Navigating the Posthuman Turn in Computing and Design: A Posthuman Vocabulary

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Abstract

As multifaceted concerns related to humans, nonhumans, ecologies, and technologies gain prominence within the design community, posthumanism is emerging as a key intellectual pathway for critical design theory and research. This study surveys 151 design papers published in ACM venues up to September 2024 to explore the operationalization of posthumanism in computing and design scholarship. Our findings indicate that papers incorporating posthumanism are shaping an emerging field of posthuman design. We argue that the posthuman turn in computing and design can be characterized into three phases: early encounters with the posthuman, the integration of posthuman concepts, and transformation into a material-discursive practice. To support and advance the objectives of this third phase, we propose a posthuman vocabulary — a conceptual framework composed of five guiding principles — post-humanism, post-anthropocentrism, post-dualism, post-Enlightenment, and post-technologism. These principles address issues of justice, sustainability, relationality, agency, subjectivity, and critique of technological intensification, offering a guide for future material-discursive design practices.

CCS Concepts

• **Human-centered computing → HCI theory, concepts and models**.

Keywords

design, posthuman, posthumanities, posthuman design, semi-systematic review, computing, sustainability, justice, design principles

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1 Introduction

In recent years, the term *posthuman* has gained significant traction within the critical computing and design research community. This growing interest aligns with efforts to respond to the challenges and complexities of the third wave of HCI [28, 78] and to seek alternatives that can be linked to pathways towards a possible fourth wave [1, 7, 13, 102]. Scholars and practitioners are increasingly exploring the potential of *posthumanism* to address ecological and technological challenges through developing innovative frameworks that transcend traditional humanist paradigms. This presents an opportune moment to map the various approaches being adopted and to examine their underlying intellectual foundations, thereby fostering community dialogue on the future directions of the field.

Bodker [28] characterizes the third wave of HCI as "a chaos of multiplicity in terms of technologies, use situations, methods, and concepts." Our study focuses specifically on the *posthuman* as a conceptual lens through which to engage with this complexity. The selection of "posthuman" as a keyword for this study is intentional: it emphasizes the term's conceptual dynamism and its potential to address pressing challenges in computing and design. While related concepts like "more-than-human" [68], "post-anthropocentrism" [57], and "nonanthropocentrism and the nonhuman" [61] provide valuable perspectives, we focus on the *posthuman* due to its distinct onto-epistemo-ethical stance that is not always shared across adjacent terms. Unlike approaches that broaden the user or context in design, the *posthuman* helps researchers engage deeply with questions of ontology, epistemology, and ethics offering a unique lens to explore design transformations.

Drawing on Barad's [12] insights, we approach the concept of *posthuman* as not a static label but a material-discursive enactment, inherently tied to the specific arrangements and practices of observation. This aligns with the agential realist perspective, where concepts are dynamic, political, and instantiated in action rather than free-floating abstractions. Our aim is not to fixate on *posthumanism* as a fixed or coherent theory, but to explore its modes of enactment, reflecting its capacity to reframe design as a politically engaged and ethically attuned practice.

In this paper, we present a semi-systematic literature review [188] of posthuman concepts in relation to computing and design, grounded in posthuman onto-epistemo-ethical perspectives. We trace how the concept of *posthuman* is being operationalized in the context of design as conceptualized by the ACM community. Rather than claiming to offer a comprehensive theory of posthuman design, we build on Barad's notion of theorizing — understood not as the production of stable theories but as an ongoing discursive-material

practice [12]. From this perspective, we understand every paper in our corpus not as an object of theory but rather an enactment of posthuman design. Our review seeks to map the contours of these enactments — by examining how posthuman design papers reflect their authors' posthuman onto-epistemo-ethical positions, we seek to showcase how these contributions are collectively reshaping the field of computing and design.

We approach this investigation by analyzing a corpus of 151 peer-reviewed computing and design papers published in ACM venues up to the end of September 2024. In our review, we categorize these works based on their engagement with posthuman scholarship. Our findings highlight the emergence of a posthuman turn in computing and design, marked by a self-sustaining discursive-material practice that engages both historical and contemporary challenges.

We identify three distinct but overlapping phases of the posthuman turn in design research: (1) early encounters with posthuman concepts, (2) partial integration of these concepts into design research agendas, and (3) the emergence of comprehensive material-discursive practices that address both ecological and technological concerns. Through all these phases, engagement with various scholars and ideas enriches material-discursive design practices, tackling challenges related to sustainability, equity, and multispecies care. We also analyze emerging trends of posthuman design in the corpus, focusing on primary research areas and onto-epistemo-ethical stances. We capture the diversity of approaches through introducing two key terms: *technological posthuman design* and *ecological posthuman design*. We relate the analysis to five different characteristics of posthumanism that we derive from its genealogy: *post-humanism*, *post-anthropocentrism*, *post-dualism*, *post-Enlightenment*, and *post-technologism*.

Building on this analysis, we offer two major contributions. First, we provide an account of how posthumanism is being enacted across computing and design research, highlighting both trajectories and gaps. Second, we propose a conceptual vocabulary, a set of five design principles, to guide future material-discursive design practices that aim to be more just, inclusive, and sustainable.

As the field of computing tackles complex issues of sustainability in the face of ecological crises, from climate change to the Sixth Mass Extinction, traditional paradigms in design are proving inadequate to address the complex entanglements of human and nonhuman actors. At the same time, powerful actors — often with TESCREAL (Transhumanism, Extropianism, Singularitarianism, (modern) Cosmism, Rationalist ideology, Effective Altruism, and Longtermism) agendas[81] — have unprecedented influence over economies and governance. This growing concentration of power raises ethical and ontological questions about who or what gets to shape the future and for whom. Posthumanism offers a timely and generative framework that aligns with key sustainability efforts in computing that are already looking at new approaches to tackle these wicked problems. By mapping current posthuman approaches in computing and design and offering a conceptual vocabulary for future inquiry, this paper contributes to reimagining sustainability in computational and design practices.

2 Background

2.1 A Brief Genealogy of Posthumanism

Posthumanism can be understood through its distinctive concerns with the construction of the human, as well as human-human and human-nonhuman relationships, in dialogue with diverse intellectual traditions such as new materialism, antihumanism, metahumanism, and transhumanism [70]. In its cultural, critical, philosophical, and political forms, posthuman scholarship draws deeply from a range of continental philosophers who challenge the foundations of humanism and anthropocentrism. For instance, Friedrich Nietzsche is foundational for his radical critique of humanist values and emphasis on becoming [125], while Martin Heidegger's critique of metaphysics and technology is central to attempts to rethink being beyond human-centred paradigms [168]. Similarly, Maurice Merleau-Ponty's ontology of intercorporeality provides an ethical framework for understanding human agency as an open, relational system [59]. Gilles Deleuze and Félix Guattari further offer concepts such as assemblage, becoming, and deterritorialization, which serve as key tools in developing alternatives to philosophies of immanence or non-linear, rhizomatic models of subjectivity and agency [50]. Michel Foucault's work on power, discourse, and biopolitics enables scholars to interrogate the historical construction of the human and to theorize alternative modes of governance across species and systems [214]. These thinkers, together with Indigenous philosophies and traditional ecological knowledge systems [21, 27, 186, 201, 212], provide a philosophical foundation for challenging humanist, anthropocentric, and dualist assumptions, and for imagining a world beyond the boundaries of the human and humanity.

Within this broader framework, different strands of posthumanism focus on distinct yet overlapping themes. Cultural posthumanism focuses on how technological and cultural shifts challenge traditional humanist frameworks [97, 148]. Critical posthumanism engages with the ethical implications of the posthuman condition, interrogating the centrality of the human in systems of power and knowledge [31, 92]. Philosophical posthumanism critiques anthropocentrism at the ontological level, advocating for a reconceptualization of existence in terms of the interrelations between human and nonhuman entities [71]. Political posthumanism addresses issues of citizenship, security, political agency, responsibility, accountability, and activism, offering politically nuanced perspectives on contemporary global challenges [48, 52, 87, 127]. These distinct intellectual and sociopolitical concerns are shaping the development of the "Posthumanities" as a pluriverse. According to Rosi Braidotti [32], this pluriverse represents a "convergence of posthumanism and post-anthropocentrism." Francesca Ferrando [71] further conceptualizes it through a tripartite model: post-humanist, post-anthropocentric, and post-dualist. Following Dedeoglu and Zampaki [53], we understand posthumanism as also encompassing post-Enlightenment and post-technologist characteristics.

2.1.1 Post-humanism: Post-humanism (with a hyphen) differs from posthumanism [71]. While the former addresses injustices associated with humanist praxis, the latter represents a more comprehensive approach that also encompasses the former.

Post-humanism critiques human domination over other humans and examines the intersections of race, gender, and class through a posthuman lens. Rosi Braidotti, for instance, scrutinizes how Eurocentric humanism has historically marginalized non-Western, non-male, and non-heteronormative individuals, calling for a "nomadic subjectivity" that resists static categories [31]. In parallel, Achille Mbembe, in *Necropolitics* [140], shows how colonial and neoliberal powers continue to govern who is deemed fully human. A post-humanist sensibility is also critical for recognizing the ideological, value-based, and belief-based biases that shape technology and policy design[54]. This framework emphasizes that posthumanism is not merely a critique of the idea of the human, but a deconstruction of specific humanist traditions that sustain power and value hierarchies. This corresponds to the post-humanist characteristic of posthumanism, distinct from post-anthropocentrism as both an intellectual and political project [71].

2.1.2 Post-anthropocentrism: Post-anthropocentrism critiques the human domination of nonhumans, proposing new frameworks of coexistence. Donna Haraway's concept of "companion species" in *When Species Meet* [91] offers an example of how posthumanism reconfigures human-animal relations by envisioning humans as entangled with nonhuman others in co-evolutionary histories. Bruno Latour's actor-network theory (ANT) [128] similarly positions nonhuman entities as active participants in shaping human societies. Barad [11] also challenges traditional human-centred onto-epistemo-ethical stances by proposing that agency is not an exclusive property of humans but is instead distributed across human and non-human entities through intra-actions. Meanwhile, Graham Harman's Object-Oriented Ontology [93] further pushes the boundaries of post-anthropocentrism by assigning agency to all objects, challenging human exceptionalism and imagining a flatter ontological landscape where humans no longer occupy the centre of existence.

2.1.3 Post-dualism: The post-dualist dimension of posthumanism deconstructs rigid binaries, such as nature/culture and human/nonhuman. For instance, Katherine Hayles, in *How We Became Posthuman* [97], provides an early critique of mind-body dualism, illustrating how cybernetic systems and humans are mutually constitutive, thereby dissolving the distinction between the biological and the technological. Barad further introduces a comprehensive post-dualist framework through the concepts of intra-action, the entanglement of matter and meaning, relational ontology — including onto-epistemo-ethics — and a critique of representationalism in scientific inquiry and knowledge production [10–12].

2.1.4 Post-Enlightenment: The critique of Enlightenment ideals of rationality and autonomy is central to posthumanism's engagement with subjectivity. Post-Enlightenment thinkers like Braidotti call for moving beyond the bounded, autonomous individual towards a subjectivity that is dynamic, embodied, and relational. Katherine Hayles extends this critique by examining the posthuman condition, where human cognition is deeply intertwined with digital technologies, arguing that the idea of a disembodied rational agent is an illusion. Michel Foucault's work on biopower also helps scholars to deconstruct the notion of autonomous individuality by showing how power operates on and through bodies, linking the critique of the Enlightenment to questions of governance and control in posthuman contexts [214].

2.1.5 Post-technologism: Posthumanism can be understood as a critique of technologism — or post-technologism — which posits that technological advancements alone are insufficient to resolve complex ecological and social issues. On the contrary, technological policy processes — such as the creation and governance of smart cities, often dominated by public-private partnerships — tend to exacerbate the problems faced by already vulnerable communities. In this context, Hayles' emphasis on the co-evolution of humans and technology becomes crucial for re-examining these assemblages through a new lens. Similarly, Haraway's cyborg metaphor [92] challenges simplistic technological optimism, offering instead a vision of hybridity that resists the binary opposition between human and machine and highlights the entanglements of human, dehumanised and nonhuman.

It is important to note that these five characteristics, which address technological and ecological concerns, are not mutually exclusive. Researchers exploring technological or ecological problems may find connections to all these characteristics in the writings of Donna Haraway, Rosi Braidotti, Bruno Latour, and others. However, our aim here is not to present an exhaustive list either. We align with Karen Barad's notion of posthumanism: "My point is not to get beyond the human, but to ask the prior question of what differentially constitutes the human — and for whom" [12]. We believe these five characteristics provide a framework for questioning the construction of the human and the world, whether scientifically or otherwise.

2.2 Posthuman Theorizing of Design in Computing

Responding to an interview question on theory, Barad asserts that "[f]or all theorizing, all materializing, and all mattering is political" [12]. Drawing from this notion, we approach design not as a static body of knowledge but as a dynamic material-discursive practice that evolves through ongoing political intra-actions among humans, nonhumans, and their environments. This stance invites designers to critically reflect on the ethical implications of their work, positioning design as a deeply political act embedded in socio-ecological systems.

The political-ethical dimension of design extends beyond merely solving problems; it acknowledges the augmented responsibility of the computing and design community to consider how their decisions co-shape the material-discursive landscape. Inspired by calls for designing with nature [205] and response-able design [166], as well as the premise of incorporating augmented political responsibility in assemblaged systems [52], we propose that designing is akin to a citizenship deed, positioning designers as co-authors of both technological and ecological futures.

Posthuman theorizing in design has already gained momentum through diverse methodologies and epistemologies that address different characteristics of posthumanism mentioned in the previous section. For instance, Verbeek [203] redefines the designer's role through mediation theory, emphasizing technology's influence on human practices and advancing responsible design as a deliberate, ethical act. Forlano [75] expands on this by tracing posthumanist

perspectives across fields like actor-network theory and feminist new materialism, focusing on socio-technical systems and advocating for justice and equality in design. Liu et al. [130] introduce "symbiotic encounters" in sustainable agriculture, demonstrating how humans and nonhumans co-create evolving assemblages and relational practices. Frauenberger [78] proposes "Entanglement HCI," grounded in relational ontologies, to address ontological uncertainties and ethical responsibilities in human-technology relationships. Wakkary [205] advocates for "nomadic practices," a framework that embraces situated knowing, multiplicity, and the dismantling of universalist design paradigms. More recently, Biggs et al. [26] have introduced methods like "noticing" to decenter the human, using autoethnographic practices to foster ecological thinking and relational attunement. Similarly, Nicenboim et al. [151] explore "decentering through design," emphasizing material practices where more-than-human designers generate and enact posthuman knowledge. Together, these works shape a posthuman ethos that reimagines design as an ethical, relational, and political material-discursive practice.

In the following sections, we seek to contribute to such ethos by providing a detailed mapping of the posthuman in the design corners of computing.

3 Methods

To understand how posthuman concepts are used in design papers, we searched for papers in the ACM Digital Library. The corpus included papers from diverse conferences, including CHI, DIS, CC, NordiCHI, OzCHI, SIGGRAPH, TEI, and others. Table 1 provides a summary of the counts by venue. It is important to note that our claims are limited to the ACM Library corpus and do not extend to the entire field of design.

3.1 Phase 1: Identifying a Broad Corpus

The search was confined to the ACM Digital Library, filtering for only full research papers utilizing the keywords "posthuman*" or "post-human*," capturing variants such as "posthumanist," "posthumanism," "post-humanist," "post-humanism," alongside the keyword "design." The search period included papers published up to September 2024. The search query used was:

> 'query': AllField:(posthuman* OR post-human*) AND AllField:(Design)
> 'filter': Article Type: Research Article, E-Publication Date: (* TO 09/30/2024), ACM Content: DL

This search yielded an initial corpus of 216 papers that included both "posthuman" (and variants) and "design" anywhere in the text.

3.2 Phase 2: Filtering

In the filtering phase, papers were subjected to stricter inclusion criteria to ensure relevance to the review. While 216 papers within the initial corpus utilised both "posthuman*" / "post-human*" and "design" within their text, not all aimed to operationalise posthuman concepts. Papers were excluded if they mentioned the term "posthuman" / "post-human*" only in the bibliography, appendix, or footnotes, or referred to it only in passing within one of the paper sections. Similarly, we filtered out any papers that did not explicitly engage with "design," i.e., did not have substantive content in the paper that reflected on, applied, or critically interrogated design processes, but instead only referenced the word "design" in passing. We also removed papers that, while they used the term "posthuman" / "post-human*," were transhumanist in their focus.

Following this stage of filtering, the corpus was reduced to 151 papers that met the criteria for inclusion. For each included paper, metadata such as publication year, author names, author affiliations, institutional regions, and additional keywords were documented. The papers were further clustered based on their associated publication venue. Further, the research team included a brief description of how the paper defined and used posthuman concepts.

3.3 Phase 3: Reading Papers, Tracking Terms, and Tracking Scholars

After the corpus was finalized, the research team applied reflexive thematic analysis [33] to collaboratively analyze the corpus. This approach involved an iterative process of familiarization with the text in the papers, coding, theme generation, and refining of themes. While primarily emic, where we focused on how posthuman concepts were operationalized within the ACM design research community, this was complemented by etic moments, particularly in interpreting these enactments through broader posthuman genealogies and ontological commitments, as detailed in the Background section.

Our analysis was not aimed at producing a prescriptive theory of posthuman design; rather, aligning with Barad's conception of "theorizing" [10], each paper in the corpus was treated as an enactment of posthuman thinking in situated research contexts. In other words, our purpose is not to *theorize* posthuman design, but to read our corpus as an instance of design theorizing that engages with and contributes to the concept of the "posthuman." Accordingly, we analysed each paper's use of posthuman concepts alongside its scholarly influences. The authors then created working definitions of posthumanism based on the five characteristics discussed in the Background section, i.e., post-humanist, post-anthropocentric, post-dualist, post-Enlightenment, and post-technologist, emphasising the diverse influences within the field. After establishing these definitions, we then compared them with how these characteristics aligned with existing definitions or were being interpreted or reconfigured by authors within the corpus. These definitions were used not as rigid taxonomies, but as sensitising concepts to help characterise the conceptual tendencies across the field.

After generating initial codes, the team engaged in collaborative discussions to refine and merge them into coherent themes. Using these themes, we categorized how a paper engaged with posthuman concepts. We came up with three subsets of papers: (1) early encounters with the posthuman, (2) the integration of relevant concepts into design research agendas, and (3) the emergence of more comprehensive posthuman material-discursive practices.

Our coding process further revealed distinct thematic orientations across the corpus, particularly with respect to the *primary concerns* of the papers. We used this distinction — between ecological concerns, technological concerns, or both — as an analytic heuristic to trace recurring patterns of engagement. Importantly, this distinction was grounded not in surface-level topics, but rather

Conference	Count of Papers
CHI	40
DIS	27
NordiCHI	7
SIGDOC	6
SIGMIS	6
PDC	6
MOCO	6
TEI	5
TOCHI	5
C&C	4
Other	39
Grand Total	**151**

Table 1: Paper Count by Conference, Until September 2024

in the underlying objective(s) articulated by the authors. For example, a paper may focus on human–animal relations, yet its primary objective might not be ecological. Instead, it may be an attempt to understand what can be learned from animal (or plant) behaviour to design better technologies. Conversely, a paper might centre on a technology, such as environmental sensing, but its objective could be ecological, such as improving the well-being of nature. This analytic distinction enabled us to remain attentive to the intentionality of the paper and its entanglement with broader ethical and onto-epistemological commitments.

3.4 Limitations

This is a semi-systematic review [188], which differs from a systematic review in its objectives and methodological flexibility. While a systematic review aims for exhaustive coverage, a semi-systematic review is more appropriate for mapping emergent or fragmented fields (such as posthuman design). The interpretive analysis afforded by this approach allows an analysis of multiple forms of engagement with a concept, highlighting the evolving (often heterogeneous) nature of scholarly discourse. In this paper, it supports the goal of tracing how posthuman concepts are being taken up, interpreted, and instantiated within the ACM computing and design research community. As such, the findings should be understood as indicative rather than comprehensive.

Our review is thus limited by a) reliance on a single database — the ACM digital library, b) focus on full research papers, and c) filtering by keywords "post-human"/"posthuman" and "design." Given the fragmented nature of this field, this review does not aim for exhaustive coverage. Instead, it seeks to map the corpus to clarify some of the ways "posthuman" concepts have been used and operationalized in relation to design. Additionally, while mapping the authors' engagement and citations, we narrow our focus to thinkers and researchers who are engaged in conceptual framework or discussion sections of the papers in our corpus.

We also recognize that early contributions by scholars such as Ron Wakkary [207] and Carl DiSalvo contributed to posthuman themes well before the terminology became prevalent. For instance, Carl DiSalvo and Jonathan Lukens published two relevant works in 2009 and 2011 on nonanthropocentric design, aiming to decenter the human in design [60, 61]. These foundational works undoubtedly informed later developments, even if not always captured under the same lexicon.

We further acknowledge that our exclusion of short papers or extended abstracts omits avenues where community engagement around these ideas happens. However, by focusing on peer-reviewed published papers, we are able to analyse research papers that have engaged more rigorously with posthuman concepts. Furthermore, by not including terms such as "more-than-human," the review deliberately focuses on the "posthuman" terminology, and we concede that this will exclude overlapping but other distinct discourses (e.g., Eriksson et al. [68]).

4 Mapping the Posthuman in Computing and Design

We categorize our findings into three main sections: (1) the general trend of the posthuman turn in design, (2) the evolving scholarly composition of the field over time, and (3) the technological and ecological concerns of posthuman design, along with the dominance of post-anthropocentric and post-dualist characteristics of posthumanism.

4.1 Posthuman Turn: General Remarks

Papers in our corpus exhibit a consistent publication trajectory beginning in 2011 (Figure 1), with a notable spike in 2016 coinciding with a special issue on sociomateriality in the ACM SIGMIS Database — and a sustained upward trend since 2019. Given the number of papers published up to our cutoff date (September 2024), this trajectory suggests continued growth through 2025. We refer to this shift as a posthuman turn — an onto-epistemo-ethical turn in computing and design research. The ontological, epistemological, and ethical aspects of this turn are experienced simultaneously [12], since our assumptions about the world and our place in it are inherently connected to our assumptions about knowledge and our experience of it. This shift also carries significant ethical

and methodological implications, as will be seen in the following sections.

Several factors contribute to the trend of the posthuman turn. First, as design scholars increasingly focused on ecological and climate crises, contributing to areas like sustainable computing and HCI [62, 185], posthumanism has provided them with new conceptual tools to further navigate these challenges. Second, alongside ecological concerns, technological advancements — such as artificial intelligence — created new opportunities and imperatives to move beyond anthropocentric design paradigms. Third, the rise of interdisciplinary approaches aligns with the emergence of posthumanities beyond ACM venues. Notable developments include the launch of the *Posthumanities* book series by Minnesota University Press in 2007 and the *Journal of Posthuman Studies* by Penn State University Press in 2017. Meanwhile, influential scholars such as Bruno Latour, Donna Haraway, and Rosi Braidotti have continued to publish works and shape discourse, extending their impact beyond the social sciences and humanities into computing and design research.

4.2 Three Phases of Posthuman Turn

The evolving collaboration between posthumanism and design in computing can be understood through three phases (Figure 1).

4.2.1 Phase I: Encounter. The first phase marks the initial emergence of "the posthuman" in computing and design, characterized by isolated and exploratory engagements. While precise periodization remains challenging, the earliest paper identified in our search — "Computer Aided Creativity: Practical Experience and Theoretical Concerns" by Robert Pepperell [163] — signals an early engagement with posthuman themes. Pepperell, also the author of *The Post-Human Condition*[162], is recognized as one of the early contributors to posthuman scholarship more broadly. However, his work appears to have been largely overlooked within the computing and design community in subsequent years.

During this first phase — which extended into the mid-2010s — scholars began to address issues tangentially related to posthumanism, often without explicit references to posthuman scholarship. Technological concerns dominated this phase, with researchers experimenting with ways to move beyond user-centred paradigms. These papers explored how technologies could reshape notions of interaction [82], identity [190], subjectivity [94], and creativity [163] among others, setting the groundwork for more comprehensive posthuman theorizing in later years. However, in this phase, the term "posthuman" has not yet been clarified, often oscillating between posthumanist and transhumanist interpretations.

Towards the end of this phase, some papers engaged more directly with posthumanities, while others continued to explore posthuman concepts without explicitly referencing it. For example, "Smelling, Pulling, and Looking: Unpacking Similarities and Differences in Dog and Human City Life" [8] explored animal-computer interaction without citing any posthuman scholarship, yet it challenged anthropocentric view of human-dog relations in the city and discussed the opportunities that arise from doing so. In contrast, "Self-Tracking Cultures: Towards a Sociology of Personal Informatics" [136] explicitly drew on the "entanglements of bodies, technologies, and selves," incorporating the works of Donna Haraway and Katherine Hayles into its sociological approach.

4.2.2 Phase II: Integration. The second phase, spanning from the mid-2010s to around 2019–2020, reflects deeper integration, as scholars purposefully applied posthuman concepts to computing and design. This phase also shows scholars embracing diverse approaches rooted in posthumanities, and an increasing recognition of ecological concerns alongside technological ones, reflecting a shift in priorities. A notable change in this phase was the dominance of new materialist approaches, often described as part of the "entanglement turn" [78], alongside an increased attention in post-anthropocentric design [57].

Studies during this phase explored a wide array of topics, including agriculture [130], agency [15, 57, 74], animal and plant well-being [9, 211], the body [34, 83], automated driving systems [36], and performative arts [146, 192], each adopting a posthuman onto-epistemo-ethical perspective. Some notable works published during this phase that exemplify this shift include:

- "Becoming With: Towards the Inclusion of Animals as Participants in Design Processes", by Westerlaken and Gualeni [211], aligns with the animal-computer interaction agenda, exploring post-anthropocentric interaction design methodologies through the concept of "becoming with," inspired by the works of Latour and Haraway. Their contribution advances a participatory design paradigm that transcends anthropocentrism.
- "Designing for Cohabitation: Naturecultures, Hybrids, and Decentering the Human in Design" [187], by Nancy Smith, Shaowen Bardzell, and Jeffrey Bardzell [187] examines urban contexts to reveal the potential of concepts such as natureculture [89], hybridity, and decentering the human in design, offering new perspectives on animal-human-computer interaction.
- "Politics of Mattering in the Practices of Participatory Design" [165]. Pihkala and Karasti advocate for reimagining participatory design in ways that align with the ontological turn and the posthuman landscape.

With the rise of new materialist and post-anthropocentric approaches, this phase witnessed the exploration of increasingly diverse topics and integration of posthuman onto-epistemologies into participatory design, multispecies interactions, and sustainable technological practices. This phase set the stage for a more self-sustaining posthuman material-discourse, preparing the field for a deeper transformation.

4.2.3 Phase III: Transformation. The third phase marks a certain maturation of posthuman scholarship in computing and design, characterized by a deeper engagement with posthumanities by scholars such as Laura Forlano, Chris Frauenberger, Ron Wakkary, Shaowen Bardzell, Jeffrey Bardzell, and colleagues. Unlike earlier phases, where scholars frequently drew on posthuman scholarship beyond ACM venues, from this phase onwards there is a greater engagement with scholarship within the ACM corpus, suggesting the development of a self-sustaining body of posthuman research within computing and design.

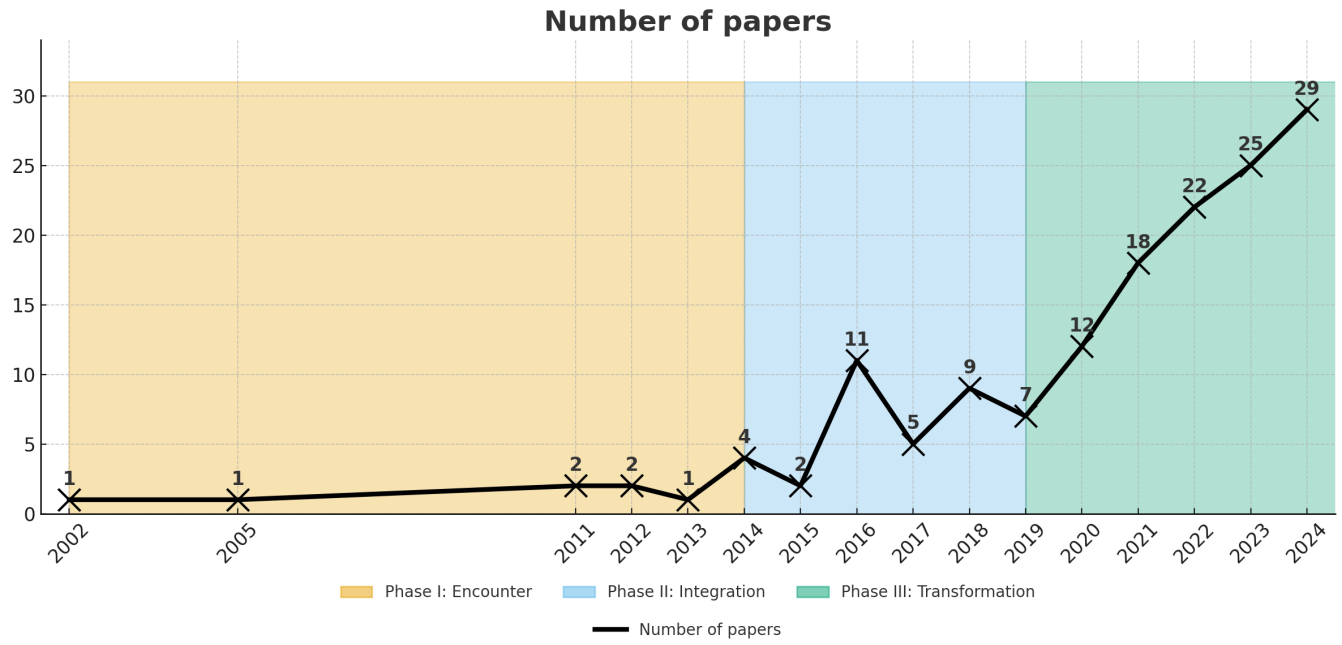

Figure 1: Paper Counts over Time

A notable development in this phase is the increasing conceptual distinction between posthumanism and transhumanism. While a few papers continue to use "posthuman" to describe enhanced human capacities and capabilities, reflecting a transhumanist perspective, recent scholarship predominantly aligns with posthumanism's critical focus on decentering the human in design. This shift also challenges the myth of human exceptionalism and exemptionalism, particularly in relation to ecological concerns. Further, although new technological agendas, such as music performance [218], continue to emerge, the primary focus of this phase is largely ecological — essentially, to "design with nature." Scholars who seek to investigate more ecological design alternatives engage with Forlano, Wakkary, S. Bardzell, and J. Bardzell, while Frauenberger's work is preferred by the papers concerned with technological concerns. For instance, recent scholarship on music and technology [173, 193] follows Karen Barad through the "entanglement turn," as described by Freuenberger [78].

4.3 Bridging Computing and Design with Posthumanities

One way to trace the evolution of posthuman scholarship in computing and design is through an analysis of the scholars that the corpus has engaged with. This approach also offers insights into how the field has transformed over the three phases. Figures 2 and 3 illustrates the evolution of scholarly engagement and posthuman knowledge accumulation throughout the years for the top 5 scholars from within and outside the ACM community.

Examining these trends and considering the three phases of posthuman theorizing, we make three observations: First, while postmodern and poststructuralist thinkers such as Gilles Deleuze, Felix Guattari, and Michel Foucault, as well as phenomenologists like Martin Heidegger and Maurice Merleau-Ponty, appear in these discussions, they are not the primary sources of knowledge production. Instead, their ideas traverse through the works of posthumanities scholars.

Second, the scholars mentioned in Figures 2 and 3 are rarely engaged with in isolation; they are often referenced alongside others, depending on the paper's main concern, i.e. whether ecological or technological. Nevertheless, most papers engage with at least one or two key concepts from these scholars. This practice of engagement enables us to map the primary themes within the corpus.

Donna Haraway emerges as the most-engaged-with posthumanities scholar, offering foundational concepts such as cyborg theory, natureculture, and companion species [89, 91, 92], which have guided post-anthropocentric design approaches. Karen Barad [10, 11] follows closely, influencing both theoretical perspectives and methodological frameworks through concepts like agential realism and intra-action. Bruno Latour and Rosi Braidotti contribute significantly, with Latour's ANT informing discussions on non-human agency [127] and Braidotti's *The Posthuman* [31] shaping definitions of posthuman hybridity. Similarly, Katherine Hayles [97] provides critical insights into posthuman embodiment and the critique of Cartesian dualism, influencing studies in computing and design from a post-dualist, post-Enlightenment angle. More recently, María Puig de la Bellacasa [51] has gained prominence for her conceptualization of care, integrating ethical and ecological concerns into computing and design. Likewise, Anna Tsing's practice of noticing [200] and Tim Ingold's object-oriented anthropology [109] have been attracting considerable interest among researchers in the field.

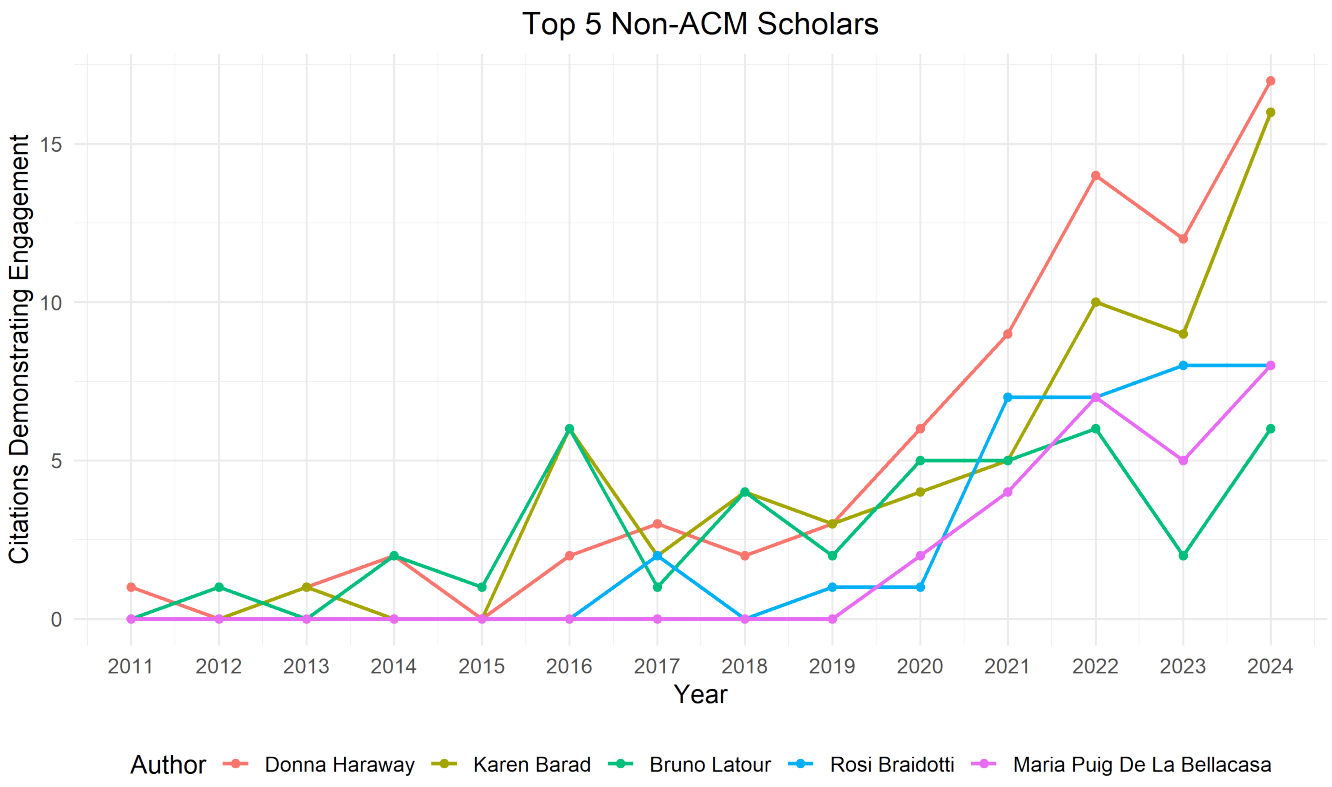

Figure 2: Engagement Trends over Time: Non-ACM scholars

Other scholars and concepts that migrate from posthumanities into the papers in our corpus include, but are not limited to, Jane Bennett's vibrant matter [20], Don Ihde's [107] and Peter-Paul Verbeek's postphenomenology [179], Graham Harman's object-oriented ontology [94], Timothy Morton's agrilogistics and hyperobjects [144, 145], Stacy Alaimo's transcorporeality [3], Diana Coole's and Samantha Frost's new materialist approach to agency [46], and Patricia MacCormack's posthuman teratology (the study of monsters) [137]. Collectively, these scholars and their theories signal a shift toward more entangled, relational, and materially engaged modes of thinking and designing, signalling a significant posthuman turn in computing and design research.

Third, there has been a posthuman knowledge accumulation in the field of computing and design. Initially, posthuman scholarship was predominantly influenced by research published outside ACM venues. Since the late 2010s, scholars such as Jeffrey Bardzell, Shaowen Bardzell, Laura Forlano, Chris Frauenberger, and Ron Wakkary — along with their collaborators — have contributed to the development of a self-sufficient posthuman material-discourse within computing and design. This development also reflects a convergence of posthuman scholarship across both ACM and non-ACM venues, as evidenced by the trends of papers engaging with these scholars.

Laura Forlano emerges as a key bridging figure between computing, design, and the broader field of posthumanities. Although her 2017 paper "Posthumanism and Design" [75] was published during the second phase, we argue that its conceptual impact places it as an early signal of the third phase, given the limited engagement it received before the 2020s. In this work, Forlano provides a toolkit for moving beyond human-centred and user-centred design. She traces posthumanist influences in ANT, feminist new materialism, object-oriented ontology, non-representational theory, and transhumanism. Crucially, she also presents critical perspectives on posthumanism from critical race theory and decolonial theory, broadening posthuman material-discourse beyond Eurocentric concerns. We consider this critical approach essential for developing a multi-dimensional understanding of posthumanism in design, which we will revisit in the Discussion section.

Shaowen Bardzell and Jeffrey Bardzell are other two scholars who enormously contributed to the shaping of posthuman design in the third phase. One example of these contributions is "Symbiotic Encounters: HCI and Sustainable Agriculture" [130], by Szu-Yu Liu, Shaowen Bardzell, and Jeffrey Bardzell. This ethnographic study of alternative farming practices incorporates Anna Tsing's concept of "noticing" from *The Mushroom at the End of the World* [200] and Haraway's "companion species" [89, 91]. This study aims to situate design within posthuman assemblages and temporalities while exploring design alternatives through the concepts of "Earth as a lab" and "intimacy beyond the Biosphere."

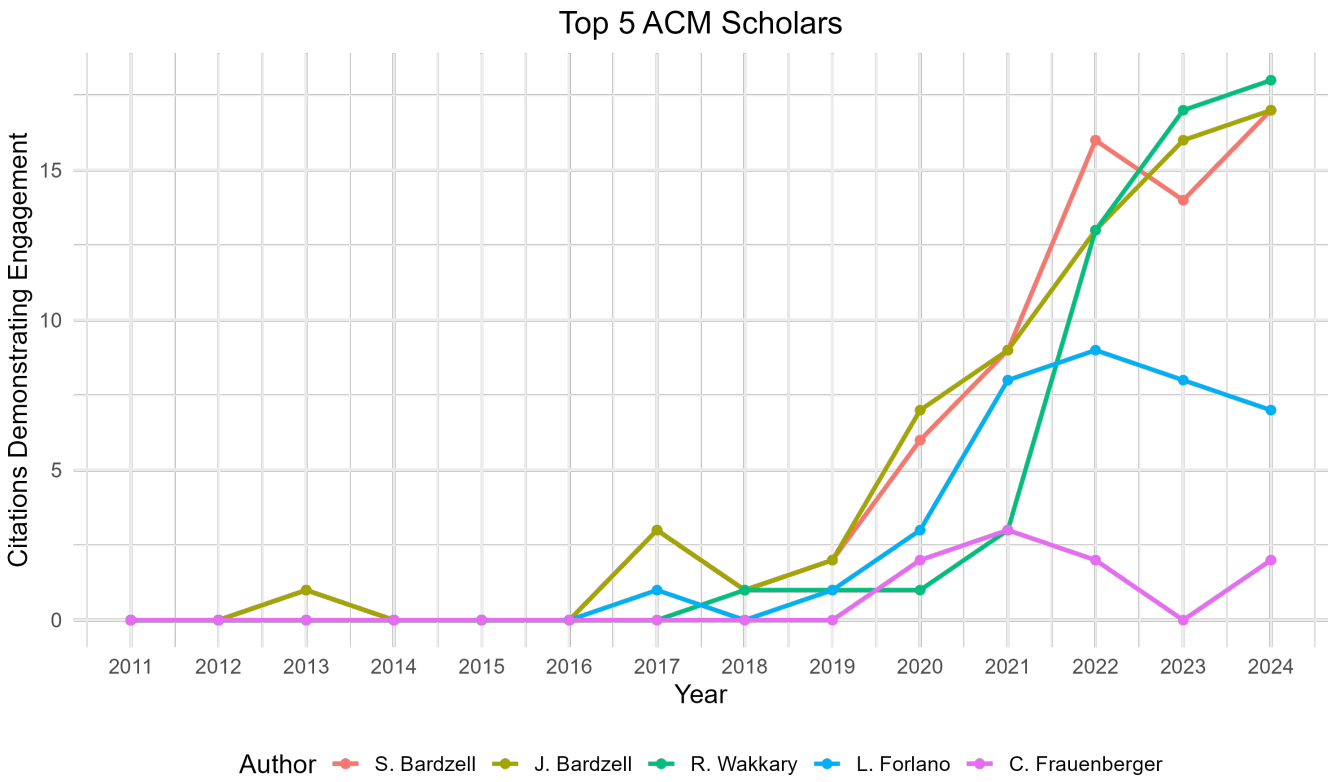

Figure 3: Engagement Trends over Time: ACM Scholars

Ron Wakkary's "Nomadic Practices: A Posthuman Theory for Knowing Design" [205] and *Things We Could Design: For More Than Human-Centered Worlds* [206], represent some of the most influential contributions to the posthuman transformation of design. In these works, Wakkary develops a design paradigm called "designing with," which acknowledges the interconnectedness of human and nonhuman entities and recognizes the agency of nonhumans. Oogjes and Wakkary [158] demonstrate this approach by combining Tsing's concept of noticing with Latour's translations and Laura Watts' landscape ethnography to develop a posthuman repertoire.

Finally, Frauenberger's "Entanglement HCI: The Next Wave?" [78] maps the field of HCI through its engagement with actor-network theory, object-oriented ontology, post-phenomenology, and agential realism — what he refers to as theories of relational ontology — and describes the tendency toward relational ontologies as the "entanglement turn." Although the emphasis on entanglement as a central concept appears to be a scholarly choice, Frauenberger's work is one of the few in the corpus that effectively addresses the five characteristics of posthumanism discussed earlier. We expand on this in the Discussion section.

4.4 Posthuman Design and Computing: Different Concerns, Similar Characteristics

As shown in the previous section, researchers in computing and design engage with different aspects of posthumanism and various scholars, depending on their specific research concerns. While these engagements vary in focus, they reflect both the diverse concerns and the shared characteristics of posthumanism.

Figure 4 illustrates the distribution of papers across two broad concerns — technological (n = 106) and ecological (n = 65) — and their intersections with the five defining characteristics of posthumanism: post-humanism (PH) (n = 34), post-anthropocentrism (PA) (n = 132), post-dualism (PD) (n = 98), post-Enlightenment (PE) (n = 21), and post-technologism (PT) (n = 9). As shown in the figure, a significant portion of papers exhibit both post-anthropocentric (PA) and post-dualist (PD) characteristics (n=40 for technological, n=19 for ecological), or are solely post-anthropocentric (PA) (n=18 for technological, n=12 for ecological). This indicates that papers address design concerns related to relationships between humans and nonhuman relations, including animals, plants, or technologies (PA), as well as issues stemming from a dualistic understanding of subjectivity and agency (PD).

There are also papers that exhibit additional posthuman characteristics, either in conjunction with PA and PD or independently of them. Papers aligned with post-humanism (PH) critique the exclusionary legacies of humanist thought. While papers engaging with post-Enlightenment (PE) question the figure of the autonomous, rational subject, those attentive to post-technologism (PT) problematize techno-solutionism and interrogate its associated socio-ecological harms. Collectively, this distribution demonstrates

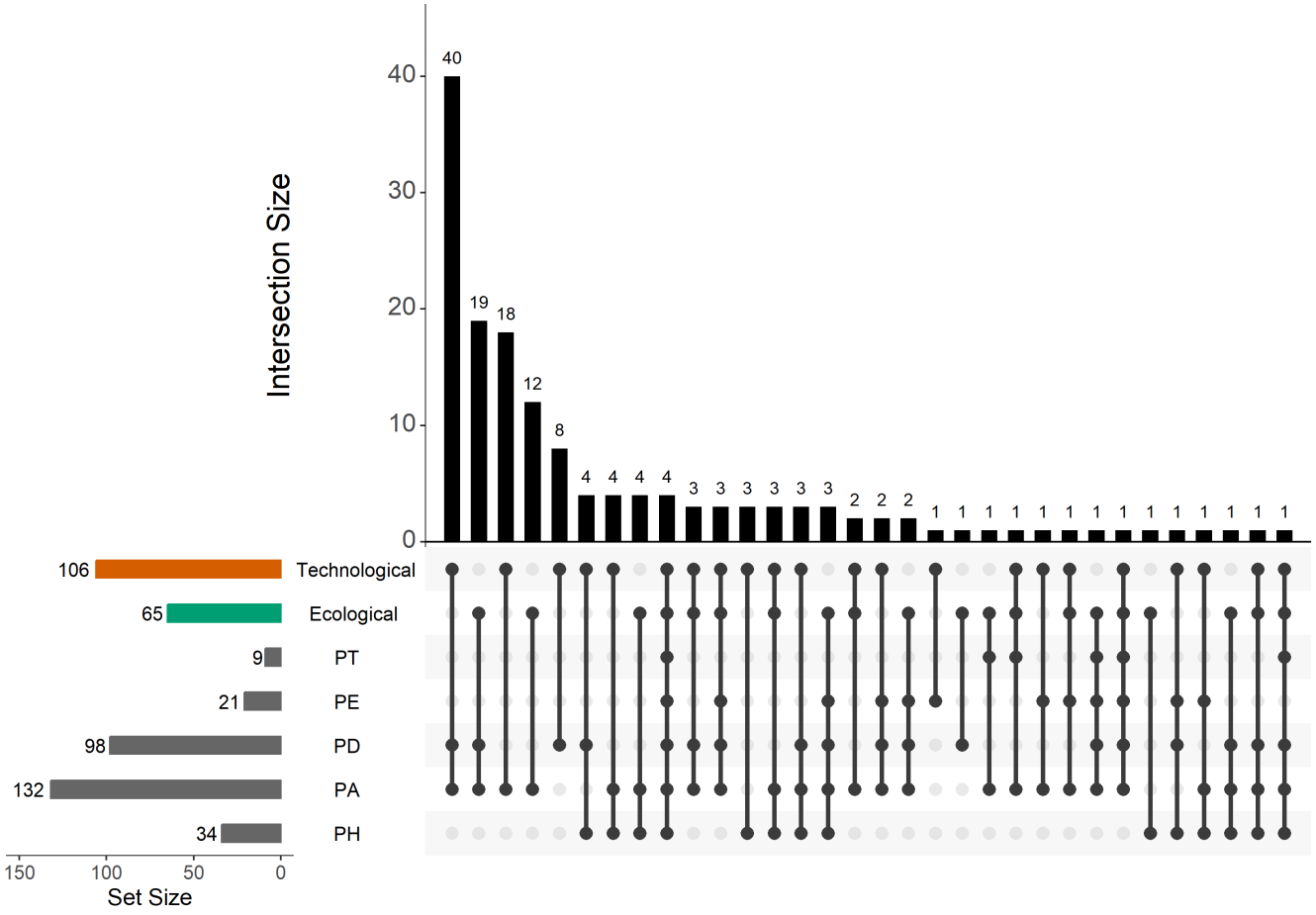

Figure 4: This plot visualizes the relationships between five posthumanist characteristics (PH, PA, PD, PE, PT) and ecological and technological orientations. The set size bars represent the total number of papers categorized under each dimension, while the intersection bars display co-occurrences, highlighting significant overlaps in conceptual frameworks.

that while post-anthropocentric and post-dualist themes dominate, there is an emergent attention to the political, epistemological, and technocritical dimensions of posthumanism in computing and design research. The Appendix captures the coding for each paper in the corpus, including its primary concern(s) and posthuman characteristics.

Notably, four papers [25, 78, 106, 118] address both technological and ecological concerns while exhibiting all five characteristics of posthumanism. In the Discussion, we explore the value of engaging with all these characteristics.

4.4.1 Technological posthuman design. Technological posthuman design challenges the assumption that agency is exclusively a human trait. Papers in this domain consider technology as possessing nonhuman agency within the design process. In this context, sustainability should not be understood solely in terms of ecological sustainability but rather as the sustainability and maintenance of design processes and artifacts. The posthuman condition, therefore, offers both challenges and opportunities for rethinking human-machine interactions through the lens of sustainable design.

As an attempt to turn the posthuman challenge into an opportunity, designers attribute creative agency to interactive and digital technologies. For instance, "Cracking the Code" [116] and "Design Ideation with AI" [197] (by the same authors, published in different venues) explore processes of "co-creation." These papers engage with and expand contemporary perspectives by emphasizing the uncertainties and inconsistencies inherent in programming, while incorporating creative, embodied, and craft-oriented approaches. Moreover, the authors of "Message Ritual" [170] suggest that posthuman design can take many forms, with their contribution specifically focusing on the integration of artificial intelligence into "the assembly of agents within the system." Remarkably, while all three papers exhibit post-anthropocentric and post-dualist characteristics, "Cracking the Code" also demonstrates post-Enlightenment attention, as it implicitly questions the Enlightenment subject(ivity).

4.4.2 Ecological posthuman design. Ecological posthuman design emphasizes ecological sustainability and the well-being of organic human and nonhuman forms. Following Biggs et al. [26], this concern can be seen as the extension of sustainable HCI's response to the Anthropocene. The papers in this subsection explore various topics, such as small farm practices as an alternative to agrilogistics [23] — a hegemonic agricultural practice that has prioritized human civilization at the expense of other life for centuries [145], the potential role of blockchain technologies in promoting global food justice [98], the intersection of care ethics and posthumanism, proposing epistemological care as a design approach in designing for more-than-humans [121], nature-related technology design for forest-goers [4], autoethnographic design experiments with living matters such as bacteria [155] and bees [108] and posthuman, place-based design methodologies such as "Dear Nature" [72].

Among ecological posthuman design papers, some also demonstrate the multi-dimensionality of posthumanism. For instance, Lindström et al. [129] foreground grief and hope as affective pedagogical tools, emphasizing the need to unlearn optimism and confront environmental realities. The study circles introduced in their research challenge the Enlightenment ideal of the rational, autonomous individual, advocating instead for collective, situated, and emotional engagement with the future through decarbonization beyond technology. Another multi-dimensional posthuman approach to ecological concerns comes from Ikeya et al. [108], whose design experiment with bees leads to a critical self-reflection on the anthropogenic remnants in the study. They acknowledge that "[t]he introduction of the red mason bees is an anthropogenic action which could instead have been done by waiting for the species to naturally visit and inhabit there" [108]. This reflection aligns with alternative approaches to designing-with, which we will revisit in our discussion of the post-technologist principle.

4.4.3 Bridging technological and ecological concerns. We observe that some papers combine technological posthuman design and ecological posthuman design, demonstrating how these concerns intersect in practice. In "Weaving Stories," Oogjes and Wakkary address the question of how nonhuman agency can be incorporated into design by drawing on Wakkary's concept of "repertoires" — actions that human designers can take to enable nonhuman participation in the design process [158]. Building on Anna Tsing's concept of noticing, Bruno Latour's translations, and Laura Watts' landscape ethnography, the paper develops three repertoires: noticing through fragility, translating through questions, and employing landscape ethnography through temporalities. Ultimately, the paper interprets the results of weaving projects as repertoires for "the speaking subject," or for understanding what the non-speaking subject communicates with designers. Such repertoires are valuable as they can be applied to both technological and ecological concerns in design.

Similarly, the researchers of "Plant Radio" [177] grapple with the challenge of incorporating nonhuman agency into design by enhancing the agency of a plant. They achieve this by removing the button that controls the radio, which is connected to the plant via sensors, thus giving the plant more control over the system. This experiment addresses both the ecological concern related to plant agency and the technological challenge of designing with plants in a viable way.

Lastly, there are also papers in our corpus that bridge technological and ecological concerns through technological interventions. For instance, Brown et al. [35] explore post-human design research through the development of "Nature Scenes," a project that integrates DIY technological devices with urban ecological engineering to create interspecies interactions.

5 Discussion: A Posthuman Design Vocabulary

Remembering that all theorizing is inherently political, we contend that posthuman theorizing of design — and of designers — should remain attentive to the various interpretations of posthumanism. We propose that a more comprehensive application of posthumanism in design is necessary, one that aligns with the five characteristics of post-humanism, post-anthropocentrism, post-dualism, post-Enlightenment, and post-technologism (Table 2). Our analysis suggest that some of these characteristics are already reflected, in varying degrees, in the corpus.

As noted, four studies address both technological and ecological concerns while demonstrating all five characteristics of posthumanism. We believe that Frauenberger's comprehensive study [78] offers a compelling example of this effort, bringing a fresh perspective to HCI by exploring the potential of various interpretations of entanglement for design and for mattering beyond user-centred approaches. Similarly, Ianniello et al. [106] engage with all five characteristics, by incorporating decolonial and posthuman feminist frameworks into their discussion. Jääskeläinen et al. [118] extend diverse posthuman perspectives into AI-driven design, critiquing the embedded biases of Creative-AI systems and proposing care ethics as a speculative method for reimagining AI's interactions with both humans and more-than-humans. This study particularly emphasizes multispecies cohabitation, distributed agency, and a commitment to care and responsibility toward ecological and social sustainability. Additionally, Biggs et al. [24] investigate how historic redlining — an explicitly racialized housing policy from the 1930s — intersects with contemporary sustainability issues through an interdisciplinary lens, attending to both human and nonhuman factors. By incorporating a multi-dimensional framework, this study also introduces a political dimension to posthuman design.

We particularly value these efforts because they highlight the inseparability of onto-epistemo-ethics. By addressing all five characteristics, the researchers advance a design praxis that promotes sustainability in relation to both technological and ecological concerns. Through the integration of theory and practice, they support our view of posthuman theorizing as a form of intra-action.

Within this context, we propose a vocabulary of design principles corresponding to each posthuman characteristics to advance a more comprehensive posthuman design approach toward just and inclusive sustainable futures. We believe this goal aligns with the concerns regarding ethical conundrums [78] and 'not always positive' consequences [84], such as unseen labour [121] or food insecurity [64].

Design-PA. It is evident that posthumanism is primarily understood as post-anthropocentrism in the papers within our corpus.

Design Principle	Concepts	Key Problems
Design-PA (Post-anthropocentrism)	Decentering the human, Noticing, Multispecies cohabitation, Nomadic practices, Designing-with, Material expressivity	Anthropocentric design norms, Lack of nonhuman agency in design, Over-reliance on human intentions, Ethical considerations in decentering the human
Design-PD (Post-dualism)	Beyond binaries, Natureculture, Intra-action, Subject/abject relations, Transcorporeality	Persisting dualistic thinking, Challenges in integrating nonhuman perspectives, Othering in design methodologies
Design-PH (Post-humanism)	Intersectional justice, Decolonial perspectives, Pluriversal design, Response-ability	Risk of overlooking human injustices, Need for intersectional inclusivity, Persisting techno-colonialism
Design-PE (Post-Enlightenment)	Distributed agency, Algorithmic subjectivities, Situated knowledge, Epistemic humility	Autonomy-centric design frameworks, Mastery and control in design, Human exceptionalism in knowledge production
Design-PT (Post-technologism)	Critical technological reflection, Undesigning, Design inaction	Uncritical technological progress, Overemphasis on innovation, Environmental and social harms of extractive design

Table 2: Principles, Concepts, and Key Problems in Design

Moving beyond the primacy of the human species, Design-PA reconfigures the human as one among many actants within an interconnected network [57]. This principle compels us to design with an empathy to the symbiotic relationships between human and more-than-human worlds, promoting ecologies of concern that foreground the sustainability of all life forms, not merely human interests.

This principle aligns with the efforts of other design researchers. For instance, Wakkary's nomadic practices [205] reconfigures design as an evolving, decentralized, and interconnected set of knowledge systems that do not privilege the human as the sole or primary agent. Instead of adhering to universalizing, human-centred disciplinary structures, those practices emphasize situated knowing, multiplicity of intentionalities, and nomadism, allowing for a more fluid engagement with nonhuman entities.

Another relevant effort was recently made by Bourgault and Jacobs [30]. They contribute to the principle of post-anthropocentrism by emphasizing the decentering of the human in digital fabrication processes. The study argues that digital fabrication should not merely serve human intentions but should engage with machines and materials as active participants in the design process. This work extends post-anthropocentric thinking into HCI fabrication by fostering new ways of designing with rather than of materials and machines, promoting an approach that values distributed agency and material expressivity.

Design-PD. Design grounded in post-dualism rejects the binary oppositions — such as nature vs. culture, human vs. machine, or mind vs. body — that have long structured Western thought. Instead, it envisions existence as a fluid and dynamic interplay of forces, where boundaries dissolve into interfaces of co-emergence. This principle requires design to flourish symbiotic connections, acknowledging that all systems, whether biological, technological, or cultural, are deeply enmeshed in one another [78].

In "Watching Myself Watching Birds: Abjection, Ecological Thinking, and Posthuman Design," Biggs et al. [26] argue that although there is no strict binary between humans and nonhumans, dualistic thinking has historically caused humans to define themselves through the process of Othering. Since the abject — following Julia Kristeva's concept of abjection — is a psychological extension of the human, they argue that designing for nonhumans presents significant challenges. The authors therefore propose replacing the subject/object distinction between humans and nonhumans with a subject/abject relationship.

Contrary to this assumption, Sondergaard and Woytuk argue that the "understanding of more-than-human bodies should not be seen merely as an extension of the body" [194]. Instead, they highlight the "fluidity, porosity, and 'transcorporeality'" — a concept borrowed from Stacy Alaimo — that exists between human and nonhuman bodies, reflecting a more complex experience and interaction. Stacy Alaimo's concept of "transcorporeality" is indeed useful here in understanding the interconnectedness and encounters between human and nonhuman bodies and for post-dualist principle. According to Alaimo, "[t]ranscorporeality does the opposite of distancing or dividing the human from external nature" [3]. From a posthuman design perspective, the human is inherently posthuman; without the nonhuman, the human cannot exist. In this light, we interpret the statement in "Watching Myself Watching Birds" regarding the nonhuman as an extension of the human subject as based on psychoanalytic, rather than biological, ecological, or evolutionary grounds. While humans are biologically, ecologically, and evolutionarily intertwined with the material world, human civilization has distanced itself from the nonhuman conceptually and psychologically. This feature of civilization is what Timothy Morton critiques in their problematization of agrilogistics, a foundational but problematic pillar of human civilization [144, 145].

Design-PH. We contend that posthuman design must go beyond simply being more-than-human-centred. In order to design for just

and inclusive sustainability futures, we should decenter the human but still take injustices against marginal human communities into account. Several papers in our corpus, as well as others encountered during our research, argue that posthuman perspectives should be integrated with indigenous and decolonial philosophies, as they risk overlooking the human in their focus on decentering it [106, 121, 194].

Pihkala and Karasti's [166] emphasis on relational ontologies through the concept of response-ability aligns with the posthuman commitment to dismantling exclusionary structures and fostering ethical engagements both within the human species and across species and material entanglements. Similarly, Falk et al. [69] argue for diversity computing as a means to integrate pluralistic perspectives into design, resisting tokenistic inclusion and instead creating agonistic spaces where intersecting identities and perspectives can coexist meaningfully. This resonates with the posthuman imperative to not only decenter the human (post-anthropocentric) but also confront historical and systemic inequalities that shape participation in design (post-humanist). Similarly, Ianniello et al.'s [106] exploration of pluriversal design further reinforces this approach by advocating for decolonial and post-human feminist perspectives, dismantling species hierarchies, and positioning design as a facilitator of more-than-human symbiosis.

The discussion of "post-growth" [183], by introducing an alternative economic orientation, also questions computing's role in exacerbating unsustainable growth and advocating for redistributive, localized, and care-based approaches in sociotechnical systems. Janicki et al. [113] demonstrate how more-than-human entanglements are not merely ecological but also deeply political, intersecting with histories of racial capitalism and environmental dispossession. Lastly, Biggs et al.'s work [25] highlight how interdisciplinary methods, such as map-making, can reveal the entanglements of past and present, advocating for posthuman design principles that take racial and social justice into account. Together, these works highlight that posthuman design is not merely about expanding the scope of agency beyond humans but also about embedding justice, care, and political responsibility into design methodologies.

In this respect, the Design-PH principle must fundamentally challenge and subvert systems of domination and exclusion that have historically privileged certain groups of humans while marginalizing others. At its core, this principle seeks to dismantle human hierarchies rooted in the legacies of advanced capitalism, colonialism, and racial and gender oppression. Design-PH envisions a world where the inherent worth of all individuals is recognized, irrespective of race, gender, belief, ability, or socio-economic standing. By resisting the commodification and instrumentalization of human life, this approach refuses to reduce individuals to their economic or functional roles. Instead, it calls for design practices that foster human dignity, promote equity, and cultivate spaces of collective flourishing, thus transcending exclusionary humanist frameworks.

Design-PE. A post-Enlightenment approach to design critiques the ideal of the autonomous, rational individual that dominated modernity. It embraces a relational and embodied onto-epistemo-ethics that challenges notions of knowledge and agency as predetermined by the figure of the Western, Christian man. Design, from this perspective, must move beyond mastery and control, cultivating forms of practice that recognize the interdependence of all beings and the situated nature of knowledge.

This shift requires recognizing knowledge and agency as distributed across human and nonhuman actants, material infrastructures, and algorithmic processes. In this respect, Baumer et al.'s [16] discussion of algorithmic subjectivities critiques the assumption of an autonomous human subject, instead highlighting the co-constitution of human identities, technological infrastructures, and systemic classification mechanisms. On a similar ground, Ikeya et al. [108] critiques traditional human-centric approaches by demonstrating how design can foster multispecies relationships through attentiveness to local ecologies. This aligns with the post-Enlightenment rejection of mastery and control, positioning the designer as a cohabitant rather than a dominant force. Similarly, Ferreira and Hsi [72] undermine the Enlightenment ideal of objective, universal knowledge by emphasizing the subjective and affective dimensions of data representation. These studies illustrate how post-Enlightenment design methodologies cultivate epistemic humility — which aligns with situated knowing behind the ideal of "designing with" [205]. This embraces pluralistic, embodied, and contextual forms of knowledge while actively resisting the hierarchical structures of modernity.

Design-PT. In resisting the uncritical celebration of technological progress, Design-PT calls for a reflective stance on the socioecological consequences of technological intensification [164]. It urges design to interrogate the entanglement of technology with systems of injustice and exploitation, advocating for a reorientation toward technologies that promote sustainability, ethical accountability, and the flourishing of both human and nonhuman worlds. Post-technologism can be practiced in two ways: designing differently and undesigning.

We can imagine Design-PT in terms of alternate ways of designing with [206]. In this sense, "Designing for Interdependence of Bees" [108] challenges conventional technological interventions by demonstrating how design can foster reciprocal relationships with nonhuman entities, encouraging attunement to ecological rhythms rather than technological control. Similarly, "Dear Nature" [72] offers an alternative to the dominant data-driven paradigm, where qualitative, embodied, and context-rich data practices promote deeper engagement with environmental sensemaking instead of reducing nature to quantifiable metrics. These works exemplify alternative approaches that align with post-technologism's call to not only reflect on the socioecological consequences of technological intensification but also actively explore forms of design that move beyond innovation-driven problem-solving.

The design field is still understandably dominated by technological innovation. However, we also need to focus on unmaking and undesigning material-discursive practices as a social innovation, which corresponds to post-technologism. This principle is reinforced by scholarship advocating for undesigning and design inaction as legitimate — and even necessary — responses to unsustainable technological intensification. Pierce's *Undesigning Technology* [164] introduces the concept of intentional negation of technology, arguing that design should not only create but also dismantle technologies that contribute to environmental and social

harms. Sandelin and Homewood [182] further develop this idea by framing inaction as a form of activism, where the decision to not design can be an ethical, political, and designerly act. These interventions align with the principle of Design-PT by emphasizing inhibition, displacement, and even erasure of harmful technological interventions rather than perpetuating an innovation-driven approach.

We argue that posthuman design must incorporate these five principles (Design-PH, Design-PA, Design-PD, Design-PE, and Design-PT) to effectively address the intersectional challenges of the posthuman condition. While Rajcic and McCormack suggest, "[p]osthuman design explores what it is like to design with humans and non-humans, rather than for an idealized 'user'" [170], we suggest that posthuman design should encompass more, bringing attention to onto-epistemo-ethical dimensions. Based on the papers in our corpus and the preceding discussion, we propose the following definition: Posthuman Design is a critical and inclusive approach to design that challenges traditional human-centred paradigms by integrating the five principles of posthumanism: post-humanism, post-anthropocentrism, post-dualism, post-Enlightenment, and post-technologism. Grounded in these principles, posthuman design aims to dismantle hierarchical power and knowledge structures, avoid human exceptionalism and exemptionalism, and promote ethical engagements among human, nonhuman, and material realms — in short, among posthumans.

This includes avoiding the creation of new binaries, such as human versus more-than-human, while maintaining a critical focus on marginalized posthuman communities affected by oppressive structures like agrilogistics, patriarchy, colonialism, and racism. As Donna Haraway has argued, "we have never been human" [90], but have always existed within systems of marginalization, exploitation, and domination. Furthermore, Karen Barad's assertion [12] about the importance of attending to material-discursive phenomena in their entanglements — particularly in addressing "the questions of justice that are integral to the doing of science" — is equally relevant to design. A more critical political stance is necessary in design and designerly speculations about sustainable futures [189], one that explicitly rejects both human exceptionalism and exemptionalism [55] and advocates for an ethical reconfiguration of technological development that acknowledges the rights and agency of animals and ecosystems [35]. The posthuman design papers in our corpus illustrate how such a stance can be articulated and applied through multidimensional understandings of posthumanism.

6 Conclusion

Through this study, we demonstrate that posthuman design is emerging as a significant paradigm that moves beyond human-centred approaches in design and computing research. Our findings build upon and extend Bødker's emphasis on participatory and shared interactions [28] and Harrison et al.'s [95] discussion on paradigms by framing posthuman design as a multi-species participatory response to contemporary challenges in computing and design.

Our findings show how posthuman design is actively challenging anthropocentric and technocentric biases, addressing injustices against both marginalized human and nonhuman communities, and applies posthuman perspectives through material-discursive practices. From participatory engagements with nonhuman ecologies to critical technological interventions resisting extractivist and exclusionary design models, posthuman design is reshaping the field.

At the core of posthuman design are five interconnected principles: post-humanism (Design-PT; an inclusive understanding of the human), post-anthropocentrism (Design-PA; an inclusive understanding of species), post-dualism (Design-PD; rejection of binary oppositions), post-Enlightenment (Design-PE; critique of the rational, autonomous individual), and post-technologism (Design-PT; a critical stance toward technological progress). These principles challenge the dominant narratives of modernity, human exceptionalism, and techno-solutionism, urging us to rethink design in ways that promote just sustainabilities. Our findings illustrate how these principles are already being explored in the computing and design research communities, but they also highlight the need for a more explicit articulation of posthuman design's political and ethical commitments. By integrating these principles, posthuman design offers a transformative framework for reimagining policy and technology design, including the design of AI systems, in shaping more just, equitable, and sustainable futures.

While this study has mapped the landscape of posthuman design and articulated its foundational principles, future work should further explore how posthuman perspectives can be leveraged as a lens for understanding and advancing social justice within human communities. Although posthuman design has largely focused on decentering the human and addressing injustices against nonhuman entities, there remains an opportunity to explicitly examine how posthumanism can contribute to intersectional justice efforts, particularly in relation to race, gender, disability, and class. Future research should investigate how posthuman design principles — such as post-dualism and post-Enlightenment critique — can be applied to dismantle social hierarchies that persist within technological development and design practices.

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A Corpus of Papers with Classifications

Paper Title	Conference	Year	Posthumanist Principles	Eco, Tech, or Both
Computer aided creativity: practical experience and theoretical concerns [163]	C&C	2002	PA	T
Constituting, traversing and perforating boundaries: embodied interaction in immersive virtual spaces [82]	C&C	2005	PA, PD	T
Syncretic Post-Biological Digital Identity: Hybridizing Mixed Reality Data Transfer Systems [190]	DS-RT	2011	PA	T
Unpleasurable products and interfaces [139]	DPPI	2011	PA	B
What does it mean to be enhanced? [213]	VRIC	2012	PA, PD	T
Designing with templates in instructional design [210]	SIGDOC	2012	PA	T
Stories of the Smartphone in everyday discourse: conflict, tension & instability [94]	CHI	2013	PA	T
Breakdown, obsolescence and reuse: HCI and the art of repair [111]	CHI	2014	PA, PD	T
Object intermediaries: How New Media Artists Translate the Language of Things [6]	SIGGRAPH	2014	PA, PD	B
Transmission: A Telepresence Interface for Neural and Kinetic Interaction [85]	SIGGRAPH	2014	PA	T
Self-tracking cultures: Towards a sociology of personal informatics [136]	OzCHI	2014	PH, PA, PD	T
Smelling, pulling, and looking [8]	ACE	2015	PA	E
Factors to actors: implications of posthumanism for social justice work [178]	SIGDOC	2015	PH, PA	T
Probing the Potential of Post-Anthropocentric 3D Printing [57]	DIS	2016	PA	T
Plant-computer interaction, beauty and dissemination [9]	ACI	2016	PA	E
Becoming with: Towards the Inclusion of Animals as Participants in Design Processes [211]	ACI	2016	PA, PD	E
spaceDisplaced: Investigating Presence Through Mediated Participatory Environments [192]	MOCO	2016	PA	T
Doing Sociomateriality Research in Information Systems [67]	SIGMIS	2016	PA, PD	T
Negotiating "Messy" Research Context and Design Through Adaptive Research Stances: Experience Report [5]	SIGDOC	2016	PA	T
New Technology and the Post-human Self: Rethinking Appropriation and Resistance [172]	SIGMIS	2016	PA, PD	T
Rethinking, "Rethinking: Post-Human Boundaries": Pregiven or Performed? [160]	SIGMIS	2016	PA, PD	T
Strong versus Weak Sociomateriality: Neither Subordinate nor Privileged- A rejoinder to "New Technology and the Post-human self: Rethinking Appropriation and Resistance" [120]	SIGMIS	2016	PA, PD	T
Critical Realism as a Sociomaterial Stream of Research [49]	SIGMIS	2016	PA, PD	T
Editorial: A Brief History of the Material in Sociomateriality [96]	SIGMIS	2016	PA, PD	T

Designing for Cohabitation: Naturecultures, Hybrids, and Decentering the Human in Design [187]	CHI	2017	PA, PD	E
Post-userism [15]	CHI	2017	PH, PD, PE	T
Manifesting the Cyborg through Techno-Body Modification: From Human-Computer Interaction to Integration [34]	CHI	2017	PA, PD	T
Movement Matters: How a Robot Becomes Body [83]	MOCO	2017	PA, PD	T
Critical Appropriations of Biosensors in Artistic Practice [146]	MOCO	2017	PA, PD	T
To whom does the driver's seat belong in the future? [36]	GenderIT	2018	PH, PA, PD	T
When toys come to life: Considering the internet of toys from an animistic design perspective [216]	IDC	2018	PA, PD	T
Posthuman Gesture [114]	MOCO	2018	PA, PD	T
Emotional Biosensing: Exploring Critical Alternatives [105]	CSCW	2018	PA, PD	T
A postphenomenological method for HCI research [115]	OzCHI	2018	PD	T
Rewilding Wearables: Sympoeitic Interfaces for Empathic Experience of Other-than-human Entities [74]	TEI	2018	PA, PD	B
Politics of mattering in the practices of participatory design [165]	PDC	2018	PD	T
Rhetorically Defining 'Information' For Designers and Technical Communicators: Transport, Institutional Shift, and Usability [133]	SIGDOC	2018	PE	T
Multimodal conversation analysis and usability studies [45]	CDQ	2018	PA, PD	T
Encoding Materials and Data for Iterative Personalization [147]	CHI	2019	PA	T
Symbiotic Encounters: HCI and Sustainable Agriculture [130]	CHI	2019	PA, PD	E
Cuteness as a 'dark pattern' in home robots [124]	HRI	2019	PD	T
Reconfiguring Human-centred Design of Technology as a Technohuman Intervention [149]	HTTF	2019	PA, PD	T
Performance, Art, and Cyber-Interoceptive Systems (PACIS) [104]	MOCO	2019	PA, PD	T
Redesigning audiences in technical communication [80]	SIGDOC	2019	PA	T
Entanglement HCI The Next Wave? [78]	TOCHI	2019	PH, PA, PD, PE, PT	B
And This, Kids, Is How I Met Your Mother: Consumerist, Mundane, and Uncanny Futures with Sex Robots [199]	CHI	2020	PA, PD	T
Monsters, Metaphors, and Machine Learning [65]	CHI	2020	PH	T
IoT Data in the Home: Observing Entanglements and Drawing New Encounters [56]	CHI	2020	PA	T
Making Air Quality Data Meaningful: Coupling Objective Measurement with Subjective Experience through Narration [131]	DIS	2020	PH, PA, PD, PT	B
Removal as a Method: a Fourth Wave HCI Approach to Understanding the Experience of Self-Tracking [103]	DIS	2020	PH, PD	T
Fostering More-than-Human Imaginaries: Introducing DIY Speculative Fabulation in Civic HCI [152]	NordiCHI	2020	PA	E

Design (In)actions [182]	NordiCHI	2020	PA, PT	E
Knowledge-creation Processes in Crafts-based HCI Research: Introducing a Sympoietic Framework [77]	NordiCHI	2020	PA, PD	T
Making-with: Nonhuman Animal Inclusivity in an Electronic Literature Practice [123]	ACI	2020	PA, PD	T
Piracy and the Impaired Cyborg: Assistive Technologies, Accessibility, and Access [40]	CSCW	2020	PH, PA	T
Expanding Participation to Design with More-Than-Human Concerns [2]	PDC	2020	PA, PD	E
Hybrid collectivity: Hacking environmental risk visualization for the anthropocene [157]	CDQ	2020	PA, PD	B
Watching Myself Watching Birds: Abjection, Ecological Thinking, and Posthuman Design [26]	CHI	2021	PA, PD	E
Algorithmic Food Justice: Co-Designing More-than-Human Blockchain Futures for the Food Commons [98]	CHI	2021	PH, PA	E
Tracing Conceptions of the Body in HCI: From User to More-Than-Human [101]	CHI	2021	PH, PA, PD	B
Machine Learning Uncertainty as a Design Material: A Post-Phenomenological Inquiry [19]	CHI	2021	PD	T
Wanting To Live Here: Design After Anthropocentric Functionalism [14]	CHI	2021	PH, PA	E
Eyecam: Revealing Relations between Humans and Sensing Devices through an Anthropomorphic Webcam [196]	CHI	2021	PD	T
Entangled Reflections on Designing with Leaky Breastfeeding Bodies [99]	DIS	2021	PA, PD	T
What We Speculate About When We Speculate About Sustainable HCI [189]	COMPASS	2021	PA	E
Circular Species [63]	IDC	2021	PA, PD	E
Transient Pattern – the Model of Digital Layout [86]	ARTECH	2021	PA, PD	T
Embedding an interactive art installation into a building for enhancing citizen's awareness on urban environmental conditions [161]	MAB	2021	PA, PD	T
Plant(e)tecture: Towards a Multispecies Media Architecture Framework for amplifying Plant Agencies [184]	MAB	2021	PA	B
Leashing the City: Dog-Leash-Human Entanglements and the Urban Space [181]	ACI	2021	PA, PD, PE	E
The Art of Point Clouds: 3D LiDAR Scanning and Photogrammetry in Science & Art [110]	ARTECH	2021	PA, PD	T
Alternatives to Agrilogistics: Designing for Ecological Thinking [23]	CHI	2021	PA, PD	E
Contact Zones: Designing for More-than-Human Food Relations [167]	CSCW	2021	PH, PA, PD	E
Interrogating Alexa: Holding Voice Assistants Accountable for Their Answers [100]	SIGDOC	2021	PD	T
Deep mapping for environmental communication design [37]	CDQ	2021	PA, PD	E

Cracking the code: Co-coding with AI in creative programming education [116]	C&C	2022	PA, PD, PE	T
Exploring Kolam As An Ecofeminist Computational Art Practice [119]	C&C	2022	PA, PD	E
Methodological Reflections on Ways of Seeing [117]	CHI	2022	PA, PD	T
Making New Worlds – Transformative Becomings with Soma Design [191]	CHI	2022	PA, PD	T
The Eco-Technical Interface: Attuning to the Instrumental [132]	CHI	2022	PA, PD	E
Weaving Stories: Toward Repertoires for Designing Things [158]	CHI	2022	PA, PD, PE, PT	B
Patterns and Opportunities for the Design of Human-Plant Interaction [41]	DIS	2022	PA	E
What Is Meaningful Human-Computer Interaction? Understanding Freedom, Responsibility, and Noos in HCI Based on Viktor Frankl's Existential Philosophy [150]	DIS	2022	PH	T
Plant Radio: Tuning in to plants by combining posthumanism and design [177]	DIS	2022	PA, PD, PE	B
Feminist Care in the Anthropocene: Packing and Unpacking Tensions in Posthumanist HCI [121]	DIS	2022	PH, PA, PD, PE	E
Making space for material entanglements: A diffractive analysis of woodwork and the practice of making an interactive system [153]	DIS	2022	PA, PD	T
From Concern to Care: A Transformative Reflection on Designing-with the Living [159]	NordiCHI	2022	PA, PD	E
Exploring More-than-Human Caring in Creative-Ai Interactions [118]	NordiCHI	2022	PH, PA, PD, PE, PT	B
Me, the Hill and My Browser – Investigating the Role of Time in Posthuman Interaction [44]	NordiCHI	2022	PA, PD, PE	B
The Problem(s) of Caring for the Commons [79]	NordiCHI	2022	PA, PD	E
Phenology Probes: Exploring Human-Nature Relations for Designing Sustainable Futures [175]	OzCHI	2022	PA, PD	E
Technology toward more-than-human symbiosis: Critical reflections from the design perspective [106]	Mindtrek	2022	PH, PA, PD, PE, PT	B
Subverting machines, fluctuating identities: Re-learning human categorization [135]	FAccT	2022	PD	T
Science Fictioning Participatory Design [126]	PDC	2022	PD	E
Towards Response-able PD: Putting Feminist New Materialisms to Work in the Practices of Participatory Design [166]	PDC	2022	PH, PA, PD	T
Would the Trees Dim the Lights? Adopting the Intentional Stance for More-Than-Human Participatory Design [47]	PDC	2022	PA	E
Two Years or More of Co-speculation: Polylogues of Philosophers, Designers, and a Tilting Bowl [208]	TOCHI	2022	PA, PD	T
Feminist Posthumanist Design of Menstrual Care for More-than-Human Bodies [194]	CHI	2023	PH, PA	E

AdaCAD: Parametric Design as a New Form of Notation for Complex Weaving [58]	CHI	2023	PA, PD	T
Felt Experiences with Kombucha Scoby: Exploring First-person Perspectives with Living Matter [155]	CHI	2023	PA, PD, PE	E
Message Ritual: A Posthuman Account of Living with Lamp [170]	CHI	2023	PA, PD	T
Redlining Maps and Terrains of Sustainability: Interdisciplinary Mapping of Racialized Redlining to Present-Day Sustainability Agendas in HCI [25]	CHI	2023	PH, PA, PD, PE, PT	B
Lydspor: An Urban Sound Experience Weaving Together Past and Present Through Vibrating Bodies [180]	CHI	2023	PA, PD	T
What is Human-Centered about Human-Centered AI? A Map of the Research Landscape [38]	CHI	2023	PA	T
Three Design Directions for a Diversity Computing Design Space [69]	CHI	2023	PH	T
Shifting from Surveillance-as-Safety to Safety-through-Noticing: A Photovoice Study with Eastside Detroit Residents [134]	CHI	2023	PH, PA	T
HCI Research on Agriculture: Competing Sociotechnical Imaginaries, Definitions, and Opportunities [64]	CHI	2023	PA	E
Design Ideation with AI - Sketching, Thinking and Talking with Generative Machine Learning Models [197]	DIS	2023	PA, PD	T
Pull It Together: Textile Patina as an Interface for Externalizing Invisible Tension [142]	DIS	2023	PA	T
Fabulation as an Approach for Design Futuring [195]	CHI	2023	PH, PA	T
Nature Fictions: Designing for a Sustainable Future through Nature Relations [176]	DIS	2023	PA	E
ARECA: A Design Speculation on Everyday Products Having Minds [43]	DIS	2023	PA, PE	T
Designing and Using the Wild Probes Toolkit (v1) to Co-Design From-the-Wild [4]	DIS	2023	PA	E
TikTok as a Stage: Performing Rural #farmqueer Utopias on TikTok [24]	CHI	2023	PH	E
Unusual suspects - visualizing unusual relationships of complex social phenomena with climate change [39]	GoodIT	2023	PH, PA	B
On Futuring Body Perception Transformation Technologies: Roles, Goals and Values [202]	Mindtrek	2023	PA, PD	T
Networks of Migrants' Narratives: A Post-authentic Approach to Heritage Visualisation [204]	JOCCH	2023	PD	T
Exploring the Eco-Digital: Performative Sensing with Plants and Data [215]	SIGGRAPH	2023	PA, PD, PE	B
A Practice-Based Approach to Post-Human Computer Interaction: Design Notes from Nature Scenes [35]	TEI	2023	PH, PA	B
SCOBY BREASTPLATE: SLOWLY GROWING A MICROBIAL INTERFACE [17]	TEI	2023	PA, PT	B
Speculative Histories, Just Futures: From Counterfactual Artifacts to Counterfactual Actions [76]	TOCHI	2023	PH, PD	T

Post-growth Human–Computer Interaction [183]	TOCHI	2023	PH, PA	E
Entangling Entanglement: A Diffractive Dialogue on HCI and Musical Interactions [143]	CHI	2024	PH, PA, PE	T
Living with Cyanobacteria: Exploring Materiality in Caring for Microbes in Everyday Life [217]	CHI	2024	PA, PD	E
Towards a Diffractive Analysis of Prompt-Based Generative AI [169]	CHI	2024	PA, PD	T
Thinking with Sound: Exploring the Experience of Listening to an Ultrasonic Art Installation [174]	CHI	2024	PA	T
Shape-Changing Clay-Dough: Taking a Material-Oriented Approach to 3D Printing Ceramic Forms [18]	CHI	2024	PA	T
Thrown from Normative Ground: Exploring the Potential of Disorientation as a Critical Methodological Strategy in HCI [22]	CHI	2024	PH, PA	B
Microbial Revolt: Redefining biolab tools and practices for more-than-human care ecologies [42]	CHI	2024	PA	E
Technologically Mediated Experiences of Visitors to the Frederic Chopin Museum: Postphenomenological Perspective on Touchscreens Affordances [66]	JOCCH	2024	PA	T
Base and Stitch: Evaluating eTextile Interfaces from a Material-Centric View [171]	TEI	2024	PA	T
Sensing Bodies: Engaging Postcolonial Histories through More-than-Human Interactions [113]	TEI	2024	PA, PD	E
Algorithmic Subjectivities [16]	TOCHI	2024	PA, PD, PE	T
Encountering Human-Plant Relations: a Discussion of How Interaction Design Can encourage Human Sensibility to More-than-human Plants [88]	DIS	2024	PA, PE	B
Articulating Felt Senses for More-Than-Human Design: A Viewpoint for Noticing [154]	DIS	2024	PA, PD	E
The Organium: A Library of Technical Elements for Improvisatory Design Thinking [138]	AM	2024	PA, PD	T
Seeding a Repository of Methods-To-Be for Nature-Entangled Design Research [198]	DIS	2024	PA, PD	E
Crip Reflections on Designing with Plants: Intersecting Disability Theory, Chronic Illness, and More-than-Human Design [112]	DIS	2024	PA, PD	E
Designing for Interdependence of Bees, Garden, Designer, and the Changing Season [108]	DIS	2024	PA, PD, PE, PT	E
Sonic Entanglements with Electromyography: Between Bodies, Signals, and Representations [173]	DIS	2024	PA, PD	T
All Is Heard: Reimagining The Sounds of Home With Care [218]	DIS	2024	PA	T
Tracing as a Strategy for Orienting to Nonhuman Perspectives [156]	DIS	2024	PA	E
NEXUS: A Tangible Multi-User Sensor-Based Telematic Novel Mixing-Interface for Multimedial Exploration [209]	AM	2024	PA, PD	T
Reorientations: Practicing Grief and Hope in Post-Carbon Futures [129]	PDC	2024	PH, PA, PD, PE	E

Dear Nature: Using data drawings to promote sensemaking in human-nature relations [72]	DIS	2024	PH, PA, PD, PE	E
The New Vitruvian: Becoming-with an AI Recognition Algorithm [141]	MOCO	2024	PH, PD	T
"Tuning in and listening to the current": Understanding Remote Ritual Practice in Sufi Communities [122]	DIS	2024	PH, PD	T
Millipath: Bridging Materialist Theory and System Development for Surface Texture Fabrication [30]	DIS	2024	PA, PD	T
Towards Relatable Climate Change Data: Untangling Tensions in Engaging with a Hyperobject [73]	DIS	2024	PA	E
The Perceptron: A Multi-player Entangled Instrument based on Interpretive Mapping and Intra-action. [193]	AM	2024	PA, PD	T
Embodied Traces: Multispecies Entanglement in Urban Spaces [29]	DIS	2024	PA. PD	E