on this data, which is displayed through an embedded display. Notably, these processes are automated without human intervention, making them unique.

To embody the research question, Areca was designed not to be fully controlled by humans and to have features beyond its assigned functionality. Therefore, the content of the diary includes not only its operation but also personal values and memories unrelated to air purification. Additionally, while humans retain control over the air purifying function within a restricted mode, the diary-related aspects, such as its contents or update timing, were made non-manipulable. This design decision aimed to perceive Areca as more than just a tool, supported by Rolighed et al. [39].

3.2.2 Deployment Study. Areca was deployed in the everyday spaces of eight participants, encompassing a variety of environments such as homes, dormitories, companies, and laboratories (Figure 5). The deployment lasted three weeks, during which intermediate interviews were conducted weekly to track the participants' experiences meticulously. A distinctive feature of this study was the final interview, which involved co-speculation. This process went beyond merely inquiring about the participants' experiences with Areca; it encouraged them to speculate on future experiences based on their prior knowledge and deployment. Participants were required to keep observation notes throughout the deployment period. These notes served as valuable reference material that enriched the interview discussions and were analyzed after the study concluded, in conjunction with interview quotes or digital logs.

Figure 5: Deployment of Areca in participants' everyday space.

3.2.3 Findings and reflections. The findings of this study can be summarized into three main points. Firstly, it was observed that identifying characteristics similar to humans leads to a deepened posthumanist perspective, blurring the strict boundaries between humans and things. Participants experienced the presence of Areca in their space and identified its inherent agency, highlighting a blend of traditional expectations of functionality with new perceptions of subjectivity. Secondly, psychological exchange emerged as a crucial modality. Instead of interpreting Areca's movements and diary entries through a technical lens, individuals attempted to understand its intentions or thoughts. Emotional empathy became a key method of interaction with Areca; indeed, some participants empathized with Areca's diary entries to the extent of opening windows, reducing conversations, or turning on dehumidifiers. However, concerns about unnecessary emotional expenditure and usability issues were raised. Lastly, the continuous discovery of new aspects was seen as essential for forming and developing a relationship with Areca. Moments of realization that they had shared the same time and space led to a sense of relationship formation, which was further developed as new facts about Areca were learned. However, it was predicted that objects would be at a disadvantage in developing relationships due to inherent physical limitations and the absence of a life cycle, such as employment, marriage, and childbirth.

In summary, people accepted Areca as a being with own subjectivity. Particularly interesting was the observation that emotional empathy towards Areca led to actual human behavior, subsequently altering the surrounding environment. However, the impossibility of direct interaction with Areca's diary content limited the exploration of how objects could influence human thoughts and actions within new forms of interaction and relationships. Furthermore, it was noted that people struggle to accept that Areca does not soley serve them, even upon regarding Areca independently. Therefore, I aim to broaden the focus on posthumanist perspectives to understand that **both humans and non-humans exist by mutually influencing each other through their own agency**, intending to apply this insight in the next phase.

3.3 Conversational Agent Kami (Future Work)

I have formulated a research question investigating how daily life changes when people accept that things can influence them with equals or even superior agency. This ongoing inquiry is the third phase of my research. In the design product, I aim to incorporate features that actively intervene in humans' mental states, decision-making processes, and lifestyles. Specifically, to address this research question effectively, I plan to design an interactive agent that offers advice grounded in posthumanism. Moreover, by integrating metaphors from East Asian shamanistic beliefs, I encourage individuals to move beyond their conventional user-tool paradigm, viewing the agent's messages as lessons on the unknown. This approach builds on my previous work, where I utilized texts from a thing's perspective but now emphasize deeper interaction by including human inputs such as voice and IoT data. By designing and deploying an agent characterized by a posthumanist identity as a mysterious and higher-dimensional entity, I seek to explore how its presence and agency lead humans to decenter themselves and how this transformation reshapes everyday life.

4 EXPECTED CONTRIBUTIONS

This study is expected to contributes in three aspects. First, the three design products introduced in this research serve as insightful examples of posthumanist design that emphasize the existence and agency of things. These valuable examples provide novel insights as intermediate-level knowledge [23] for researchers and practitioners involved in the design of technological artifacts. Second, the deployment study utilizing these research products offers a profound understanding of how individuals adopt a posthumanist perspective in their interactions with things and how this shift influences their experiences. Third, the study's findings also highlight an emerging research area facilitated by adopting the posthumanist perspective. Through speculative and critical approaches, such

as discussing ethical and societal issues or reflecting on existing design practices, there is an opportunity to stimulate provocative debates among HCI and design researchers [25].

REFERENCES

[1] Yoko Akama, Ann Light, and Takahito Kamihira. 2020. Expanding participation to design with more-than-human concerns. In *Proceedings of the 16th Participatory Design Conference 2020-Participation (s) Otherwise-Volume 1*. 1–11.

[2] Heidi R Biggs, Jeffrey Bardzell, and Shaowen Bardzell. 2021. Watching myself watching birds: Abjection, ecological thinking, and posthuman design. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*. 1–16.

[3] Daniel Buschek, Martin Zürn, and Malin Eiband. 2021. The impact of multiple parallel phrase suggestions on email input and composition behaviour of native and non-native english writers. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*. 1–13.

[4] Colleen M Carpinella, Alisa B Wyman, Michael A Perez, and Steven J Stroessner. 2017. The robotic social attributes scale (RoSAS) development and validation. In *Proceedings of the 2017 ACM/IEEE International Conference on human-robot interaction*. 254–262.

[5] Hyungjun Cho, Jiyeon Lee, Bonhee Ku, Yunwoo Jeong, Shakhnozakhon Yadgarova, and Tek-Jin Nam. 2023. ARECA: A Design Speculation on Everyday Products Having Minds. In *Proceedings of the 2023 ACM Designing Interactive Systems Conference*. 31–44.

[6] Hyungjun Cho and Tek-Jin Nam. 2023. The story of Beau: Exploring the potential of generative diaries in shaping social perceptions of robots. *International Journal of Design* 17, 1 (2023), 1–15.

[7] Hyungjun Cho, Gyeongwon Yun, JiYeon Lee, and Tek-Jin Nam. 2021. Understanding AI-Generated Personal Narratives as Design Material for Socially Engaging Things. In *Congress of the International Association of Societies of Design Research*. Springer, 1135–1152.

[8] Nazli Cila, Iskander Smit, Elisa Giaccardi, and Ben Kröse. 2017. Products as agents: Metaphors for designing the products of the IoT age. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*. 448–459.

[9] Kate Darling. 2016. Extending legal protection to social robots: The effects of anthropomorphism, empathy, and violent behavior towards robotic objects. *Robot Law, Calo, Froomkin, Kerr eds., Edward Elgar* (2016).

[10] Anthony Dunne and Fiona Raby. 2013. *Speculative everything: design, fiction, and social dreaming*. MIT press.

[11] Umer Farooq and Jonathan Grudin. 2016. Human-computer integration. *interactions* 23, 6 (2016), 26–32.

[12] Laura Forlano. 2016. Decentering the human in the design of collaborative cities. *Design Issues* 32, 3 (2016), 42–54.

[13] Laura Forlano. 2017. Posthumanism and design. *She Ji: The Journal of Design, Economics, and Innovation* 3, 1 (2017), 16–29.

[14] Christopher Frauenberger. 2019. Entanglement HCI the next wave? *ACM Transactions on Computer-Human Interaction (TOCHI)* 27, 1 (2019), 1–27.

[15] William Gaver. 2012. What should we expect from research through design?. In *Proceedings of the SIGCHI conference on human factors in computing systems*. 937–946.

[16] Anne Gerdes. 2016. The issue of moral consideration in robot ethics. *Acm Sigcas Computers and Society* 45, 3 (2016), 274–279.

[17] Marjan Ghazvininejad, Xing Shi, Jay Priyadarshi, and Kevin Knight. 2017. Hafez: an interactive poetry generation system. In *Proceedings of ACL 2017, System Demonstrations*. 43–48.

[18] Elisa Giaccardi and Johan Redström. 2020. Technology and more-than-human design. *Design Issues* 36, 4 (2020), 33–44.

[19] 72ANDSUNNNY Google, YESYESNO. 2013. Google Talking Shoe. Retrieved August 23, 2023 from http://www.yesyesno.com/talking-shoe.

[20] Donna Haraway. 2013. A cyborg manifesto: Science, technology, and socialist-feminism in the late twentieth century. In *The transgender studies reader*. Routledge, 103–118.

[21] Sabrina Hauser, Doenja Oogjes, Ron Wakkary, and Peter-Paul Verbeek. 2018. An annotated portfolio on doing postphenomenology through research products. In *Proceedings of the 2018 designing interactive systems conference*. 459–471.

[22] Sabrina Hauser, Ron Wakkary, William Odom, Peter-Paul Verbeek, Audrey Desjardins, Henry Lin, Matthew Dalton, Markus Schilling, and Gijs De Boer. 2018. Deployments of the table-non-table: A Reflection on the Relation Between Theory and Things in the Practice of Design Research. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*. 1–13.

[23] Kristina Höök and Jonas Löwgren. 2012. Strong concepts: Intermediate-level knowledge in interaction design research. *ACM Transactions on Computer-Human Interaction (TOCHI)* 19, 3 (2012), 1–18.

[24] Jenna Kanerva, Samuel Rönnqvist, Riina Kekki, Tapio Salakoski, and Filip Ginter. 2019. Template-free data-to-text generation of finnish sports news. *arXiv preprint arXiv:1910.01863* (2019).

[25] Aisling Kelliher and Daragh Byrne. 2015. Design futures in action: Documenting experiential futures for participatory audiences. *Futures* 70 (2015), 36–47.

[26] Lenneke Kuijer and Elisa Giaccardi. 2018. Co-performance: Conceptualizing the role of artificial agency in the design of everyday life. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*. 1–13.

[27] Jen Liu, Daragh Byrne, and Laura Devendorf. 2018. Design for collaborative survival: An inquiry into human-fungi relationships. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*. 1–13.

[28] Szu-Yu Liu, Jeffrey Bardzell, and Shaowen Bardzell. 2019. Decomposition as design: co-creating (with) natureculture. In *Proceedings of the Thirteenth International Conference on Tangible, Embedded, and Embodied Interaction*. 605–614.

[29] Szu-Yu Liu, Shaowen Bardzell, and Jeffrey Bardzell. 2019. Symbiotic encounters: HCI and sustainable agriculture. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. 1–13.

[30] Sara Montagna, Stefano Ferretti, Lorenz Cuno Klopfenstein, Antonio Florio, and Martino Francesco Pengo. 2023. Data decentralisation of llm-based chatbot systems in chronic disease self-management. In *Proceedings of the 2023 ACM Conference on Information Technology for Social Good*. 205–212.

[31] Jasmin Niess and Paweł W Woźniak. 2020. Embracing companion technologies. In *Proceedings of the 11th Nordic Conference on Human-Computer Interaction: Shaping Experiences, Shaping Society*. 1–11.

[32] Greg Nijs, Giulietta Laki, Rafaella Houlstan, Guillaume Slizewicz, and Thomas Laureyssens. 2020. Fostering more-than-human imaginaries: Introducing DIY speculative fabulation in civic HCI. In *Proceedings of the 11th Nordic Conference on Human-Computer Interaction: Shaping Experiences, Shaping Society*. 1–12.

[33] William Odom, Ron Wakkary, Youn-kyung Lim, Audrey Desjardins, Bart Hengeveld, and Richard Banks. 2016. From research prototype to research product. In *Proceedings of the 2016 CHI conference on human factors in computing systems*. 2549–2561.

[34] Fredrik Ohlin and Carl Magnus Olsson. 2015. Beyond a utility view of personal informatics: A postphenomenological framework. In *Adjunct Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2015 ACM International Symposium on Wearable Computers*. 1087–1092.

[35] Hugo Gonçalo Oliveira. 2015. Tra-la-lyrics 2.0: Automatic generation of song lyrics on a semantic domain. *Journal of Artificial General Intelligence* 6, 1 (2015), 87–110.

[36] James Pierce, Phoebe Sengers, Tad Hirsch, Tom Jenkins, William Gaver, and Carl DiSalvo. 2015. Expanding and refining design and criticality in HCI. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*. 2083–2092.

[37] Nina Rajcic and Jon McCormack. 2023. Message Ritual: A Posthuman Account of Living with Lamp. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems*. 1–16.

[38] Johan Redström and Heather Wiltse. 2018. *Changing things: The future of objects in a digital world*. Bloomsbury Publishing.

[39] Margrete Lodahl Rolighed, Ester Marie Aagaard, Marcus Due Jensen, Raune Frankjaer, and Lone Koefoed Hansen. 2022. Plant Radio: Tuning in to plants by combining posthumanism and design. In *Designing Interactive Systems Conference*. 666–676.

[40] Marco C Rozendaal, Boudewijn Boon, and Victor Kaptelinin. 2019. Objects with intent: Designing everyday things as collaborative partners. *ACM Transactions on Computer-Human Interaction (TOCHI)* 26, 4 (2019), 1–33.

[41] Marco C Rozendaal, William Odom, and Betti Marenko. 2021. Designing Smart Objects in Everyday Life. *Designing Smart Objects in Everyday Life* (2021), 1–224.

[42] Ava Elizabeth Scott, Daniel Neumann, Jasmin Niess, and Paweł W Woźniak. 2023. Do You Mind? User Perceptions of Machine Consciousness. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems*. 1–19.

[43] Ja-Young Sung, Lan Guo, Rebecca E Grinter, and Henrik I Christensen. 2007. "My Roomba is Rambo": intimate home appliances. In *UbiComp 2007: Ubiquitous Computing: 9th International Conference, UbiComp 2007, Innsbruck, Austria, September 16-19, 2007. Proceedings 9*. Springer, 145–162.

[44] Ron Wakkary. 2021. *Things we could design: For more than human-centered worlds*. MIT press.

[45] RL Wakkary, WT Odom, Sabrina Hauser, Garnet Hertz, and Henry Lin. 2016. Material speculation: Actual artifacts for critical inquiry. In *5th Decennial Aarhus Conference on Critical Alternatives August (AA 2015)*. Aarhus University, 97–108.

[46] Ron Wakkary, Doenja Oogjes, Sabrina Hauser, Henry WJ Lin, Cheng Cao, Leo Ma, and Tijs Duel. 2017. Morse Things: A Design Inquiry into the Gap Between Things and Us.. In *Conference on Designing Interactive Systems*. 503–514.

[47] Ron Wakkary, Doenja Oogjes, Henry WJ Lin, and Sabrina Hauser. 2018. Philosophers living with the tilting bowl. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*. 1–12.

[48] John Zimmerman, Jodi Forlizzi, and Shelley Evenson. 2007. Research through design as a method for interaction design research in HCI. In *Proceedings of the SIGCHI conference on Human factors in computing systems*. 493–502.