MORE-THAN-HUMAN DESIGN IN PRACTICE

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Introduction

More-than-human issues are inherently systemic and complex in their character. More-than-human design in practice thus requires systemic thinking that is concrete and action-oriented while simultaneously remaining ontologically open, critical and questioning. In this chapter, we present a set of questions and related considerations that highlight our thinking when we have approached more-than-human design as a systemic issue from diverse epistemological positions.

Systems thinking as an academic discourse was developed in the 1920s by biologists, Gestalt psychologists, ecologists and quantum physicists (Hansson et al., 2021). Several shifts of perspective characterise systems theory: from the parts to the whole, from disciplines to multidisciplinary, from objects to relationships, from measuring to mapping, from quantities to qualities, from structures to processes, from objective to epistemic science, and from the 'universal' truths of Cartesian certainty to approximate and situated knowledge (Hansson et al., 2021). In particular, the posthuman perspective on systems does not think of a system as fixed, finite and entirely visible. Instead, systems are understood as fluid and transitional, haphazard, and spontaneous, organic and unforeseen. In the words of Anna Tsing (2015) many systems are "an open-ended assemblage, not a logical machine" (p. viii).

Designers need to take such organic and open-ended systemic aspects into account. However, given the long history of systemic thinking, it is impossible to give a complete and comprehensive overview of systemic and relational thinking for more-than-human design. Instead, we offer four questions in this chapter 1) How are systemic relationships established? 2) How do we select who or what to consider in a system? 3) How can more-than-human systems be mapped? 4) How can designers intervene in systems? We identified these questions by reflecting on the design process.

First one needs to be aware of the wider ideological setting in which you are designing. Then you need to define and concretely illustrate what your systemic design space is. Only thereafter can you begin to consider how to potentially intervene. These questions are also reflected in recent critiques towards systemic thinking within the field of design research where Buchanan (2019) argues that it is important to critique a) whether the system exists b) what is systemised

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c) how the system operates and d) why the system exists. The contribution of our questions is thus twofold. First, the questions may act as concrete and practical guidance in design processes, prompting consideration of various systems thinking approaches in multiple stages of the design process. Second, the questions act as a scaffold for structuring a more nuanced discussion in this chapter of tension in systemic thinking, such as the risk of oversimplification, rendering phenomena invisible or utilizing systemic patterns for oppression. In addition, we point to concrete exercises, methods and probes that can be used to address the four questions. Our questions and their related considerations are intended to help others to problematise more-than-human design spaces as relational and systemic, and encourage efforts to intervene in them, despite their complexities.

How are Systemic Relationships Established?

A first question to consider in systemic more-than-human design is how systemic relationships are established. As illustrated in Figure 10.1 and Table 10.1 there are many parallel discourses on how sustainable and more-than-human systems are established. In this section, we provide an overview of some of these perspectives.

Greek philosophers discussed a 'system' as comprising of smaller components that in some ways form a larger whole. More recent attention to the term started to emerge in connection with ecosystem science and ecology, and later also industrial management discourse. With contemporary discourse connecting design with systems, the concept has in many cases been taken over by casual business talk, while it is inevitably also present in connection with interdisciplinary research, innovation and sustainability transitions. In studies of contemporary design, a systems lens has been an especially salient concept. The field of science and technology studies (STS) emerged between the 50s to 70s to consider large scale energy transitions and their societal governance (e.g., coal mining and labour issues in the UK, nuclear energy) (Ropohl, 1999). Here, actor-network theory (ANT) (Latour, 1999) connected the governance of technology systems with social inquiries connecting both humans and non-humans. A few decades later, transition management (TM) building on 'multi-level perspective' (Geels, 2002) emerged as a more positivist lens to assess dynamics and challenges in managing technology transitions and innovation.

These diverse lenses and discourses illustrate how our understanding of system dynamics is affected by different interpretations of systems. According to Ropohl (1999), some approaches apply a "structural concept" of a system, in which the system is perceived to consist of a set of elements and relations between them. By contrast, approaches aligning with the more contemporary "functional concept" suggest that a system is an entity – sometimes a "black box" – that transforms inputs to outputs according to "specific internal states" (Ropohl, 1999) The interplay of approaches may eventually suggest also a "hierarchical concept," in which sub-system elements connect to a larger "supersystem". Lastly, these three concepts connect in a "general systems theory" that outlines general "laws" for thinking about systems (Ropohl, 1999).

In contemporary sociology, in contrast with the formal rationalist tradition of modernity, one main view is that the world around us becomes structured through communication (Habermas, 1992). In this view, the social reality is created of networked elements emerging through public and expert discourse and interaction, and the system as the realm of formal rationality requires a critical approach. The philosophical concept of "autopoiesis" ('self-creation' (Maturana & Varela, 2012)), originally taken to sociological discourse from biological studies, is suggesting that anything which functions as unity in a system – element, operation, structure, or boundary – results from the systemic production processes, consequently emerging as a subcomponent of the system itself. With a similar notion of the communicative rationale, systems theorist Niklas Luhmann (2012) proposes that a modern society is based on emergent differentiation between innumerable interaction systems and more long-term organizations, however with deep and interconnected hierarchical structures. Consequently, particularly under the condition of 'functional differentiation' that dominates the postmodern era an increasing amount of synchronization is required (Albert, 2016). This latter perception distinguishes between society and functionally differentiated social subsystems, suggesting the existence of both structured hierarchy and emergence between systemic levels of order, while the first viewpoint emphasises the power of meanings in things and communication. In sum, comprehension on various systemic lenses is of need in setting up collaborative design and action with a more-than-human approach.

The underlying philosophical standing points affect how systems are understood. Ropohl (1999) links this with how we understand unity and diversity, holism versus atomism, and the modelling of reality in general. Different perspectives connect with understanding on how systems emergence, equilibriums and transitions are taking place. For example, according to ANT each part of a system should be viewed as equally important and as belonging together in an interactive relationship, while in contrast, TM is more hierarchically structured in projecting a "multi-level perspective" into technological change (Geels, 2002). Figure 10.1 illustrates that while different systemic perspectives perceive the environment and socioeconomic processes as more or less connected, the hierarchies between them can have fundamental variations. The triple-bottom-line model (Figure 10.1, left; Elkington, 1994) separates the environment from human economic and sociocultural activities, thus enforcing an anthropocentric principle that seems integral through emphasis on projecting systems separately from humans despite already facing the Anthropocene (Steffen et al., 2011). By contrast, the nested approach to sustainability (Munro, 1991) (Figure 10.1, middle), suggests a hierarchy that is based on physical reality, however with human activity at the centre. Here sociocultural emerges from the environment, and the economy is an expression of the sociocultural (as in Stockholm Resilience Institute's wedding cake model (*The SDGs Wedding Cake*, 2016)). The nested approach to sustainability progresses logically also further towards more non-anthropocentric models, with a focus on interactions between the different 'realms' of earth–atmosphere, hydrosphere, lithosphere and biosphere – that have offered a main framework for the major international sustainability programmes for over half a century –with a "human sphere" emerging as one important new realm amongst them (Himiyama, 2020). A possible non-anthropocentric model for sustainability (Figure 10.1, right) would perhaps consequently frame human systems only as a minor part of the whole biosphere that in turn develops within the geosphere, atmosphere and hydrosphere.

The examples of different perceptions to sustainability exemplify how the various hierarchical settings and different disciplinary and philosophical emphases play a crucial role in studying and managing interactions within a system. Consequently, to properly set up the stage for an inquiry into systems involving both human and non-human actors, at least the following considerations are necessary to be reflected on. First, the epistemic and ontological standing points need to be openly discussed (see Table 10.1). What is expected and why? What is the focus of possible interactions? This derives into understanding various positions in relation to systems and their dynamics. Second, the above standing points trickle down into questions on how agency and the dynamic settings of a system are conceived.

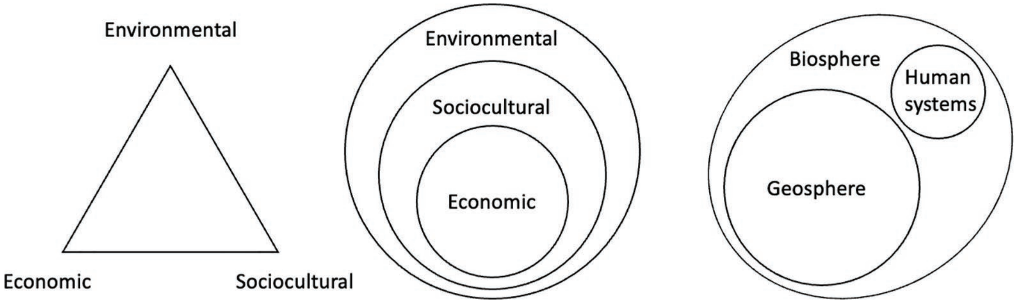

FIGURE 10.1 Different systemic approaches to sustainability issues: triple-bottom line perspective (Elkington, 1994), nested model (IUCN), and a non-anthropocentric model Source: the authors

TABLE 10.1 Elements of discourse, practice and emphasis in sustainable design action today

	Epistemological and ontological approach	*Focus on interaction and development*	*Emphasis for sustainable design*
Singular design approach:	Modernism; techno positivism	Focus on non-human aspects, materials, production networks	Eco-design
Systemic design approach:	Socio-technical systems theory; multi-level perspective	Focus on optimization of human-environment systems	Product-service system design
Pluralistic, transdisciplinary design approach:	Deep ecology; emergent systems theory	Focus on supporting interaction in actor networks, natural systems	Design for sufficiency; critical design

To conclude, an open setting for discussions on a variety of systemic perspectives leaves more room to consider more-than-human design. Perspectives differ on which extent the world can be governed by understanding how to affect systems. Thus, the way we interpret the discourse on systems connects with how we understand relations and agency in a system. Here, a focus on more-than-human design renders the question of agency both more crucial and more complicated. This implies that more-than-human components in a system need to be brought under critical scrutiny, as addressed in what follows.

How Do We Select Who or What to Consider in a System?

A second question to consider in systemic more-than-human design is how we select who or what to consider in a system. In other words, it matters what we assign inside and outside the system – and thus the focus of our concerns. However, it is not always easy to define or name entities of a system. As touched upon in the above section, one of the key characteristics of systemic perspectives, regardless of disciplinary origins, is the attention paid to the relationships between elements. It is through these interrelations that system behaviour emerges. A significant challenge in studying or intervening in systems is to make decisions on how and where to set systemic boundaries, given that each system is part of larger systems in a nested way. In this section, we provide two approaches that may help more-than-human designers frame and scope their systemic focus. The first concept – agential cuts – is a philosophical position, while the second concept is a more practically oriented typology of more-than-human entities in systems. By juxtaposing these quite different approaches to answering the question “How do we select who or what to consider in a system?” we hope to illustrate the breadth of what systemic thinking can be in more-than-human design.

First, it may be beneficial to be aware of the process itself of defining what is inside and outside a system. Helpful for this is the theory of agential realism as proposed by the feminist theorist and physicist Karen Barad (2014). In agential realism, the universe consists of phenomena which are “the ontological inseparability of intra-acting agencies”. While these entities are inseparable – in other words systemic – we may make momentarily analytical separations to better make sense of phenomena. For this, Barad uses the term agential cuts. Here “agential” stands for a focus on the inseparable flow of agency in a system, while “cuts” stands for the momentarily analytical separations of such agency when we choose to focus on a particular phenomenon. Agential cuts thus momentarily stabilise specific qualities of a phenomenon of interest. This is phrased by Barad as the “cutting together/apart within phenomena in a two-folded movement that produces the boundaries through which something is made” (Barad, 2014). Agential cuts can thus be a way of determining what actors are relevant in the system through enacting what is “inside” and “outside”. We introduce agential cuts in this chapter, as a sensitizing concept that may help more-than-human designers navigate analytical spaces where they simultaneously need to recognise “everything as connected” while being able to recognise the uniqueness of situated phenomena. For more-than-human design in practice, a useful and generative agential cut creates a design space that is manageable while recognizing potential systemic consequences. Another beneficial practice could be shifting the agential cuts you are making, taking different perspectives on the design space by framing the space itself in new ways, thus creating conditions for understanding more systemic aspects by re-framing the design brief.

To concretise this thinking Poikolainen Rosén developed “Agential Cutters” cards (see Figure 10.2) that are intended to 1) make designers aware of the agential cuts they are making in their design process and 2) prompt designers to make agential cuts that would not necessarily be made automatically. These cards should not be viewed as fully encompassing or explaining the theory of agential cuts, but rather as probes for exploring its applicability to understand and inspire design processes. Each Agential Cutter includes guiding questions that can help to both open and narrow down the scope of the space related to a particular topic (see Figure 10.2). References to additional readings are provided on the backside of each card to offer paths for a more in-depth engagement. While the Agential Cutters are purposefully ambiguous and open-ended they are intended to be used to stabilise the focus and consider the opportunities for design in this space. For example, one card (see Figure 10.2) prompts designers to define their design space as extending into both past and present, thus requiring considerations of historic injustices (Sheikh et al., 2023) and future consequences. While another card prompts questions on the economic viability of the system, and who economically gains from it. By contrasting different cards with each other, different aspects become important – or inside, with agency – in the design space, helping the designer to be more aware of what is left outside or rendered invisible, seeing how parts are connected and which parts seem incompatible.

Our second example focuses on a more concrete level, on how frameworks and typologies may facilitate a more holistic consideration of diverse systemic entities. In Table 10.2, we offer one example of a typology of more-than-human entities in nature as identified by Veselova and Gaziulusoy (2021), to illustrate how this approach can make more-than-human stakeholders

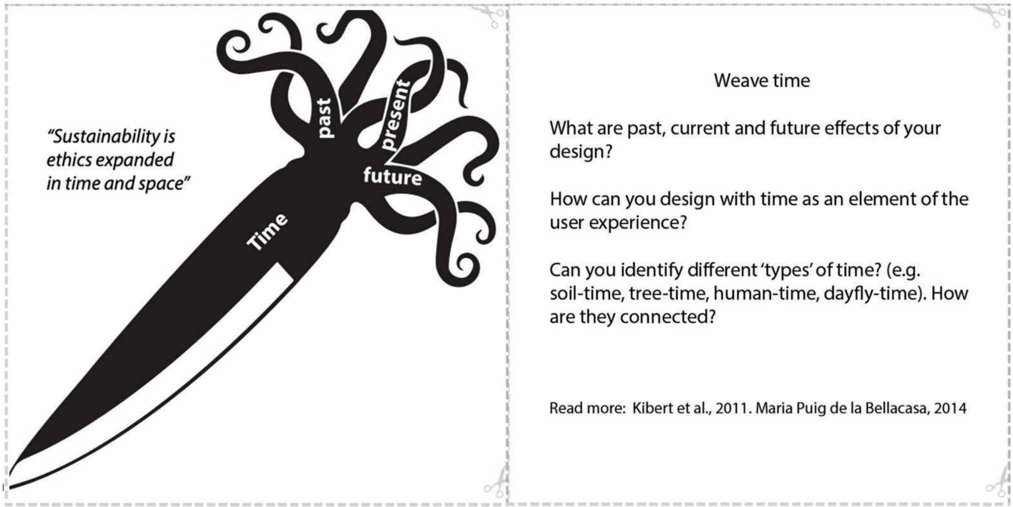

FIGURE 10.2 Example of an Agential Cutter card, front and back. Available at www.poiros.com

TABLE 10.2 A systemic typology of naturally occurring more-than-human entities (Veselova & Gaziulusoy, 2021)

Type	*Example*
Individual organism an organism is typically seen as an independent living entity (but is also a system in itself).	Plants, animals, incl. mammals, birds, reptiles, insects, amphibians, crustaceans and molluscs
Single species collective A collective of organisms from a single species that live together and might have a special organization of their life.	Social insect colonies bryophytes, incl. mosses and hornworts, algae, fungi.
Multispecies collective A collective of living organisms (such as microorganisms, insects and worms) that jointly partake in life processes.	Bacterial collectives, lichens, soil, compost animal manure.
Life Process Flows of elements between living and non-living parts of the biosphere.	Photosynthesis, decomposition of organic matter, respiration, nitrogen fixation.
Living system A location-tied system of living organisms, collectives and the organic and inorganic matter and gasses that jointly partake in life processes.	Garden, lawn, greenhouse, forest and river.
Biogeochemical cycle A cyclical flow of an element between the living and non-living parts of the biosphere).	Carbon cycle, nitrogen cycle, phosphorus cycle, water cycle.
Processes of the atmosphere A short-, mid-, or long-term process in the atmosphere that determines the presence of elements and energetic resources for life processes.	Weather, season and climate.

more present and pronounced in design processes. While the typology was not created with the theory of agential cuts in mind, it can be seen as an example of the making of agential cuts in practice, of conducting analytical framings of "the ontological inseparability of intra-acting agencies" (Barad, 2014) that make sense when we want to practically understand and intervene in and ecology.

This typology was developed empirically using multispecies ethnography (Kirksey & Helmreich, 2010). Veselova spent five immersive weeks in her family's garden in Latvia collecting rich, qualitative data using multiple methods including participant observations, interviews with the garden owners, recording ad hoc conversations of people working in the garden, photos, short and long audios/videos of the garden, its elements and inhabitants. Then Veselova and Gaziulusoy iteratively and collaboratively analysed the data using the DSRP (distinctions, systems, relationships, patterns) model of systems thinking (Cabrera & Cabrera, 2022). This resulted in the typology presented in Table 10.2 of seven key types of natural more-than-human stakeholders. However, typologies are guilty of simplifying, sometimes quite important, complexities of reality. So, Veselova and Gaziulusoy underlined that despite the seven types presented as distinct, a single natural entity represents several stakeholder types simultaneously because of the nestedness of complex systems. There is no easy way to map an observed more-than-human stakeholder onto a single type – an apple tree is an individual organism, a multispecies collective, a part of life processes and biogeochemical cycles all at the same time. Depending on what agential cut you make the apple tree can appear as any of these types.

The implication of this for design is that designers need to understand this complexity of interlinked interdependencies, needs, causes and effects to practice more-than-human design at any level of sophistication that complex systems call for. No stakeholder in a more-than-human world is an isolated entity; it is a part of nested living systems, an entangled part of a collection of several systemic stakeholders. Therefore, in more-than-human design practice, a shift is necessary towards a systemic mental model about who and what is considered a stakeholder. In practice, this might for example imply a shift from viewing compost as a material usable to produce lettuce, to viewing compost as a multispecies collective that sustains the individual organism of lettuce. This shift may help designers better see the interdependencies or needs of all in the system, not just the end outcome of producing food for humans. Similarly, there is a need to rethink what participation means in design, given that almost none of the stakeholder types in Table 10.2 can participate in design processes through direct and deliberate communication. What would design look like were we try to invite the multispecies collective of a compost into our design process? While there is still a significant need for further research and tool/method development to cope with such questions of participation in more-than-human design practice, the typology can assist designers in analysing the stakeholders and interrelationships between them as a starting point. The typology can also assist as a reflective and heuristic tool to make system boundary judgements in more-than-human design projects and enable transparent documentation of the implications of such boundary judgements.

How can More-Than-Human Systems be Mapped?

Once designers have a better understanding of who and what they should focus on they may begin to map them in a system. By representing the connections between entities and elements, designers may gain insights into the interdependencies within a system, enabling a nuanced understanding of how different entities – such as those outlined in Table 10.2 – influence one another. One aim of system mapping is to *understand complexity and dynamics* by revealing intricate relationships between human and non-human entities (Hansson et al., 2021). Another aim is to *identify root causes and effects* by identifying the dynamics of relationships (Hansson et al., 2021)**.** These understandings may lay a foundation for future interventions such as: identifying strategic leverage points, promoting holistic problem-solving approaches, understanding – often unintended – cause and consequence, and facilitating communication and stakeholder alignments.

There are different methods of mapping a system, depending on the purpose, scope and perspective of the analysis. Table 10.3 provides a selection of some mapping methods that can be potentially useful for more-than-human design. Our intention in including this table is to emphasise how different methods make visible different aspects of a system – and that no systems map will ever be complete or fully comprehensive. Another way to phrase it, is that different

TABLE 10.3. Systems mapping methods and approaches that can benefit more-than-human design.

Mapping methods	*Typical application scenarios – what does the approach emphasise in the system?*
Value chains and networks focus on the sequential activities and processes that add value to a product or service within a specific industry or organization. Value networks expand this to encompass the complex web of relationships and collaborations among various stakeholders in a network (Büchel & Raub, 2002).	Business operations, economic systems, industrial systems and production-consumption systems.
Food chains and ecosystem mapping illustrate the hierarchical feeding relationships in an ecosystem, showcasing the flow of energy as organisms consume one another. While ecosystem mapping captures the complex interactions between living organisms and their environment, showcasing the ecological relationships within an ecosystem i.e., it recognises more kinds of relationships than feeding. (Martínez-Harms & Balvanera, 2012)	Ecological research and conservation.
Stakeholder networks map out the interconnected relationships between different individuals, groups, or organizations that have an interest or stake in a particular system or project (Roloff, 2008).	Social systems, project planning and management.
Circular mapping visualises information in a circular format, often used to represent cyclical processes or interconnected elements (Richardson, 1999). Relates to the concept of *feedback loops* described in the section "How can designers intervene in systems"	Process visualization and management.
Spatial mapping depicts the physical layout, arrangement, or distribution of elements within a space, offering insights into spatial relationships (Ramachandra & Shruthi, 2007). This technique harnesses various forms of geographic data, such as soil composition, land use patterns, hydrological features, elevation, or solar exposure. Sometimes 3D scanning is used to transfer the real-world environment into virtual representations.	Urban planning, geography, environmental studies.
Gigamapping is super-extensive mapping across multiple layers and scales to construct a rich picture of real-life complexity (Sevaldson, 2011).	Systemic design and urban planning.

mapping methods will result in different agential cuts. Notably, most of the approaches and methods are not mutually exclusive, meaning that you can shift between these perspectives when mapping a system. We have found that creative design processes often benefit from more informal systems mapping that includes elements from one or several of the methods and approaches in Table 10.3. Next, we provide two examples of how this can unfold in practice in the projects of two of the authors of this chapter “Being with Wetland” by Chen and “Urban Permaculture Farm” by Poikolainen Rosén.

In the project ‘Being with Wetland’ Chen approached a wetland in China from a socio-environmental systems perspective. The work used visual communication tools – such as system maps (see Figure 10.3), introduction brochures and animations – to stimulate and structure systemic thinking and thus allow the complexities of the wetland system to be communicated The project was thus a mix of methods of spatial mapping, ecological mapping and stakeholder mapping (see Table 10.3), leveraging their strength in capturing the complexity of the ecosystem and socioeconomic system. Through these methods, a comprehensive image of the wetland was revealed by combining existing knowledge from natural science and local ethnographic observations. The wetland was considered a living system (see Table 10.2) that supports the individual organisms’ living. The individual organisms living in the wetland, such as fish, migrant birds and plants were considered stakeholders. The stakeholder network mapping methods (see Table 10.3) were applied to critically analyse the potential stakeholders and possibilities to intervene in the social-environmental conflicts. Statistical information related to the ecology system (wetlands, birds) in government reports, journal articles, monographs and press releases was used to make these judgments. The human stakeholders’ relationship was mapped via interviews and participatory observation. However, it is important to acknowledge that this method also has its limitations, such as potentially overcomplicated information, capturing a relationship wrong or incompletely, or illustrating a false cohesiveness. In terms of supporting concrete design ideation and development, the mapping for example revealed a communication gap between the decision-makers and the on-site operators. Therefore, an introduction brochure and a related animation video were designed to build a shared understanding of the wetland, the surrounding environments and the human and non-human activities. These two introductory materials attempted to communicate the wetland’s geological formation process, ecological condition, original flora and fauna and the modern history of social-ecology development to the public in a compassionate, understandable way. The local youngsters, visitors and tourists were considered as the main audience group of these materials.

The study further intervened in the complex social-ecological system by starting with birds’ habitat conservation practices and then exploring the possibilities of restoring sustainable ecological resources within the local context. Here, the composition of stakeholder mapping and ecosystem mapping emphasised the wetland as a living system where humans and nonhumans are actively living with the system and others – and became a tool for communicating these insights to others. This example illustrates how more-than-human systems mapping is beneficial as a *communication engagement tool* for supporting communication and engagement in more-than-human design, fostering collaboration and shared understanding. It is further an *insight generator* in design practice that can spark creative ideas and innovative solutions.

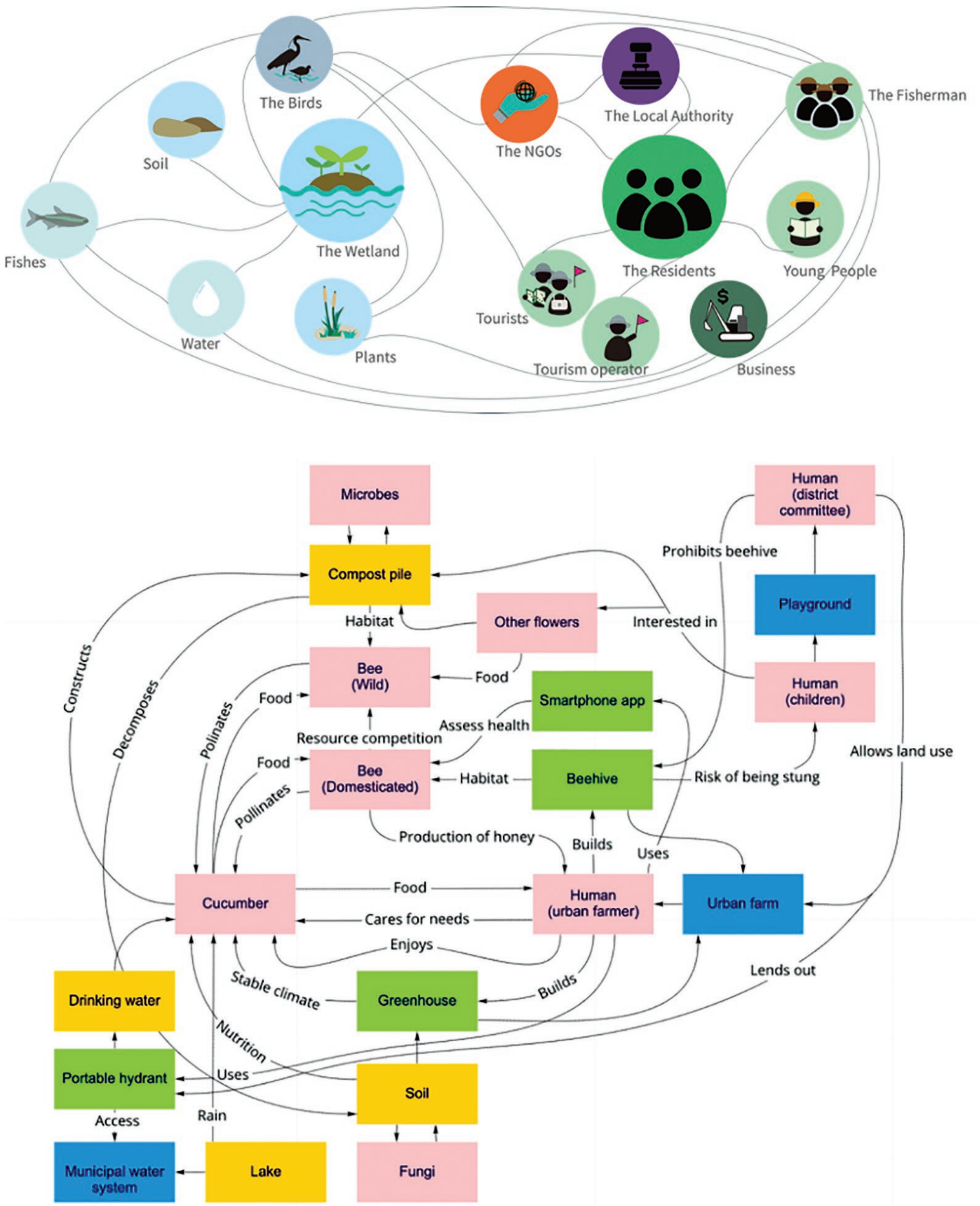

FIGURE 10.3 System maps. Top: Example of a design-oriented system map of a wetland in Tianjin, China. The mapping emphasises both ecological, social and economic relationships. Bottom: Example of a design-oriented system map of an urban farm in Stockholm, Sweden. Naming the relationships and adding a directionality emphasises interactions in the system.

Lastly, it can be used for the *alignment of stakeholders*, as in the example above, including residents, NGOs, policymakers and others, in the pursuit of a common vision and strategy in more-than-human design.

The process of creating the system map involved creatively and freely combining elements of food chains, ecosystem mapping and stakeholder networks (see Table 10.3). At the centre of this system map is the relationship between the individual organisms' bees, cucumbers and humans. Based on insights from a multispecies ethnography, relationships to additional related entities were sketched out such as beehives (single species collective), municipal water systems (an infrastructure for life-processes) and compost piles (multispecies collective). Elements of food chains involve identifying "who eats who" while a focus on broader ecosystem mapping helped to reveal more mutual relationships such as pollination. Elements from stakeholder mapping helped to nuance how the same species (bees, microbes, humans) could take on different systemic roles depending on their relational placement in the system – such as the three ways of being human "urban farmer", "child" and "district committee member", or the two ways of being a bee "domesticated" and "feral". The map also emphasised biochemical cycles such as the recycling of carbon and nitrogen through compositing. This illustrates how the selection of what entities to include in the map is a reflexive process of deciding what matters to design for and who or what belongs in the design space, where inclusion and exclusion happen, thus requiring extra efforts of care and being aware of own biases and potential lack of empirical understanding. Here, naming the relationships and adding a directionality – i.e., identifying and indicating system dynamics – emphasises interactions in the system, thus offering opportunities to identify mutual reciprocity such as how bees feeding on cucumber nectar also act as pollinators. Notably, relationships can be practical, political, economic, emotional etc. Therefore, this design-oriented mapping of a more-than-human system includes for example both that cucumbers provide food for humans, but also that urban farmers enjoy looking at the plants and caring for them. Lastly, the map supported concrete design ideation. For example, an application where the systemic needs could be communicated to the district administration, as the map revealed the administration as a central stakeholder in anything from lending out portable hydrants, banning beehives and contributing with organic matter to the compost.

We want to end this section with some practical considerations on technological and material choices of how to map systems since such considerations are directly relevant to design practice. The two above examples (see Figure 10.3) show a digitally fleshed-out map. However, it is often sufficient and more time-efficient to iteratively sketch a system with pen and paper – as this already offers a great first step of opening the design space as more systemic (see Figure 10.4). The purpose of such "quick and dirty" systems maps is to support processes of ideation and knowledge compiling of the design space for the designer, rather than presenting it as an outcome of the design process to be communicated externally. However, it may sometimes be beneficial to capture and visualise the dynamic changes, expansiveness and interactions of systems. In such cases digital and interactive maps are beneficial – if there is time, knowledge and resources to develop these within the scope of the design project. One prominent example of a creative digital systems map is the Feral Atlas (www.feralatlas.org) which uses the affordances of links to make visible unexpected systemic connections on multiple levels.

In sum, mapping supports working with design spaces as more systemic and relational and offers an entry point into thinking of how to affect the system positively. We will address the intervention in systems in what follows.

FIGURE 10.4 Systems sketched out with pen and paper by students in a design course. In this task, the students start from an IT device they own. They then trace economic/emotional/political etc. relations to at least one other person, non-human being, mode of production and ecology. All individual systems are then connected. This exercise reveals how a design never acts in isolation and how also very human-centred technologies have implications for the more-than-human world. Below is an example of a used Leverage Pointer, front and back. Available at www.poiros.com

How can Designers Intervene in Systems?

When we understand how systemic relationships are established; we have identified who and what to focus on, and have mapped these entities and relationships, a particularly salient question emerges. How can designers intervene in systems?

Several principles for systemic intervention have been identified in more-than-human design research. One way to intervene in systems is by *providing a scaffold* for natural processes to unfold on their own such as in fermentation, or drop glazing (Liu et al., 2019; Ståhl et al., 2017). Others have suggested that it is sometimes most beneficial to *refrain from intervention* (Poikolainen Rosén et al., 2022) in these cases, the system benefits from quitting a particular practice, such as stopping mowing grass to allow flower meadows to grow, thereby providing food for insects.

Another promising direction is to identify *leverage points* in the system (see Figure 10.5). Leverage points are locations within a system where a slight change in one aspect can result in significant system-wide change (Meadows, 1999). High-level points are hard to change but have massive systemic effects. Lower lever points are easy to change but have a limited effect on the system. This typically works by enforcing positive or negative feedback loops. A positive feedback loop is a self-reinforcing mechanism where a change leads to further changes in the same direction. In other words, it amplifies the original change, creating a feedback loop that can either enhance or destabilise a system. A negative feedback loop is a self-regulating mechanism in a system where a change in a particular direction leads to responses that work to counteract or diminish the original change. In contrast to a positive feedback loop that amplifies the change, a negative feedback loop tends to stabilise the system and maintain a relatively steady state. If designers are aware of and understand such feedback loops their design interventions may submerge skilfully in systems, creating the desired change. Likewise, ignorance of how an intervention may enforce a positive feedback loop may cause systemic havoc.

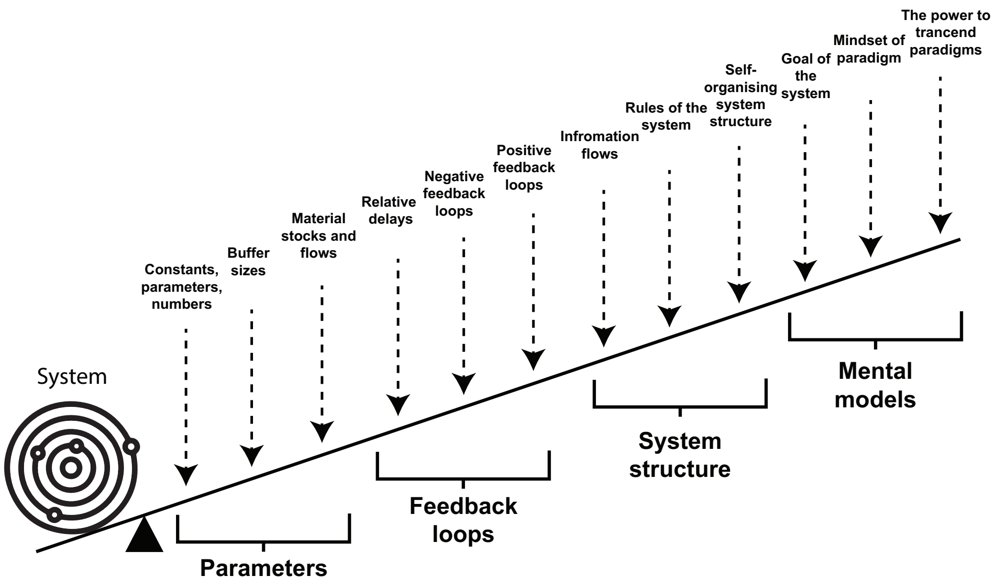

FIGURE 10.5 Leverage points: places to intervene in a system. Our illustration is based on Meadows (1999) and Angheloiu & Tennant (2020).

While the benefits of identifying leverage points are clear, it is not always easy to communicate these to others. Therefore, Poikolainen Rosén developed *Leverage Pointers* cards (see Figure 10.4). Like the Agential Cutters, these cards should not be viewed as fully encompassing or explaining the theory of leverage points but should rather be viewed as probes for exploring the applicability of Leverage Point theory in design processes. The theory is made more accessible as, on each card, a question focuses on how the leverage point can be affected while the back side contains text that explains the leverage point further. Concretely, the Leverage Pointers are intended to be placed out on a mapped system to point at leverage points i.e., places for potential design intervention.

To end this section with an illustration of the concrete applicability leverage points, in the project "Being with Wetland" depicted in Figure 10.3, a low-level (easy to change) leverage point could be to increase the water flow of a dam, i.e., changing a parameter that affects the overall landscape. An example of more mid-level leverage was changing the information flows in ways that increased the public's recognition of wetlands' value and the understanding of wetland reserves, operating systems and policies. This approach of communication contributed to a positive feedback loop as increased community engagement and stewardship for the wetland, in turn, led to more information being spread and discussed, thus resulting in a larger socioeconomic impact for the local authority – and benefitting the reservation area's ecological condition. An example of a high-level leverage point would be to change the people in power in the municipal government to a party with another ideology that would change the policies regulating the wetland, thus changing the foundational rules of interaction in the system or changing the mindset of the community from a human-centred to a more-than-human centred. Here, identifying the leverage points can help designers better understand the systemic impact of their potential interventions.

Concluding Discussion: Human Being and Becoming in More-Than-Human Systems

We have outlined considerations for systemic more-than–human design through four questions: 1) How are systemic relationships established? 2) How do we select who or what to consider in a system? 3) How can systems be mapped? 4) How can designers intervene in systems? The sections focusing on each question relay philosophical grounding balanced with practical possibilities to explore what more-than-human design might mean in practice. What becomes clear in these discussions is the paradoxical position of being a human trying to understand and design for a complex more-than-human world – i.e., the impossibility of capturing all details and complexities of reality yet striving to partly do so – and the messiness and entanglement of designer researchers being beings that inevitably affect systems both physically and socially through our mere presence.

In dealing with this, we have arrived at a reflection regarding the epistemology and performance of more-than-human design (MtHD). The MtH designer researcher learns and performs MtHD, by themself or with others, often with the responsibility of taking decisions that influence research outputs within MtHD. In our examples, this involved utilising the approach of agential cuts to make sense of complex systems by mapping stakeholders in a system in Chinese wetlands and Swedish urban farms and categorizing typologies of stakeholders as in the work of multispecies ethnography in Latvia.

In such processes, making educated decisions is intrinsic to the role of a designer researcher. However, these decisions are limited by the perceived involvement or embeddedness within systems. As MtH Designers we are often periodically and sporadically entering systems of study, and it is that particular entrance that might affect the system in unintended or intrinsic ways. For example, the introduction of a designer researcher in an existing complex ecological environment might result in rippled effects; on a very physical level, this might involve increased local temperature generated by bodily heat, additional carbon dioxide concentration from respiration, or disturbance of wild animals and insects. Accounting for such implicit change is thus necessary. In the words of Donna Haraway (2016, p. 101), "[it] matters which stories tell stories, which concepts think concepts. Mathematically, visually and narratively, it matters which figures figure figures, which systems systematise systems". Right now, we – as humans, designers and researchers – are the ones telling the stories. Thus, a meaningful starting point for human designer researchers when approaching design as a systemic multispecies challenge is an in-depth reflection on assumed hierarchies and agency of more-than-human phenomena within processes of design. It is a matter of ethics, a "looking around rather than ahead" (Tsing, 2015, p. 22) – a certain noticing of who or what gets to tell their stories, which histories allow agency and where voices are (un)heard. This also means recognising that a political dimension is embedded into both human and nonhuman living. Who or what can afford privileged and unreserved storytelling by highlighting their place in systems (Tsing, 2015)? Here, multispecies storytelling through mapping– as shown in the case of the "Being with Wetland" project where local youth was engaged in mapping the role of birds in their wetlands – is a way of focusing on more-than-human narratives in a systemic understanding of a whole.

In the introduction to the chapter, we discussed Buchanan's critiques (2019) arguing that it is important to critique whether the system exists, what is systemised, how the system operates, and why the system exists. Tied particularly to the discussion here on the human physicality of being in systems, *whether the system exists* is directly delimited by the human perception and sensorial ways of experiencing the world around us since we cannot escape our human bodies. The positioning that this entitles us to is the ability to perceive what is visible to us and make sense according to logical reasoning. However, as mentioned when discussing the development of the more-than-human typology in this chapter, frameworks formed by us as designers and researchers *might be guilty of oversimplifying rather important complexities in reality.* This leads to an important yet slightly ironic conclusion: performing MtHD meaningfully links to our understanding and acceptance as human stakeholders – physiologically being a human being, and existentially, of our *humanness.* This ties in with an emphasis that was placed at the beginning of this chapter, that *more-than-human design in practice requires systemic thinking that is concrete and action-oriented while simultaneously remaining ontologically open, critical and questioning.* Rosi Braidotti and Simone Bignall (2019) similarly discuss becoming-human. In their words:

> The 'posthuman turn' – defined as the convergence of posthumanism with postanthropocentrism – is a complex and multidirectional discursive and material event. It encourages us to build on the generative potential of the critiques of humanism developed by radical epistemologies that aim at a more inclusive practice of becoming-human. And it

> also supports an opening out of our conceptual imagination, the power (potentia) of thinking beyond the established anthropocentric frame, towards becoming-world.
>
> (p. 1)

Becoming-human is thus a process that happens alongside MtHD thinking and performance, in both time and even by being entangled in linear and temporal immersion, growth and development of the person doing MtHD thinking and performance (with its subsequent interactions) within a complex world. *We ourselves are shifting, and thus we shift the systems around us consequentially*. This is neither a positive nor negative suggestion, but simply the way our relational world works. Thus, performing MtHD has its inbuilt assumption – that we are only able to observe and explain what we sense and know at a particular time of how the world is, and who we are. Relating to more posthuman thinking, Donna Haraway in *When Species Meet*, also suggests this similarly in saying that a part of being – or *becoming* – human thus means, "to become worldly and to respond" (Haraway, 2013, p. 41). Therefore, "to respond", is to be reflexive and iterative in exploring the four questions within this chapter. As these questions are not final destinations in themselves, but rather, points of departure for further exploration.

In conclusion, it is both a challenge and an opportunity to creatively structure the inherently emergent and complex more-than-human world through designerly systems thinking methods. There are myriads of ways to go about systemic thinking in more-than-human design, of which this chapter has only briefly touched upon a few. Beyond our four central questions for guiding design processes as more systemic we thus ask the reader:

- How can we make more space for more-than-human systemic thinking in the design process?
- What are the hegemonic ways of systemic thinking in contemporary design and what is made 'possible' or 'impossible' by these approaches?

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