



# Exploring Opportunities from the More-than-Human Perspective for Investigating Wicked Problem in Our Entangled World

Risa Kimura<sup>(✉)</sup> and Tatsuo Nakajima

Department of Computer Science and Engineering, Waseda University, Tokyo, Japan  
{risa.kimura, tatsuo}@dcl.cs.waseda.ac.jp

**Abstract.** This paper emphasizes the significance of embracing the more-than-human perspective, which goes beyond conventional human-centered design approaches and offers a foundation for innovative design methodologies. We will delve into the fundamental concepts underpinning the more-than-human perspective, elucidating its core principles. Following this, we will present recommendations on integrating this perspective into distinct design methodologies, fostering a comprehensive and inclusive approach to design. Furthermore, the paper will illuminate the practical implications of adopting the more-than-human perspective through three detailed case studies. These case studies will serve as practical illustrations of how this perspective can influence the design process, unlock novel design possibilities, and contribute to the development of innovative solutions. By delving into these real-world scenarios, we aim to showcase the tangible benefits and transformative potential of the more-than-human perspective in the realm of design.

**Keyword:** Entanglement · More-than-Human · Posthuman · Hybrid · Affordance · Ontological Turn · Practice Theory · Generative AI

## 1 Hybrid and Entangled World

In recent years, the design field has witnessed a growing interest in shifting away from the traditional human-centric approach, ushering in a more inclusive design paradigm referred to as More-Than-Human Design (MTHD) [9, 14, 30, 35] for investigating a variety of wicked problems in our entangled world. The term “entangled world” refers to the interconnectedness and interdependence of various elements and phenomena in the contemporary global context. It suggests that different aspects of our world—such as technology, economies, cultures, societies, and the environment—are deeply intertwined and influence each other in complex ways. This interconnectedness can be observed on various levels, including social, economic, political, and environmental dimensions. Design researchers and practitioners are actively exploring collaborative design methods and strategies that encompass not only humans but also objects, animals, and robots

as integral constituents of the design process. MTHD research finds strong resonance with postpluralist ideologies, including actor-network theory, philosophy of science, and the critical intersection with posthuman concepts [14]. In the domain of human technology hybrid design, researchers are proactively forging their distinct approaches and methodologies, finely tailored to the realm of design. This paradigm shift reflects an evolving landscape in design thinking, where the boundaries of design expand to accommodate a richer and more diverse set of actors in the design process.

The burgeoning MTHD approach in the design domain exhibits two notable trends. One of these trends is rooted in the growing environmental crisis, which has led scientists to reevaluate the concept of human dominance over other species [8, 12, 32]. Design methodologies focused on sustainability are moving away from presumptions of one species' superiority over another, and instead, they are exploring alternatives that promote the overall well-being of the ecosystem. Some proponents suggest that MTHD theory could serve as a valuable framework for reevaluating global human-nonhuman interactions during the "Anthropocene" epoch, transcending the reliance on human-centric criteria [5].

Another significant trend is related to the evolving concept of what defines a product. A crucial driver behind this profound shift in the product's definition is the move from static physical objects, as commonly seen in traditional "industrial products" to dynamic and adaptable entities [14, 38]. This transformation has been significantly accelerated by the widespread integration of connectivity, machine learning, and artificial intelligence into our daily lives. The emergence of new sensing technologies and advanced data processing capabilities has enabled products to undergo substantial evolution, moving beyond their previous roles as passive objects to become active agents that influence relationships and interactions with individuals [35]. This change in concept and ontology prompts a reevaluation of the boundaries between humans and technology.

For instance, domains like virtual reality, social robotics, digital assistants, and neuroimplants challenge the conventional boundary between humans and machines, raising questions about the essence of humanity versus technology. Furthermore, this transition emphasizes the relational nature of design, positioning intelligence not as an inherent trait of machines or humans, but as an emergent property arising from their interactions [36, 40]. Designers must now shift their focus away from the traditional singular user or product to encompass multifaceted considerations involving various products, services, stakeholders, and their intricate interplay. This shift presents a challenge to the established paradigm of human-centered design [9, 14, 16, 32]. Together, these elements suggest the potential for a paradigm shift in Human-Computer Interaction (HCI), marking the advent of the third wave of HCI [4]. However, it's important to note that the HCI and design discourse on MTHD is still in its early stages [14].

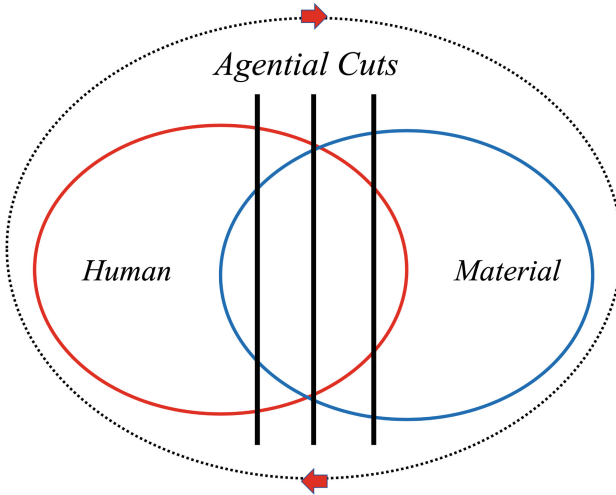
This paper focuses on the "more-than-human" perspective, departing from conventional human-centered design paradigms to encompass nonhuman elements. Its purpose is to introduce the foundational concepts that underpin this perspective and explore the potential for innovative design methodologies it offers. Additionally, it delves into how the more-than-human perspective can impact design through the lens of three case

studies. It's clear that this emerging perspective, in contrast to the traditional human-centered design approach, provides a spectrum of viewpoints and the potential to unlock new possibilities.

## 2 Research Background

### 2.1 Agential Realism and Entanglement

Agential realism is a theoretical approach rooted in the entanglement theory of physics, conceptualizing the close interconnection of matter and meaning, as well as human beings and the environment. Proposed by physicist and philosopher Karen Barad and extensively detailed in her primary work, “Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning” [3], the theory employs the notion of agential cuts to underscore the process of segregating material agency and situating it within specific relationships and states.



**Fig. 1.** Agential Realism and Agential Cuts

Agential realism introduces the concept of “intra-action” to emphasize that entities (both human and nonhuman) do not preexist their interactions but rather emerge through those interactions. This challenges traditional notions of interaction and causality. Intra-action underscores the entanglement of different elements and the continuous process of becoming through their relations. Also, agential realism stresses the agency of both human and nonhuman actors. It recognizes that material entities, such as technologies and objects, play an active role in shaping social practices. The material world is not passive but actively participates in the constitution of reality.

As illustrated in Fig. 1, agential cuts reject the dichotomy between material and meaning, defining agency interactions with precision. This process is arbitrary, allowing

researchers and observers to opt for different cuts. The flexibility and richness of agential realism emerge from these various cuts, generating diverse understandings and interpretations. In this theory, the separation facilitated by agential cuts signifies an inseparable interrelationship between the observer and the observed. Implicit in the observer's analysis of the object is the notion that the observer is intricately intertwined with the object. This introduces a novel theoretical approach to the intricate interactions of matter and humanity, meaning and the environment, fostering a comprehensive understanding of the entangled phenomenon.

## 2.2 Actor Network Theory

Latour criticizes the concept of “social explanations” rooted in the binary division of society and the individual, which is prevalent in traditional sociology and, in his view, overly simplistic and homogenous [31]. He labels this as the “sociology of society.” In contrast, Latour advocates for a “sociology of relations,” a perspective that emphasizes the intricate and unpredictable interactions among actors in everyday practices, where individual “actor” entities play essential roles in reshaping various aspects of the world [31]. In this framework, “society” is no longer the central focus of analysis; instead, attention shifts to the connections between actors and the dynamic processes through which these connections undergo transformation.

From this perspective, Actor-Network Theory (ANT) provides a unique analytical approach compared to traditional HCI methodologies. ANT places its emphasis on the interrelated and inseparable nature of various actors, including humans, objects, social factors, and technology. Services, in essence, emerge as hybrid networks composed of these human, object, social, and technological elements, requiring their consideration as a unified entity. Changes in one actor are understood to have an impact on the entire network. Therefore, when exploring the meaning of services concerning the affordances provided by these hybrid networks, it's inadequate to focus solely on human actors. It is essential to reevaluate the dynamic behaviors of stakeholders from a perspective that encompasses both humans and their associated actors. This opens up new interpretations that diverge from traditional research and provide insights into novel understandings that take into account the influence of nonhuman actors.

ANT conceives social phenomena as intricate networks involving a diverse array of actors. It adopts a relational perspective in which every actor, be it human, natural object, artifact, or any other element, is intricately interconnected, forming an inseparable network [7]. The actor-network is a concept that not only encompasses human connections but also signifies a condition in which various actors, including humans, objects, society, technology, and nature, are interlinked and function as indivisible entities. Each actor is accorded equal status as a constituent of this network. Latour further characterizes ANT as a “sociology of translation,” asserting that there are no notions of society, social domains, or social bonds. The essence of ANT lies in tracing the translation activities undertaken by the actors that constitute the network.

Despite their distinct theoretical origins, both agential realism and ANT share a common emphasis on relationships and interactions for attacking a variety of wicked problems in our entangled world. They diverge from reductionist perspectives and recognize

the intricate connections within systems. While agential realism underscores entanglement and the inseparability of the observer and the observed, ANT focuses on networks of relations among various actors. The interplay of these perspectives enriches our comprehension of complex phenomena. Therefore, agential realism and ANT contribute to a nuanced understanding of complex systems, each providing unique insights into the relational nature of phenomena while stemming from different academic disciplines.

### 2.3 Posthuman and Speculative Realism

Contemporary developments in posthumanism focus on the interaction between humans and technology, exploring key themes that leverage cutting-edge technologies such as virtual reality (VR) and augmented reality (AR). These technologies aim to enhance human capabilities and perceptions, create new realities, and transcend physical constraints [5, 13, 18, 19].

The ontological shift represents a significant advancement in posthumanism, moving beyond the limits of anthropocentrism to emphasize the status and agency of nonhuman entities [21]. This includes exploring the complex relationships with nonhuman elements, like animals, technology, and the environment, and examining their impact on the shaping of society. Ethical perspectives are also under scrutiny, encompassing relationships with animals, the use of artificial intelligence (AI) and autonomous technology, and environmental consequences—all while taking into account the needs and interests of nonhuman entities.

Furthermore, contemporary posthumanism focuses on the human body and physicality, as well as the integration of humans and technology facilitated by advances in biotechnology, wearable devices, and human-machine interfaces. Environmental posthumanism emphasizes the interconnectedness of humans and the environment, breaking down the traditional human-nature binary. In this context, research explores the ecological impact of human activities and their interplay with the environment.

Lastly, posthumanism explores scenarios in which the boundary between human and nonhuman existence becomes blurred, along with considerations about future existence and intelligence. These discussions are of paramount importance in the context of ethical implications and challenges associated with technological interactions. Recent trends in posthumanism bring forth new perspectives on human-technology interactions, and we are deeply concerned about their far-reaching implications.

Speculative Realism encompasses a collection of philosophical movements within contemporary philosophy that challenge conventional philosophical paradigms [20]. A fundamental characteristic of this philosophical wave is its critical departure from established anthropocentrism and subjectivism. Speculative realist philosophers emphasize the existence not only of human beings but also of matter, nature, and the universe. They argue that these entities possess autonomy and significance.

The connection between speculative ontology and posthumanism can be elucidated through the following pivotal points. Firstly, in their exploration of concepts, both engage in imaginative and creative conceptual investigations, encouraging us to contemplate novel facets of reality. Speculative ontology delves deeply into the nature of reality, whereas posthumanism encourages us to envision future possibilities among diverse entities, transcending our current understanding.

Secondly, in their efforts to dismantle anthropocentrism, both challenge conventional anthropocentric viewpoints. Instead, they offer more inclusive perspectives that recognize the subjectivity and significance of nonhuman entities. Additionally, within their ethical considerations, both frameworks incorporate ethical concerns. Speculative ontology scrutinizes the ethical ramifications of hypothetical scenarios, while posthumanism centers on ethical issues like human augmentation and environmental impact.

Finally, in relation to speculative posthuman futures, speculative ontology and posthumanism share a mutual interest in the future. Speculative ontology explores possibilities that extend beyond the traditional human condition, whereas posthumanism contemplates a future shaped by technological, ecological, and social transformations. In summary, speculative ontology and posthumanism enhance our understanding of reality and existence, prompting us to reconsider our relationship with the world and the uncharted possibilities that lie ahead.

## 2.4 Anthropology and Ontological Turn

The ontological turn in anthropology signifies a significant paradigm shift that unfolded in the early 21st century, representing an effort to question conventional methodologies and reevaluate the nature of human existence and social realities [15, 21]. Unlike earlier approaches that focused on external observations and analyses of culture and society, the ontological turn adopts a distinct viewpoint, centered on the multifaceted and intricate ways in which individuals perceive and engage with their own world [10, 24, 30].

The ontological turn in anthropology exhibits several distinctive features:

1. **Recognition of Diverse Ontologies:** This shift acknowledges that various cultures and social groups hold distinct ontological perspectives. It challenges the assumption of a single, universal reality and underscores the coexistence of multiple ontological viewpoints. Anthropologists embracing the ontological turn value and respect these differing beliefs, striving to comprehend the various realities they entail.
2. **Relational Nature of Existence:** This paradigm shift examines the interrelationships between humans and nonhuman entities. It challenges anthropocentric Cartesian dualism, emphasizing the interconnectedness and interdependence of all beings.
3. **Reevaluation of Subjectivity:** The ontological turn reevaluates conventional notions of subjectivity and personality. It questions the assumption that only humans possess subjectivity and influence over social and natural phenomena. Instead, it offers a fresh perspective on the constituent elements that constitute personhood.

Indeed, the ontological shift in anthropology signifies a fundamental change in perspective. It highlights the significance of comprehending and honoring diverse ontological convictions and the intricate interplay between humans and their surroundings. Through an inclusive and participatory approach, anthropologists aim to cultivate a deeper appreciation of the intricacies inherent in human existence and social reality. This paradigm shift not only enriches the field of anthropology but also makes meaningful contributions to wider discussions on cultural diversity, indigenous rights, environmental conservation, and various other pertinent topics.

## 2.5 Affordance and Thoughtless Act

Suri's concepts of the "Thoughtless Act" and "affordance" hold significance in comprehending human interactions with their environment within the realm of design [45]. "Thoughtless Act", as articulated by Suri, pertains to those minor actions that individuals perform in their everyday lives without conscious deliberation. These actions typically arise from what are known as "affordances" embedded in familiar situations and environments. The notion of "affordance" was originally introduced by Gibson [17] and refers to the inherent potential behaviors and interaction opportunities that an object or environment offers based on its physical attributes and human capabilities. For instance, a chair affords sitting, a doorknob affords turning, and a touchscreen affords tapping. These concepts shed light on how individuals instinctively and intuitively respond to their surroundings, guided by their perception of these affordances. From a design perspective, comprehending these subconscious human behaviors can lead to the creation of more effective designs. By taking into account the affordances presented by design elements, designers are better equipped to deliver intuitive and user-friendly experiences.

Individuals frequently perceive affordances, a phenomenon driven by their adaptive capacity shaped by previous experiences and the contextual factors in their surroundings. This perceptual process often results in actions performed instinctively, with individuals responding in accordance with their perceived affordances. Consequently, unconscious actions influenced by affordances play a pivotal role in how we navigate objects and spaces, fostering innovative approaches and novel uses. When affordances are transparent and intuitive, individuals are more inclined to experiment with diverse methods and explore innovative ideas. The comprehension of unconscious behavior and affordances carries immense significance in user-centered design. Designers endeavor to ensure that design elements align with people's inherent inclinations, facilitating users to engage in an intuitive experience with minimal cognitive load. In essence, the concepts of "unthinking action" and "affordance" constitute fundamental aspects in comprehending people's subconscious behaviors and interactions with their environment within the realm of design, ultimately contributing to the attainment of more effective design solutions.

## 2.6 Safety-I and Safety-II

In a context distinct from anthropology, a parallel trend is emerging, centering around discussions related to the ontological shift. Safety-II, an approach to safety endorsed by prominent international human factors authorities like Hollnagel, places its focus on adaptive flexibility to ensure and enhance safety, in contrast to the traditional Safety-I approach that primarily seeks to eliminate human error [22]. Human error, viewed as a root cause of accidents, is defined as "human actions leading to unintended consequences," and the conventional approach has revolved around the minimization of human error to ensure safety. This involves preventing "deviations from predefined and correct procedures" while emphasizing the enhancement of human reliability. Crucially, the safety of a technical system hinges on its proper functioning. Systems that operate flawlessly contribute to safety, while those that malfunction are prone to accidents. This concept extends its applicability to both physical systems and business processes. In

the pursuit of safety, enhancing human reliability becomes imperative, with the ultimate goal of reducing the incidence of human error to nearly zero.

Safety-I primarily approaches safety from a technical standpoint, operating under the premise that accidents can be averted by correct system operation. Nevertheless, Safety-I, on its own, may not offer a comprehensive solution for accident prevention within complex social and natural settings. In contrast, Safety-II places a strong emphasis on adapting to varying situations and circumstances, aiming to secure safety by enhancing human reliability. Referred to as resilience, this approach underscores the enhancement of coordination competencies. Safety-II represents a reevaluation of the conventional safety paradigm, aligning it with the requirements of contemporary society. The term “resilience” finds applications across diverse fields, encompassing biology, ecology, and psychology, and underscores the capacity for adaptability and robustness. In the context of Safety-II, the goal is to optimize the resilience of the system, requiring a focus on management responsibilities as a pivotal component of the approach.

### **3 More-than-Human Perspectives and Postpluralism**

#### **3.1 Superhuman**

The connection between the concept of “superhumans” and technology is multifaceted. Generally, “superhumans” surpass the conventional duality of nature and society, possessing extraordinary capabilities that exceed those of typical individuals. Technology serves as a facilitator or amplifier for these superhuman capacities.

1. **Human Augmentation:** Technology provides the tools to enhance physical capabilities. Artificial limbs, exoskeletons, brain-computer interfaces, and similar devices have the potential to significantly improve the abilities of individuals with physical disabilities, elevating them to superhuman levels.
2. **Artificial Intelligence and Cognitive Enhancement:** Cutting-edge artificial intelligence can perform complex tasks at high speeds and sometimes exhibit cognitive abilities that exceed those of humans. Machine learning and natural language processing have the potential to enhance human cognition and improve decision-making processes.
3. **Biohacking and Transhumanism:** Through genetic engineering and nanotechnology, biohacking aims to enhance both the body and the mind, potentially paving the way for the development of superhuman attributes.
4. **Cybernetics and Cyborgs:** The convergence of humans and machines through cybernetics has the potential to create cyborgs and amplify human capabilities. For example, brain-computer interfaces can enhance cognition and memory.
5. **Blurred Boundaries:** The interaction between technology and superhuman enhancements blurs the lines between humans and machines, prompting profound philosophical inquiries. This intersection gives rise to profound questions about the essence of humanity and individual identity.

Technology plays a pivotal role in shaping and redefining the concept of “superhuman.” However, it is of paramount importance to adopt a balanced approach that considers ethical considerations and social repercussions.



### 3.2 Hybrids and Boundary Objects

The connection between ANT and hybrids plays a fundamental role in understanding the complexities of the social domain. ANT challenges traditional social theories by presenting a network-centric perspective in which various actors, including both human and nonhuman elements, influence each other. Hybridity, a conceptual framework, explains how diverse actors come together within the network to create new entities or assemblages. According to the ANT paradigm, actors encompass not only humans but also any conceivable entities, such as animals, technology, institutions, ideas, and natural forces. These actors interconnect to form networks that are in a constant state of change. ANT assigns equal importance to all actors and views agency as dispersed and dependent on relationships.

Hybrids are essentially products or combinations that emerge as a result of diverse actors influencing each other, creating new connections and interdependencies. They serve as evidence of the fresh meanings and capabilities that result from these intricate interactions among actors. Hybrids can take on either stable or transient forms, depending on how these interconnected actors come together. The primary purpose of hybrids is to provide a framework for understanding how different actors connect, interact, and shape the social landscape. This concept of hybrids is invaluable for understanding the complexities of organizational restructuring, transformation, and societal evolution. In essence, actor-network theory introduces a novel approach that enables a comprehensive understanding of the vast diversity and complexity inherent in the real world.

Boundary objects are a pivotal concept in sociology and in the realm of scientific and technological research, where they serve various roles across different communities. These objects represent flexible units of information and data, open to different interpretations within diverse communities. However, beneath this diversity, they encapsulate a core identity or content that remains consistent. The concept of boundary objects was first introduced in 1989 by Star and her colleagues [43]. These objects play a vital role in fostering adaptability and resilience among various stakeholders working collaboratively. While they assume varied meanings across disparate social contexts, they share a common underlying structure. As such, they function as a medium for facilitating information recognition and translation between distinct communities.

The concept of boundary objects is widely accepted and applicable across a range of fields, including computer science, informatics, and management. Their adaptability allows them to meet the diverse requirements of different organizations and communities, serving as a medium for effective collaboration on shared tasks. Boundary objects play a significant role by having the ability to reconcile localized understandings among various actors and coordinate them, even in the absence of complete consensus. Furthermore, the concept of boundary objects has expanded and has been applied to facilitate cooperation between disparate communities and domains. They influence the meaning-making process, especially in interdisciplinary and cross-cultural communication, harnessing the potential of digital technologies to enable users to customize boundary objects to their specific needs.

### 3.3 Co-performance and Practice Theory

Co-performance aims to provide researchers and practitioners of HCI with a new perspective on the role of artificial agency in everyday life [29]. Co-performance is developed based on the practice theory [37, 41] and make the design focus from the issue of agency distribution during design to the issue of embodied learning of both human and artificial performers in everyday practice. The perspective recognizes the dynamic differences between human and artificial capabilities and emphasizes the fundamentally inverse relationship between professional design and use.

Agency in the practice theory refers to the ability or capacity to act that is demonstrated through the performance of a practice. According to Schatzki, agency is classified into two types: causal and performance [41]. Causal agency relates to making something happen or helping it happen, while performance agency is the performance of an action in a particular situation, while at the same time continuing the practice of which it is a part. The performance of a practice tied to an entity as a social practice is a socially shared idea of appropriate practice and persists across time and space. Social practice consists of the sum of its performances, each performance representing a reinterpretation of appropriate behavior in a situation. Performance is an important factor in shaping and changing social practice.

Social practices are ideas of appropriate forms of shared and materially embedded action. These are not abstract entities, but concrete knowledge and know-how as “body/mind” [37]. The concept of co-performance applies this to both humans and artifacts, emphasizing that changes in social practice involve concrete learning. In line with repeated performances and altered bodies/minds, ideas of appropriate practices are embodied and changed in the bodies/minds of both humans and artifacts. In other words, what is considered appropriate is adaptive in context and changes over time, but from a design perspective, the collaboration will focus on the changing division of roles and responsibilities between human and artifact body/mind and envision appropriate interactions between them. The co-performance integrates all the elements mentioned by Reckwitz [37] in the situation and integrate them into the embodiment of the practice in a way that makes sense and also summarized by Shove et al. as meanings, materials, and competences [42]. In this way, the social practice is jointly formed by the human and the artifact.

This approach is consistent with the idea of interaction and reciprocity between nonhuman actions and human objectives in HCI, but focuses on the level of social practice rather than interaction, and on the passage of time rather than just specific actions, which offers a new perspective on recursive relationships from a design perspective. Co-performance requires that design must follow at the time of use, and at the time of design involves the embodiment of ideas about specific appropriate performances, and in interaction with the human performer, the artificial performer’s embodied tendencies may lead to “appropriate” performances and inhibit others. Important in this interaction are the differences between human and artificial body/mind and how these can be capitalized both during design and during use.

### 3.4 Invisible Things and Affordance

Smart cities are initiatives aimed at addressing a variety of local challenges through the deployment of cutting-edge technologies to improve urban and regional functions and services [1, 48]. This effort promises increased comfort and added value. By systematically monitoring various aspects within a city and leveraging computer software, processes can be automated, and resources can be used more efficiently. Smart cities have now become a focal point not only for the research community but also for businesses and policymakers alike. However, the distinction between smart cities and digital transformation (DX) has become increasingly blurred, complicating understanding for those involved in these domains. To address these complex issues, adopting an affordance perspective offers a valuable approach. This perspective is well-suited for designing and analyzing multifaceted platforms like smart cities. Smart cities use technology to visualize aspects of urban life that remain imperceptible to the naked eye, enabling them to adapt services in real-time to current conditions. Moreover, these visual representations of various urban phenomena empower citizens to lead comfortable lives while remaining aware of potential urban challenges. However, as exemplified in works like “Hyper-Reality,” we must exercise caution, as an excessive provision of affordances can inadvertently transform society into a dystopian reality [34]. It’s worth noting that visualizing the imperceptible may lead to particular interpretations influenced by the designer’s intentions [46]. Thus, careful attention is imperative when designing visually presented affordances.

As mentioned earlier, the concept of affordance pertains to the potential actions and utility offered by a specific environment or object, often shaped by concealed attributes and elements. This concept is a focal point in the realms of cognitive science and epistemology, closely entwined with imperceptible elements. It encompasses the range of actions and uses implied by an object’s or environment’s characteristics, including not only those attributes readily discernible by sight but also the hidden elements that influence these affordances. For instance, consider a doorknob as part of an object, facilitating the affordance of turning. In this instance, the action of turning, though invisible in itself, holds paramount significance. Affordances associated with an environment or object may extend to include attributes or information not visible to the eye. For example, stairs provide affordances for ascending and descending, yet they are influenced by factors that evade visual detection, such as step height and the presence of handrails. These concealed attributes assist individuals in their actions and decision-making when using stairs. In the realm of technology and systems, invisible elements can similarly contribute to the formation of affordances. Take, for example, a smartphone’s touchscreen, which can detect finger movements and touch pressure, offering corresponding operations and functions. The affordances provided by these touchscreens depend on unseen sensor technology and software features.

In essence, the concepts of affordances and invisible elements share a symbiotic relationship. When we seek to comprehend the spectrum of actions and utilities offered by an object or environment, it is imperative that we consider the presence of these imperceptible elements. Affordances, coupled with the influence of concealed attributes and elements, underpin human actions and decisions, enabling individuals to effectively engage with objects and surroundings. These perspectives hold particular significance

in the context of comprehending postpluralism, where the intricate interplay between nature and society unfolds in multifaceted ways.

### 3.5 Postphenomenology and Multistability

Postphenomenology is a philosophical framework firmly grounded in the tradition of phenomenology [23, 39]. It seeks to uphold the core tenets of phenomenology while engaging in an extensive examination of the profound impact of technology on human experience and perception. Here is a brief overview of some of the central principles of postphenomenology:

1. **Technological Mediation:** Postphenomenology places significant emphasis on the role of technology as a vital medium through which we interact with the external world and with each other. It delves into the diverse forms of technology, encompassing smartphones, medical devices, and more, to investigate how they influence our perception, cognition, and physical bodies.
2. **Embodiment and Perception:** Postphenomenologists delve into the intricate relationship between technology and our bodies, as well as how it molds our perceptions. This inquiry extends to examining how technology enhances our sensory experiences, such as through the use of hearing aids and virtual reality goggles.
3. **Human-Technology Relationship:** Postphenomenology scrutinizes the intricate relationship between humans and technology, underscoring that technology is not merely a tool but an active entity that shapes our experiences and perspectives.

In addition, the concept of “multistability” holds significance in postphenomenology. It pertains to the idea that technology can provide multiple distinct yet stable interpretations or perceptions of the same phenomenon. This concept gains particular relevance in the realm of postphenomenology, which posits that technology introduces a multitude of perspectives into our perceptions. Postphenomenology provides a philosophical framework for comprehending this diversity and intricacy inherent to technology.

Postphenomenology departs from the standpoint that technology actively shapes our worldview and perceptual faculties, and it is far from being a neutral tool. In this context, the diversity introduced by technology implies the potential for a range of stable interpretations and experiences regarding a particular situation or phenomenon. These multiple interpretations can arise from the presence or use of specific technologies, as well as physical alterations. Examples of postphenomenological multiplicity include digital photography and AR. In the realm of digital photography, for instance, the same photograph can assume distinct interpretations and meanings through editing and the application of filters. Consequently, technology introduces a sense of multiplicity into the perception of a photograph. Conversely, AR overlays digital information onto the physical environment, creating a scenario where different layers of reality coexist. With AR, we simultaneously perceive both reality and digital information, thereby infusing multiplicity into our perception. In this philosophical context, postphenomenology’s notion of multiplicity challenges the idea of a single, objective reality and suggests that our experiences are significantly shaped by the technology we engage with. Furthermore, it’s essential to recognize that different technologies yield varying interpretations and experiences of the same phenomenon. Postphenomenologists use the concept of

multistability to examine how technology mediates our experiences and how divergent technologies give rise to diverse interpretations of reality.

## 4 Case Studies

### 4.1 Overview

By integrating the more-than-human perspective, this study delves into three case studies within the philosophical framework of three distinct concepts: postpluralistic ontology, affordance, and, notably, a hybrid perspective.

Postpluralistic ontology represents a philosophical perspective that extends beyond the conventional singular and monistic interpretation of reality. Within this framework, it acknowledges the existence of diverse forms of reality and modes of existence. Postpluralist ontology rejects the notion of a solitary, unified reality, recognizing instead a multitude of distinct levels or modes of existence. These encompass physical, spiritual, social, cultural, and various other dimensions. This ontology underscores the coexistence and interplay among these diverse ontologies, unveiling the intricate nature of reality. It challenges the concept of a solitary, objective reality, opting instead for the recognition of multiple, interwoven realities.

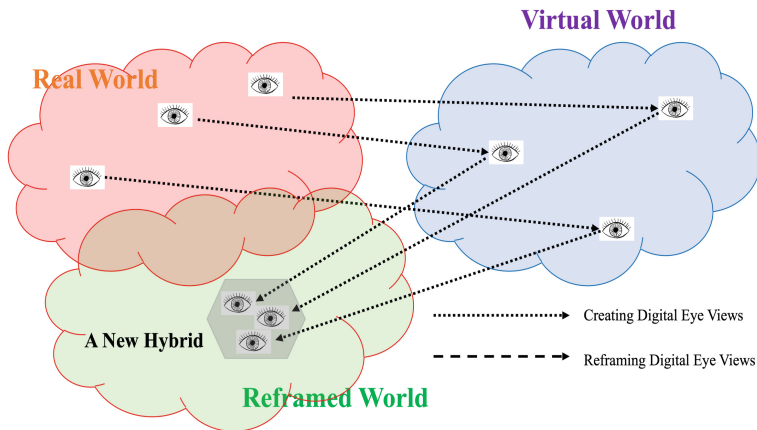
The concept of affordances, as introduced in Sect. 2, is predominantly utilized within cognitive science and ecopsychology to elucidate the possibilities for action and interaction presented by environments and objects to individuals. It posits that environments and objects possess distinct properties and characteristics, shaping how individuals can utilize and engage with them. Affordances are intricately linked to an individual's capabilities, intentions, and perceptions. Recognizing these affordances aids individuals in understanding and discerning their surroundings, enabling them to take action and navigate within them effectively. The significance of postpluralistic ontology and affordance lies in their collective contribution to comprehending the dynamic and multifaceted nature of reality, perception, and interaction. Particularly within the context of postpluralistic ontology, the concept of affordance extends beyond physical attributes, encompassing various ontologies and forms of existence. Affordance is not confined to the physical realm but extends to encompass spiritual, social, and cultural dimensions. Consequently, individuals perceive affordances through their interactions with these diverse ontologies and forms of existence. In a world where multiple ontological layers and realities coexist, it becomes evident that a single object or phenomenon can present several different affordances. Individuals or groups, influenced by distinct ontological perspectives, may discern diverse affordances for the same object or situation. This underscores the intricate interplay between postpluralistic ontology and the concept of affordances.

The coexistence of multiple ontologies and affordances underscores the intricate nature of human-environment interactions. Postpluralistic ontology challenges the notion of a singular, objective reality, while the concept of affordance acknowledges the pivotal role of perception and action in shaping our experiences within these multifarious realities. Both postpluralistic ontology and the concept of affordance share a common emphasis on the diversity of existence and the various ways individuals perceive and engage with their surroundings. By comprehending and applying the concept of affordance within the framework of postpluralistic ontology, we gain insights into how

diverse ontological perspectives shape the perception of affordance within a complex and interdependent world. This approach allows us to explore the profound influence of different ontological viewpoints on our interactions with the environment, enriching our understanding of the multifaceted nature of reality.

## 4.2 Collective Sharing Human Eyes and Ears

The initial case study revolves around a digital platform designed to aggregate a diverse array of perspectives and viewpoints contributed by individuals worldwide. These individual viewpoints, or listening points, are then digitized, as illustrated in Fig. 2, and replicated within a virtual environment for further data processing. The ultimate objective is to reassemble these gathered perspectives and listening points into innovative hybrid entities, which are subsequently presented in the physical world. The overarching goal of this endeavor is to prompt users to recognize the richness of global diversity and broaden their horizons.



**Fig. 2.** A Hybrid Created by Reframing People's Eye Views

The existing design of CollectiveEyes [26] and CollectiveEars [27] has not placed significant emphasis on hybrid viewpoints. Nevertheless, there is an opportunity to broaden the range of applications that digital platforms can offer by taking into account the context of the contributors of these viewpoints and listening points. In a more advanced iteration introduced in [28], known as Posthuman CollectiveEyes, the platform leverages the contextual information of the individuals from whom these viewpoints and listening points are collected. This opens up new potential use cases, essentially suggesting the expansion of possibilities by treating viewpoints and listening points as hybrid entities and constructing networks centered around them.

These examples revolve around the affordances associated with two distinct hybrids. The first hybrid concerns the affordances of viewpoints and listening points contributed by individuals. In the initial iterations of CollectiveEyes and CollectiveEars, the networks

supporting these hybrids were simplified, primarily relying on context-independent viewpoints and listening points. However, subsequent enhancements delve deeper into the network of viewpoints and listening points, considering the affordances of this hybrid in various contexts. The second hybrid focuses on the affordances generated by the amalgamation of collected viewpoints and listening points. The affordances of this hybrid enable the synthesis of multiple viewpoints, facilitating the construction of meaning for the user. For instance, by presenting the user with perspectives from diverse angles of their current location, this amalgamated hybrid of multiple viewpoints can offer a multifaceted understanding of that particular place.

4.3 Gamification Design from a Hybrids’ Perspective

Gamification is a strategy used to enhance user motivation and engagement by incorporating elements and principles commonly found in games into non-game environments [11]. Its application spans diverse domains, including education, business, healthcare, and marketing, among others. The primary goal of gamification is to encourage task completion and promote behavioral changes. This is achieved by introducing various components such as points, badges, rankings, competitions, missions, and rewards, all designed to inject an element of enjoyment and achievement into the user experience. Recognized for its effectiveness, gamification serves as a valuable tool for increasing user engagement, facilitating goal achievement, and instilling lasting behavioral patterns.

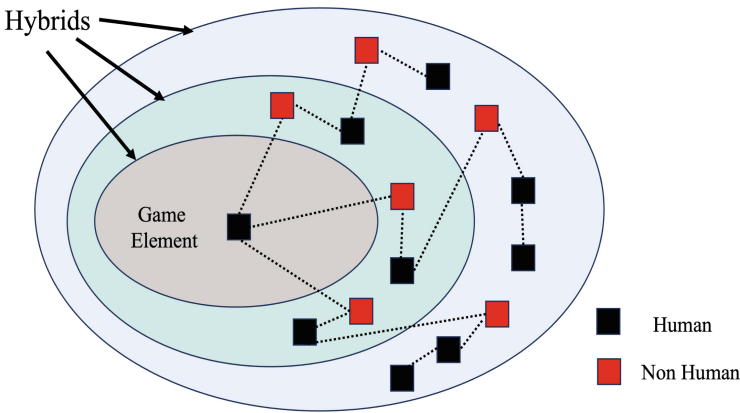


Fig. 3. Hybrids in a Gamified Service

Traditional gamification approaches have primarily focused on using game elements to enhance user motivation. In contrast, this second case study explores the affordances provided by hybrids, which consist of a combination of game elements, human elements, and nonhuman elements, while also considering the intricate interplay between these components. As depicted in Fig. 3, the innermost hybrid consists solely of game elements. The subsequent layers of hybrids include both human and nonhuman elements,



directly interacting with game elements, and they create affordances through their interconnected relationships. The outermost hybrid encompasses not only the human and nonhuman elements directly involved but also those indirectly connected to the process. Through an analysis of these distinct hybrids, we aim to understand the diverse impacts of various hybrid layers on user motivation. Specifically, as the network of relevant human and nonhuman elements within a service becomes more intricate, multiple hybrids that incorporate the same game elements can emerge. In such cases, friction between these hybrids can lead to complex shifts in user motivation. By shifting the focus toward hybrids, this case study provides fresh insights into the design of complex gamification services that cannot be adequately addressed through traditional human-centered design methodologies.

#### 4.4 Paragraphica: An AI-Enhanced Context-to-Image Camera



**Fig. 4.** Paragraphica

The third and final case study is Paragraphica, developed by Karmann<sup>1</sup>. Paragraphica is a context-to-image camera that employs location and artificial intelligence technology to generate visual representations of specific places and moments. These cameras exist in both physical prototype and virtual forms, which can be experimented with. Figure 4 showcases a screenshot of the virtual camera in action. The viewfinder provides real-time descriptions of the current location, and by pressing a trigger, the camera produces a scintigraphic depiction of that description. The camera features three physical dials that govern data and AI parameters, influencing the appearance of the image, much like conventional cameras. It operates by utilizing an open API to gather data from location-related information, incorporating details such as the address, weather, time of day,

<sup>1</sup> <https://bjoernkarmann.dk/project/paragraphica>.



and nearby surroundings. Paragraphica amalgamates all these data points to generate prompts that elaborate on the current location and moment. Using text-to-image AI, the camera transforms these prompts into “photos”. The resulting “photo” is more than just a snapshot; it serves as a visual data point and a reflection of the specific location and, to some extent, how the AI model perceives the location.

In this case study, the hybrid consists of a reality generated by a generative AI. The resulting virtual reality successfully creates a compelling experience by maintaining a unique connection with the real world. The question of whether the world is made up of distinct entities or interconnected relationships has been a topic of philosophical and scientific debate for centuries. Paragraphica suggests that both perspectives hold merit and can offer valuable insights into the nature of reality.

#### 4.5 Discussion

Design methodologies rooted in the more-than-human perspective empower us to transcend and expand our horizons beyond the conventional dualism that separates nature from society and aligns with postpluralism. In traditional service design, human-centered design has long been the standard, prioritizing the user’s perspective [33]. While these conventional design approaches excel at improving user-friendliness and meeting the needs of specific users, they may fall short when it comes to creating services that extend beyond the confines of the user’s viewpoint. Moreover, focusing solely on the user’s perspective proves inadequate for considering the numerous complexities and contexts that extend beyond the immediate scope of the user, such as economic and environmental factors intertwined with service provision.

Affordances, when examined from the standpoint of postpluralism, provide insights into the complexities arising from interactions between individuals and society. The first case study in this section demonstrates how considering hybrids formed from the multifaceted viewpoints and listening points of individuals can reveal new use cases. Conversely, the second case study suggests that integrating gamification into services and aligning it with the affordances of hybrids can lead to more suitable and thoughtful designs. As a result, MTHD, grounded in a postpluralist perspective, does not aim to replace human-centered design but rather to complement it. It offers a path to explore a broader range of possibilities and address a wider spectrum of challenges.

The next crucial aspect to consider is the inherent nature of meaning as conveyed by affordances. In the field of computer science, various approaches attempt to articulate the meaning of a program, employing methods such as operational, axiomatic, and representational semantics [47]. These methodologies aim to provide an explicit definition of a program’s meaning through mathematical or similar frameworks. In this context, it’s essential to view the meaning of affordances as a structural entity. When multiple affordances share a common underlying structure, the possibility arises to abstractly encapsulate these affordances and assign them a universal significance. For example, [28] outlines the affordances of a digital platform as abstract entities provided by the platform. Similarly, [25] elucidates the essence of affordances by naming those offered by digital artifacts as “virtual forms” and imbuing them with a structured framework of value and rhetoric. Hence, in future endeavors, it becomes pivotal to deliberate on

the appropriate structure for the discourse surrounding affordances in this specific case study.

An essential dilemma arising in these considerations concerns how to address the scale of the hybrid. As Strathern astutely notes, real-world hybrids encompass networks of infinite dimensions. However, contemplating an infinite network is inherently impractical [44]. Therefore, it becomes imperative to deliberate on the network's boundaries and establish a specific cutoff point. In contrast to conventional human-centered design methodologies, which often employ exceedingly brief network cutoffs for the sake of simplicity in analysis, neglecting the existence of hybrids, this paper argues that we should extend our considerations to include longer-than-usual network cutoffs. This extended perspective is vital, especially in scenarios involving interactions among diverse human and nonhuman elements. Debates about the appropriate length of network cutoffs are currently ongoing, and we plan to explore suitable methods for defining these cutoffs in future studies, informed by various case studies involving networks of varying lengths.

## 5 Conclusion

The more-than-human perspective represents a departure from traditional human-centered design, with the potential to inject diversity and innovation into the design process. In the future, we anticipate the integration of this perspective into both research and practical applications to advance sustainable design and foster novel innovations. A crucial aspect of future research involves making comparisons. Typically, quantitative comparisons use statistical methods. However, when the objective of the comparison is not to determine superiority but to gain fresh insights and perspectives, traditional vertical comparisons based on scientific methods may not be suitable. Instead, it is essential to approach comparisons by starting with the unique elements being compared. To facilitate these comparisons, one typically identifies common structures or abstract elements and then proceeds to examine the distinctions within those structures. For instance, in [25], the authors explore how values and rhetoric can be applied to the world based on a structured framework known as the Dimension World Model. Nevertheless, when it proves challenging to assume the existence of a common structure, devising meaningful comparisons and extracting insights from differences becomes a complex task. In such scenarios, the more-than-human perspective can introduce novel avenues for comparative analysis.

While traditional technologies like digital transformation (DX) and gamification undoubtedly offer benefits in terms of efficiency and automation, there is an inherent risk associated with overreliance on these tools. Organizations that become overly dependent on such technologies may find themselves becoming rigid and ill-equipped to adapt to the ever-changing landscape [6]. Although algorithms can deliver consistent outcomes and streamline processes, they also have their limitations, including the potential for erroneous decisions stemming from data inaccuracies [2]. Hence, organizations must strike a delicate balance between leveraging algorithms and embracing technology while preserving flexibility. The danger of over-reliance on algorithms is that it can stifle adaptability, jeopardizing an organization's competitive edge and market relevance. In

a rapidly evolving business environment, adaptability and flexibility are of paramount importance, as a failure to exhibit these qualities increases the likelihood of an organization falling behind. Therefore, achieving harmony between algorithms and the organization is imperative. Algorithms can undoubtedly enhance efficiency and automation, but concurrently, organizations must safeguard creativity, maintain sound decision-making processes, and uphold flexibility. This task poses a significant challenge, necessitating organizations to adopt a strategic approach to technology adoption. They should leverage the more-than-human perspective to unlock maximum value through human-machine collaboration.

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