

More-than-Human Biographies: Designing for their Endings

Ron Wakkary

This chapter is an exercise in *designing-with* (Wakkary 2021). Designing-with is a reworking of design that foregrounds relationality and shared agencies in more-than-human worlds. The approach articulates a practice of designing in which humans are neither central nor exceptional but are ecologically interdependent with the nonhuman world. Designing-with creates *things*. Things are nonhumans made by both humans and nonhumans. And so, in writing about things, it is unsurprising that a bird feeder, a water lily pond, a concrete sink, traffic lights, cars, bicycles, gutter spouts, a peanut butter shrub, zoning bylaws, policies, and mobile phones populate this chapter. Despite the convenience of naming things as if they are self-contained and fixed, things are fluid, and without distinct boundaries given they are fundamentally relational. Things are co-constituted meaning they only make sense in relation to other things and the multiple species worlds they cohabit. And so also present in this chapter are Northwestern crows, New Caledonian crows, Hawaiian crows, African elephants, *Mansonia* mosquitoes, humans, comet goldfish, racoons, blue mussels, hazelnuts, climbing hydrangea, and *Wanvisa* water lilies. Some of the naming of these living beings preceded settler occupations so the Northwestern crow is first known as *spó:l* in the Coast Salish dialect of Halq'eméylem, on whose unceded lands I am on as I write, or the Hawaiian crow is first known as *alalā* and the elephant is *oldome* in Maa, the language of the Maasai. In this more-than-human world there are no universalities underlying concepts like humans or crows despite what the language suggests. Rather in its place are differences grounded in the intersectionalities of race, colonization, and gender in human life, such as my presence as a settler immigrant from a family of Javanese, Sundanese, and Menadonese. And situatedness such as the very Northwestern crows who nest during breeding season in our neighborhood set at the city limits of a century ago, in our backyard, perched in the gutter spouts of our neighbors or in our peanut butter shrub.

The discussion in this chapter is about designing-with and cities. In designing-with, a designer is not exclusively human but is an assembly of humans and nonhumans in which each have qualities of agency or agentic capacities, and so together or collectively they design (Wakkary 2021). A designer is also co-constituted, meaning that it only makes sense in relation to the things it creates and how together, designer and thing cohabit more-than-human worlds. In designing-with, the concept of *biography* accounts for this co-constitution of designer and thing. A biography is an identifiable human and nonhuman life force (creative entity) that constructs and inscribes itself into the world. Further, the notion of a biography is prescriptive, it aims to make clear that the *good* in designing things is the cohabiting of the designer and thing in a shared world that is accountable for what it inscribes and leaves behind (Wakkary 2021). For example, the *Bag with handle of weldable plastic material* or more commonly, the plastic bag, patented in 1965 by the industrial designer Sten Gustaf Thulin and the company Celloplast, became a global product of convenience but also one of ongoing colossal waste and toxicity, environmental injustices, and belated legislations to curb its use. All of this together, form the shared biography of the plastic bag, Thulin, and Celloplast (Thulin 1965). We may be closing in on the end of the plastic bag biography—yet its last chapter has the resiliency to last for up to

1,000 years only to result in microplastics that will never decompose (Stevens 2001) Other biographies, extant ones like a traffic intersection, are very much in the process of being written and rewritten.

The concept of biography conceptualizes a practice of accountability by identifying the relations that gather to create a thing and keeping these relations, and new ones that form, visible throughout the life of the biography through to its end. This concept readily applies to things that can come to constitute cities. An important feature of biographies is that it makes explicit that things have endings long after their human use and value. This contrasts with the blinding attention given by designers to the beginning of a thing, its newness or perpetual promise of human value. An imaginary of progress that hides and forestalls the eventual ending of things. This understanding of biography is best acted upon while making or remaking things, well before their endings so in essence things can be designed for their ending rather than their beginnings as a strategy to better cohabit. While arguably clear as a concept, there is much work to be done to reveal, articulate, and understand biographies better, especially their endings. This chapter sets out to do that by seeing things as fragile, breaking down, and without human value to make visible their endings or signaling of their end.

The aims of this chapter are two-fold. Firstly, I want to extend the idea of biographies, with particular attention given to their endings, to understand things and cities in more-than-human terms. Secondly, the chapter aims to get a glimpse of futures with respect to cities. Not through the imaginary of human innovation and progress, but rather to trace possible futures as endings that highlight the nonhuman temporalities and nonhuman futures that are a part of the biographies of things.

This attention to the end of biographies comes with the commitment to more-than-human worlds that require care, attention, and attunement to nonhuman agencies, multi-species, and nonhuman temporalities that constitute and inform things and their gatherings. Gathering is what others have called geo-graphs (Sundberg 2014), assemblages (Deleuze and Guattari 1987), and networks (Latour 2007) and in designing-with refer to the coming together of humans and nonhumans to design a particular thing or to consider designing (Wakkary 2021). More-than-human worlds epistemologies have long been central to and are ongoing within Indigenous thinking and ways of knowing (Lewis et al. 2018; Tuhiwai Smith 2021) and much more recently in Western European thinking (e.g. (Latour 1999; D. Haraway 2003; Braidotti 2013; Puig de la Bellacasa 2017)). Further, it is important to hold more-than-human thinking to its commitments and goals of expansiveness and pluriversality through decolonial approaches and critical Indigenous scholarship such as the work of Vanessa Watts (Watts 2013), Juanita Sundberg (Sundberg 2014), Joanne Todd (Todd 2015) and others. More-than-human approaches have been applied to understanding or conceptualizing cities, including cities as multispecies configurations that raise deeper questions of sustainability (Fieuw et al. 2022), strongly question the planning of cities around the ontological exceptionalism of humans and the need for human and nonhuman co-production (Houston et al. 2018), all of which calls for decentering the human in the making of cities (Forlano 2016). Within more-than-human and human-centered thinking, grasping a metaphor for the complex entanglements that make cities is an ongoing effort.

The philosopher Graham Harman argues a city is an enduring ontological object that cannot be reduced to its components of people, culture, and infrastructure that are always changing (Harman 2016). The architect and design theorist Christopher Alexander argued a “city is not a tree” rather it is a “complex fabric” or a semilattice, a complicated mathematical abstraction that sees a well-designed city as sets of overlapping structures rather than a centralized pattern like a tree (Alexander 2015). The design and media theorist Shannon Mattern updates and extends Alexander in arguing that a “city is not a computer” (Mattern 2021). She counters and critiques the appropriation of Alexander’s semilattice city into a networked and algorithmic city, a metaphor that lurks behind every variation of the idea of the “smart city” (see, Eremia, Toma, and Sanduleac 2017). Mattern reclaims Alexander by ironically reinvoking the tree metaphor as a corrective to the city as a metaphorical computer. She offers “grafting” as a way to see how independent and local structures attach themselves onto other structures in ways that decentralize and hybridize. Grafting is a technique in which tissues of plants are joined to grow together like grafting a branch from one tree onto another. This chapter also explores the idea of a decentralized city but as a collection of biographies. The idea fits in part with Mattern’s observation of city administrators and corporate partners “grafting twenty-first-century ‘smartness’ onto existing urban scaffolds and substrates” like attaching sensors and cameras to legacy infrastructures such as utility poles and traffic signals (Mattern 2021, 5). I see this “grafting” and want to investigate it as different biographies, like what comes together to form a water lily pond or a traffic intersection, and in turn parts of a city. More apt descriptively is the metaphor of a braid offered by Robin Wall Kimmerer (Kimmerer 2015). For Kimmerer, her braid of stories is the coming together of Indigenous ways of knowing, scientific knowledge, and her story as an Anishinabekwe scientist to address what matters most. In this chapter, I humbly borrow the braid as a heterogeneous gathering as an ongoing life of a place, a coming together to form a biography, and the braiding of different biographies to make and unmake a city in ways that matter.

The Biography of a Water Lily Pond

Last summer, I created a water lily pond in my backyard; unfortunately, it lasted no more than a week. I say I created it but in fact there were many humans and nonhumans who gathered to make (and unmake) the water lily pond with me. I say “pond” when it was a concrete sink of less than a meter squared and half a meter deep that contained the water, soil, pottery shards, gravel, rocks, and two Wanvisa water lilies. The sink came with our house that dates to 1909. So, both the house and the sink are quite old by Pacific Northwest standards. Sometime ago, my partner, Resja and I hauled the sink from the dirt floor basement of our house into the garden. It is a double basin concrete sink once used for laundry that now sits at the foot of the small deck that extends from the main floor of the house. In one basin is soil, a fern, and a climbing hydrangea. In the other, for a time, were water and water lilies.

Wanvisa water lilies are small but hearty water plants that survive year-round in the Pacific Northwest. I plugged the sink basin for the “pond” and purchased the lilies from our local nursery. The lilies sat on shards of pottery, rocks, and gravel so they just broke the watersurface. In a matter of days, I could see *Mansonia* mosquito larvae wriggling just below the surface of the

water. The mosquito eggs could have come with the lilies or were already in the sink. It would be a matter of days before they would become adults. The difference between a water lily pond and a mosquito hatchery is no doubt a very blurry line. Not wanting to breed *Mansonia* mosquitoes or any mosquitoes, the options were to install a water bubbler that disturbed the eggs but not the lilies, use a water dunk, which is a chemical pesticide to kill the larvae, or add fish like comet goldfish to my pond that would feed on the larvae. I did not want to use pesticides for all the obvious reasons.¹

My partner Resja likes to feed the crows who are often around our house. Normally, all the Northwestern crows in the city roost together a few kilometers from where we live. This is a daily migration, so come evening time our sky is filled with murders of crows from all over the city flying to their roost. During the day, the crows tend to return to the same place and during the breeding season, they forgo their citywide migration to roost nearby with their young. Whether they reside only in the day or evenings, too, our backyard is home to resident Northwestern crows. Resja calls the male crow, Cy, after the painter Cy Twombly. At first, Resja would place dry cat food on the railing of our deck for Cy, his mate, and younger crows (see Figure 1). On occasion other crows would also come by. While feeding, they often knocked food off the railing that would at nighttime attract raccoons looking for leftovers. To remedy the situation, my son Andre made a crow-feeder with more surface area than the deck railing. The crow feeder was attached to a post of the deck, about three meters directly above the concrete sink. And as it turns out, the crows would still knock food off the feeder and into the water lily pond.

¹ For a detailed discussion of the relationship between humans, cities, and mosquitoes, see the chapter by Jonathan Metzger and Jean Hillier in this same collection.



Figure 1. Northwestern Crow we call Cy, on our deck railing (photo by the author)

To “solve” the *Mansonia* mosquito larvae problem, I purchased three comet goldfish that are typically sold as food for larger fish. I thought it was the perfect solution. Not only would the goldfish eat the larvae when they hatched but during dormant periods, they would be fed by the leftover dried cat food that fell from the feeder each time the crows were fed. The water lily pond was a gathering of two *Wanvisa* water lilies, three comet goldfish, a concrete sink, water, pottery shards, rocks, gravel, short lived mosquito larvae, and spilled cat-food-cum-crow-food (see Figure 2).



Figure 2. The peak of the water lily pond biography (photo by the author)

However, this was not the final equilibrium of this gathering. More would gather in the biography of the water lily pond. And it was by no means the “perfect solution,” at least not from my human perspective. It was the perfect solution for the family of racoons that visited nightly. The five toes of a racoon’s front paws are quite dexterous so they can easily grasp objects like doorknobs, latches, lids, pottery shards, rocks, potted water plants, and fish. A racoon’s keenest sense is its touch as its front paws are very sensitive. And, as I learned later, the sensitivity of its paws increased when underwater such that, when possible, racoons will examine objects in water.

One further bit of information about racoons necessary to understanding this biography is that they are omnivores.

No doubt, you the reader are far ahead of what I am about to write. During the week of the water lily pond biography, after the goldfish became part of the pond, I awoke each morning to one devastating scene after another within the basin of the concrete sink. In the sink were remnants of whatever existential drama played out the night before. The first morning, the Wanvisa water lilies were uprooted or clearly moved, the pottery shards were moved aside, and I could only see two of the comet goldfish in the muddied water. At the time, I did not fully suspect the racoons. I spent the next day adding large flagstones of Pennsylvania Sandstone to better anchor the potted roots of the lilies and create hiding spaces for the fish. And each morning the devastation was even worse as there seemed to be no rock too heavy or large to be turned over. The Wanvisa water lilies appeared as if they were plucked out of the water, roots and all, closely scrutinized, then dropped back in the sink. The goldfish were eventually eaten, yet even still each morning the lilies were uprooted, scrutinized, and left barely alive. Even without the fish, the racoons would hunt and peck for morsels of cat food lying at the bottom of the pond and in the roots of the lilies. The lives of the water lilies and the comet goldfish were over. The water lily pond was dead, its biography had come to an end.

A designer biography in its most common parlance is easy to understand as biographical relations between designer and designed, like the architect Marina Tabassum who designed the Bait ur Rouf Mosque in Dhaka, Bangladesh (Griffiths 2017). There is also a biographical relation between me and the water lily pond. And unlike the Bait ur Rouf Mosque, the water lily pond is only known by my family and as a backyard catastrophe, brought up over dinner for a good laugh. However, in designing-with, a biography is much more. In this meaning of a biography, the water lily pond is a thing. Unlike Harman and his philosophy known as *object oriented ontology* (Harman 2018), I don't look upon the water lily pond as an ontological object distinct from the material effects it has on the world. Though like Harman, I see the water lily pond as more than its components, what in a biography would be seen as a gathering or assembly. As I have shown, the biography gathered many humans and nonhumans in its making or coming into being in the world. But what is important with respect to the designing-with of the pond, are the relations between what gathered to make it and what effects or agentic forces were at work in this collective of humans and nonhumans. That is designing-with water, Wanvisa water lilies, *Mansonia* larvae, Northwestern crows, crow feeder, concrete sink and so on to produce the water lily pond. Each of these influenced the outcome, pushing the design in different directions, creating new outcomes like the addition of comet goldfish and hiding places for the fish. These are forms of nonhuman agentic forces that I'll elaborate on further in the chapter. For now, the biography reveals the relationalities at work in designing and an expansive understanding of what or who is designing. While the designer is the collective gathering, in designing-with terms, I hold a special place as a *speaking subject*, the key human actor in the assembly of the water lily pond. I have language that is shaped by my particular situation and history, and can rationalize the gathering to others and be at the origins of the biography: "wouldn't it be great if we had a water lily pond in that old concrete sink in the garden?" As the speaking subject, I am accountable for mobilizing the gathering, getting others—especially nonhumans—to participate

in the making of the thing, and for dissuading others from joining the gathering like the *Mansonia* larvae. This requires intense listening and striving for other intimate connections. As the speaking subject, I have the dubious role of speaking on behalf of the assembly, though I could never be sure if I was speaking for them or for me.

The short life of the biography of the water lily pond allows the retelling of its story and to see the dynamics and complex gathering before it became too rich and entangled to ever tell properly. I can account for how it inscribed itself in the world, becoming part of the urban ecology of our backyard and a family project of kinship across species. In this sense its effects were minimal or largely compatible with whatever else it cohabited with during the week. The story also includes the end of the biography and what is left behind. Its end in part was a result of belonging to an urban ecology that includes racoons. It is not that the racoons ended the thing rather the overall agentic forces at work created the outcome and brought the racoons to the gathering. What did it leave behind? Given that I did not use pesticides, the ongoing effect of the water lily pond is negligible. The ravaged lilies dried up and were thrown on the compost. The water drained into the soil. The Pennsylvania sandstone and pottery shards were redistributed in the garden and the concrete sink remains, partly filled with gravel and crow food (that the racoons still eat). Interestingly, the concrete sink is its own biography, over a hundred years old that was grafted onto the temporary water lily pond in line with Mattern's tree thinking (Mattern 2021). It remains, perhaps to be a legacy addition in another biography not unlike old utility poles or other legacy infrastructures of a city. Throughout this episode, the resident crows, incidental but key actors in the biography, observed the life of the water lily pond from above, involved but unconcerned.

The Biography of a Traffic Intersection

Northwestern crows feed on blue mussels. In Vancouver, near the water, I often see broken mussel shells that have been dropped by crows onto rocks, sidewalks, or roads so they can get at the protein inside. Similarly, across the Pacific Ocean in Sendai Japan, Carrion crows have been observed dropping or placing walnuts in traffic intersections to be run over by cars to be cracked open and eaten (Nihei and Higuchi 2001). Crows are well known for their resourcefulness to adapt to urban environments and incorporate things, such as the toolmaking proficiency of New Caledonian crows (Jelbert et al. 2018). These are examples of natureculture and the idea that human and nonhuman animals are “prosthetic creatures” (Wolfe 2010). Nihei and Higuchi claim that the walnut cracking routines of Carrion crows began in the 1970s in Sendai at an intersection near a driving school and spread from there (Nihei and Higuchi 2001). I now turn my attention toward another intersection that is in The Netherlands that also gathers car traffic lights, pedestrian traffic lights, bicycle traffic lights, bicycles, cars, mobile phones, drivers, pedestrians, and cyclists. In all likelihood, at times, the odd crow may well have perched on the traffic lights in this intersection. The biography of the water lily pond was clearly vital, especially since it gathered nonhumans that were very much alive in the biological sense. However, in this biography of a traffic intersection, I can show how a biography can be equally animated by nonhuman forces that do not require biological life.

In 2017, in the town of Bodegraven in The Netherlands, a prototype called +Lichtlijn (Ricker 2017) was installed at the intersection of Goudseweg and Vrije Nesse (see Figure 3). The system embeds LED strips in the sidewalk that are synchronized with the existing traffic light system. +Lichtlijn is at the right angle for mobile phone users who, while looking down at their phones, can see the traffic signal within their line of sight. The concept came under criticism from the Veilig Verkeer Nederland (Safe Traffic Netherlands) for “rewarding bad behaviors” that can be assumed to be the dangers of technology overuse (Scully 2017). However, the intersection like other traffic intersections, in designing-with is seen as a co-constitution through technological use that does not separate us from technology. What Donna Haraway sees as cyborg relations in which the boundaries between humans and technologies break down (D. Haraway 1985). In the context of a biography, +Lichtlijn helps to reveal how a traffic intersection redesigns itself and inscribes itself into the world through the agency of inert materials, technologies, and things themselves.



Figure 3: +Lichtlijn by HIG Traffic Systems in Bodegraven, Netherlands (source: HIG Traffic Systems).

So far in this chapter, I have used phrases like “nonhuman agency” or “agentic forces.” In designing-with, the specific term is *agentic capacities* (Wakkary 2021). This concept draws heavily on Jane Bennett’s description of nonhuman agency as a matter of affects rather than consciousness. Bennett in turn draws on the work of Diana Coole who investigated the idea of distributed agencies that resulted in political actions (Coole 2005). Agentic capacity can be described as having different qualities such as *efficacy* and *trajectory* (Bennett 2010, 31). Efficacy is the creative force of agency, the ability to create new things; trajectory is the direction of the force, a movement or progression without suggesting “purposiveness.” In the biography of the water lily pond, I described how the relations between those that gathered fostered a trajectory that moved the concerns in making of the water lily pond in one direction or another. From creating a water habitat for the lilies to working with the birth and feeding cycles of mosquitoes and goldfish. And how the efficacy of the agentic capacities created new participants and new configurations like the comet goldfish and stone hiding places for them.

Thinking about this in relation to the traffic intersection in Bodegraven, the addition of the mobile phone user to the gathering brought its own agentic capacities to the biography that in many respects added to a trajectory, a direction that in a sense precipitated the +Lichtlijn and it became a matter of efficacy, the creation of something new. However, in the ongoing biography of the intersection and its past, how different is this from creating traffic lights for pedestrians and cyclists in addition to lights for cars? Designing-with speaks to another agentic capacity drawn from Bennett’s descriptions of *causality* (Bennett 2010). Here Bennett refers to Hannah Arendt’s distinction between “origins” and “causes” (Arendt 1951). With agentic capacities, there is no linear cause and effect; rather, agency plays a role at the origins of an effect, which can be quite indeterminate (Bennett 2010, 33–34). As I described earlier with the water lily pond, I was at the origin as the speaking subject of that biography. The same can be said about HIG Systems who are at the origins of the +Lichtlijn as the speaking subject. But unlike the simplicity of the water lily pond, the +Lichtlijn is taken up into the larger assembly or biography of the traffic intersection of Goudseweg and Vrije Nesse. As Mattern would say, +Lichtlijn has been *grafted* on to the existing configurations or another biography to hybridize and become a part of it. HIG Systems is one speaking subject in a past of multiple speaking subjects that were at the origins and spoke on behalf of things like the pedestrian or cyclist traffic lights.

The French philosopher of technology, Gilbert Simondon would describe this coming into being of the traffic intersection biography as the *concretization* of a technical object (2017). For Simondon, a technical object originates as an immature invention that iterates to become more refined and concretizes or comes into being in ways not foreseen by the human designer at the origin. The refinements are driven by the technical relations between nonhuman components more so than human creativity or decision making. A given part or change in a part simply requires another specific part to keep the whole functioning. Simondon calls this form of iteration the “condensing” of the technical object in a way that intensifies or creates new functionalities (+Lichtlijn or audio signals for the blind and visually impaired who are part of the gathering at the intersection) while simultaneously simplifying and reducing the object to essential components or relations. In this way, the technical object or thing evolves almost on its own.

Biographies are not equal gatherings of humans and nonhumans. Shifting powers were evident between the Wanvisa water lilies, racoons, and comet goldfish in the water lily pond biography. It is clear that at the intersection of Goudseweg and Vrije Nesse, the driver and car are dominant, and the gathering organizes around this dominance. Seeing +Lichtlijn as a matter of encouraging technology overuse overlooks the larger gathering or biography it has become a part of. In these wider relations, the moving car poses an immediate existential threat to a mobile phone user of being in a fatal accident—far greater than an addiction to Instagram. The traffic light system of car signals, bicycle signals, pedestrian signals, and mobile phone user signals are militating against the dominance and dangers of the driver and car. The car dominates in other ways as well, as a matter of consumption, it consumes vast amounts of nonhumans as extracted resources and further generates vast amounts of carbon dioxide (CO₂) and nitrogen dioxide.

The privileging of certain relations over others in a biography offers insights into the political nature of things designed or what Latour refers to a *thingpolitics* (Latour 2005), in which things gather matters of concern. Matters of concern are differences that are to be negotiated and possibly addressed. In the water lily pond, the choice to avoid pesticides did not need to be negotiated but if it did, the municipal bylaws regulating pesticide use in Vancouver would become part of the gathering. Some may have reflected on or even objected to the marginalized set of relations concerning the nonhuman animals that gathered in the biography. The politics of these relations also offer a way to consider the ending of a biography like a traffic intersection. This negotiation of the matters of concern of a biography can come by design, political action, governance, or some combination, any of which can intervene to dramatically shift the dynamics and privileged relations. In The Netherlands, the Stop de Kindermoord [Stop the murder of children] movement in the 1970s led to the first city-wide infrastructure of cycling paths that are now largely taken for granted across the whole country (van der Zee 2015), and so shifting the political relations between cyclists and drivers. Some twenty years ago, the socialist mayor of Pontevedra asked the question: “How can it be that private property—the car—occupies the public space?” and so banned cars from the city center and imposed severe traffic restrictions elsewhere (Burgin 2018). It is now commonplace for European cities to create low-emission zones that shift the balance away from cars such that biographies, like those at the intersection of Goudseweg and Vrije Nesse, can become obsolete or unwanted (Jones 2018). The COVID-19 pandemic—a massive human/nonhuman commingling—has usurped countless human and technical configurations; the surrendering of car infrastructure to pedestrians to allow for two-meters physical distancing between people is creating a collapse in carbon output that while it may be temporary, it has created a new trajectory in the biographies of a city (Batty 2020).

A city as a collection of biographies and constituencies

The city council of Vancouver passed a motion to create a by-law to prohibit intentional feeding of wildlife including crows. The motion was passed just prior to the making of the water lily pond. I only learned this recently, well after the end of the water lily pond. Such bylaws exist elsewhere, including in Victoria, a neighboring city. The motion “B.6 Don’t Feed the Wildlife” makes clear that the speaking subject (me) is never aware of all the nonhumans including municipal regulations that gather in a biography. Nonetheless, this matter of concern, so clearly expressed,

cast doubts on the kinship practice of feeding Cy and his family by my family. The concerns of the motion and most discussions on such human interventions include the health and wellbeing of the animals as well as the risk of cross-species disease or zoonotic diseases, like avian flus or Corona viruses. Conservationists have long argued that human interventions can be detrimental to animals' nutritional physiology (see, Birnie-Gauvin et al. 2017) and can come at a wider ecological cost (see, Dunkley and Cattet 2003). While the general reality portrayed here is not disputed and has much practical merit, questions remain such as what is the difference between human intervention and human relations with nonhuman animals?

Charis Thompson makes this point in her study of elephant conservationists in Kenya's Amboseli National Park (Thompson 2002) in which biologists are caught in competing notions of nature that ultimately question what or who are the elephants that are being conserved. The competing worldviews come down to the degree to which conservation is seen as a relational concern or not. Thompson depicts one group of conservationists who see the African elephant in its biological essence, with limited ecological relationships, and requiring separation from humans and containment within the boundaries of the park (excluded from the boundaries of a city) to be conserved and recover their naturalness. While another group sees the elephant as part of a broad set of ecological relations that includes humans, arguing that the elephants need to be allowed to travel their migration paths beyond the park that includes cohabiting and interchange with the Maasai peoples whose territories include that of the park and the elephant migration paths. Thompson sides with the "relationalists", seeing the need for conservation "to be responsive to and expressed within the existing political potentialities" (Thompson 2002, 167).

Thom van Dooren, in his studies of the conservation of the Hawaiiin crow or *alalā*, encounters similar issues that he sees as authenticity or what is an authentic crow? (van Dooren 2016). The *alalā* are extinct save for the hundred or so that are in captivity as part of an effort to eventually restore them to their original habitats. Like Thompson, van Dooren sees the successful return of the *alalā* happening in a context in which emergence is accounted for across human and nonhuman divides. He cites the example of one conservationist, who would like to see a "soft release" of the *alalā* in which the aviary remains open for a period as a reliable locale for food. As part of monitoring the released crows, food might be dispensed in bowls at the trunks of the trees where they are nesting when offspring are born, and even antibiotic treatments may be necessary at times. Van Dooren makes clear that this is a minority position amongst the biologists as many would oppose this degree of intervention and human/nonhuman relationship. However, there is a clear survival argument for this type of soft release as the environment has changed since the *alalā* became extinct in which commingling with humans is unavoidable, new diseases have developed, and a range of new predators have emerged.

On a philosophical level, van Dooren argues for what he sees as the "performative identity" of the *alalā* rather than an imagined "authentic crow" of the past:

The simple fact of inter-generational difference cannot be so easily read as the 'loss' of anything, certainly not an ideal authentic state. Instead, our attention is drawn towards the agency of non-humans in the shaping of their own individual species identities: as crows conduct experiments in

emergent forms of crow-ness. Far from any singular telos, individuals and species are engaged in multiple forms of becoming, all of them reiterative and ongoing, all of them co-constitutive and collaborative (even if unequal). (van Dooren 2016, 38)

Seeing the identity of crows as performative, he draws on Karen Barad's idea of "posthumanist performativity" in which materiality and material bodies are iteratively and reiteratively produced (Barad 2003). For Barad this process of materialization is one in which the separate categories of humans and nonhumans are questioned. Not unlike Haraway's "materialized refiguration" that is emblematic in the game of cat's cradle (D. J. Haraway 1994) – a game in which string figures, patterns of looped and knotted string, are created by passing a loop of string back and forth between the hands and fingers of multiple players. The game creates the string figure by maintaining the pattern while simultaneously experimenting with new possibilities and doing so collectively. For Haraway, it is a metaphor for nonhuman kinship. It is a heterogeneous collective that works across species and nonhumans, knotted, and entangled in ongoing configurations and *refigurations*. It is a collective self-formation or collectively producing entity that she refers to as *sympoiesis*, a boundaryless form of autopoiesis (D. Haraway 2016). Not unlike Kimmerer's description of braiding sweetgrass that is best done with another. Braiding also suggests time and performativity as a journey of reciprocity as the braid gets finer and thinner as it continues until it is down to individual blades of grass that are tied off together (Kimmerer 2015). Van Dooren assigns this performativity to the biological identity of the crow that is co-constituted in its environments and through its relations with others and through time. This is the same performativity of biographies. As previously discussed, a biography is an ongoing process of inscribing and reinscribing itself, as with the traffic intersection in Bodegraven or the concrete sink in my backyard. The performativity of biographies means that it also includes the historical not unlike the crows and their past, and hence political processes that iteratively form and reform the speaking subjects and the ongoing thing. Further, biographies like the water lily pond or the Bodegraven traffic intersection do not simply appear, rather they emerge from the heterogeneous participants that hold up the strings in Haraway's cat's cradle or Kimmerer's blades of sweetgrass. In designing-with, this is referred to as a *constituency*.

A constituency is the assembly of humans and nonhumans from which designers of things are gathered to go on to design things and form biographies (Wakkary 2021). To imagine a constituency when thinking about cities is to start with thinking of the sociomaterial interdependencies that make up cities. These include human actors (e.g., speaking subjects, residents, families, politicians, immigrant settlers, Indigenous peoples, business people, activists, unhoused, city workers, and so on that are racialized and intersectional) as well as nonhuman actors (e.g., neighborhoods, electricity, sewage, materials, technologies, houses, buildings, parks, homeless shelters, walk-in medical clinics, nonhuman animals, plant life, organizations, institutions, activist groups, by-laws, cars, bicycles, sidewalks, speed bumps, crosswalks, rain, wind, and so on). These interdependencies form the geographies or locations that have their own histories and geopolitics, from which constituencies actively gather. Juanita Sundberg, informed by the Zapatista principle of *walking with*, carefully describes such *geo-graphs* (what I call gatherings) as situated and fostering of "multi-epistemic literacy" and political engagement (Sundberg 2014). Further, in designing-with, a gathering is constituted through an ongoing intention to design something. That is, a gathering to negotiate and consider the making of things

and assembling the designer before things are made or biographies form. My backyard garden is the constituency from which the water lily pond biography was formed.

The biography can be said to be a product or an outcome of the constituency. Within this gathering of the garden, that has spawned other biographies such as our vegetable garden, there are the humans and nonhumans assembled some of which were needed to participate in the making of the water lily pond, others who did not participate or I did not want to participate, and others that had to be brought into the constituency such as the water lilies and comet goldfish. Constituencies are where the politics and intentionalities are negotiated such as cities as settler occupations, plots of land divided as settler properties, pesticide free growing, planting of only local plants, and organic fertilizers. The constituency is not a physically bound place, and as is evident in the political agreements that gather on their own in our backyard constituency such as unceded territories, pesticide by-laws, and a wildlife feeding motion for a bylaw.

If a city is a braiding of biographies, to accept the gift of the metaphor from Kimmerer (Kimmerer 2015), it is also a braiding of constituencies that precede biographies. Further, constituencies are not only the collectives in which biographies form, but also the collectives in which they end. The water lily pond ended within the constituency it began, in my backyard, whereas the Bodegraven traffic intersection will be inherited by other constituencies when it comes to an end, and the plastic bag biography is inherited or “exported” to constituencies unwillingly, unknowingly, and exploitatively as waste when it ends.

The endings of biographies

The end of the water lily pond biography is a story of fragility. My backyard constituency is relatively stable for the Northwestern crows, the concrete sink, the climbing hydrangea, and the racoons but less so for Wanvisa water lilies. This contrast between fragility and stability is evident in how short the biography lasted and how easily its gathering dispersed and found places in other gatherings in the backyard such as compost; and how easily biological lives of the lilies, mosquito larvae, and fish came to an end. Of course, this contrast can only be drawn within the short time span of the water lily pond, over time in relation to other gatherings my backyard could also be seen as fragile—perhaps at its end. Nevertheless, I told the story of the water lily biography through what is called a *repertoire* in designing-with (Wakkary 2021). Repertoires are the methods and positionalities by which speaking subjects seek ways to understand nonhumans through listening and touching as well as speaking, to aid in their representation and participation in biographies and constituencies. Specifically, I utilized a repertoire called *noticing through fragility*, developed by Doenja Oogjes (Oogjes and Wakkary 2022). This repertoire of noticing draws on Anna Tsing’s art of noticing (Tsing 2015). It focuses on precarity and disturbances to increase attention, to notice the relations between nonhumans in non-anthropocentric ways to the extent that’s possible. The method of noticing follows a particular nonhuman, like the Wanvisa water lilies, through its fragile relations with others in the

gathering to draw out the relations and agentic capacities at work. The repertoire lends itself to events of fragility, in which relations are often tentative and uncertain.

As a braiding of biographies, cities are inscribed and reinscribed by such fragile biographies such as temporary and ad hoc shelters for or by the unhoused. This example makes clear that the performativity of fragility is not enacted solely in the active undoing of the relations as with the failure of the water lily pond but also in the potential undoing or fragility as with ad hoc shelters. This constant potential to be fragile extends to traffic intersections like at Goudseweg and Vrije Nesse in Bodegraven. As described earlier, even ongoing biographies like traffic intersections or other forms of urban transportation can be undone by political and ideological change whether by a grassroots movement like Stop de Kindermoord or through reclaiming of public property as in the city of Pontevedra (van der Zee 2015; Burgen 2018) or municipal bylaws to prevent the feeding of crows. Climate change and global pandemics also deftly strip away the certainties of biographies to reveal the possibility of underlying fragilities.

Biographies that endure despite the constant possibility of coming undone, are seen as stable, like the Bodegraven traffic intersection. The stability successfully masks the underlying fragility to the extent it makes things and biographies unnoticeable. Biographies become like infrastructure, submerged as a substrate upon which the daily life of humans and nonhumans go about their business. Whether it is commuters getting to work or Carrion crows settling in to feast on walnuts. Stability fosters reliance, making many biographies unremarkable and invisible. However, as infrastructure studies show, stability is an effect that results from ongoing maintenance and repair that not only staves off potential fragility but attends to the related idea of breakdown. Ultimately, infrastructures fall prey to decay, ruin, and destruction (Steinhardt 2016). This holds clear lessons for the performativity of biographies and their end. Like infrastructures, a constant in the life of a biography is breakdown and repair, these are central and ongoing performances. The other lesson is that breakdown is a constant reminder, an abject reminder, of the inevitable decay or feeble resilience in the face of political or catastrophic forces that may cause a biography's abrupt end.

Breakdowns that necessitate repair is what makes stable biographies like infrastructures visible again. It is commonly understood among those who study infrastructures that it “becomes visible upon breakdown” (Star and Ruhleder 1996, 113). Steve Jackson goes so far as to say that repair offers an epistemic position from which technologies, infrastructures, and in our case things can be seen more clearly (Jackson 2014). Seeing breakdowns as part of the performativity of biographies opens it to the epistemological lens of repair. And in this chapter, we can extend this knowing to what makes a city. Traditionally, in what can be described as the “dominant productivist imaginings of technology” (Jackson 2014, 227), technologies like the +Lichtlijn are seen as innovative and progressive, intrinsically valuable by bringing the traffic intersection into a new and interconnected world—the very idea of a smart city. Conversely, seeing the world through repair, +Lichtlijn is the repair of a breaking down biography. The relations that make up the biography of the traffic intersection need being fixed, namely the need to repair the relations with pedestrians that use mobile phones, which if left unrepaired means the traffic intersection is outmoded, failing to achieve its goal of minimizing accidents, fatal and otherwise. Jackson would

describe this as a “constant process of fixing and reinvention, reconfiguring and reassembling into new combinations and new possibilities...” (Jackson 2014, 222). This epistemological view moves past the occlusion of technological progression to better see the performative nature of biographies in which repair keeps it alive and effective in the world. There is of course labor in repair (Llorente-González and Vence 2020), in the case of things this is aptly described by Hamid Ekbia and Bonnie Nardi as *heteromation*, labor divided between humans and machines done at the lowest costs to keep things running (Ekbia and Nardi 2017). If breakdowns make biographies visible again through repair, this reappearance is disruptive unlike its first appearance as something new and innovative. Breakdown as when a traffic signal fails is disruptive. And if repair makes biographies visible again it does so abjectly. Repair signifies ruin and so is best hidden from view, done during off-hours. Surely, breakdown withholds functionality and makes a thing unreliable which is reason enough to be upset. Yet arguably, repair makes a thing visible in a way that disrupts the imaginaries of innovation and progress as Jackson argues (Jackson 2014). More to the point, the abjection of repair and breakdown arises from the clarity that the biography will eventually end. The real emotions of despair caused by disrepair are the opposite of the gleeful fantasies of innovation and newness of a thing in perpetuity.

To best understand biographies is to shield them from the imaginaries of innovation and progress. In addition to keeping the end of things in sight, this shielding offers the additional gain of moving past narrowly anthropocentric perspectives. Things can certainly be described as the performances of humans and machines entangled together in a biography but can also be seen as competing or cooperating agencies across multiple species that also shape or co-constitute what a thing is. Again, we can learn from infrastructures. Maan Barua offers a wider, more-than-human ontology, for understanding infrastructures (Barua 2021). He describes three types of more-than-human infrastructures that also navigate fragility and breakdown. These include: 1) *repurposing infrastructures* such as termites that inhabit and enliven infrastructures to construct habitats that require working with or against when it comes to maintenance and repair; 2) *recombinant infrastructures* in which novel compositions form within estranged gatherings such as peppered moths, lichen, and sulfur dioxide from pollutants to thrive together in industrial towns; and 3) *reconciliation infrastructures* that entails infrastructures that support and modulate nonhuman life engagements like green roofs and wildlife bridges (Barua 2021). These descriptions of more-than-human configurations can readily be applied to biographies. They help articulate the role in the gatherings of the biographies I’ve described in this chapter like the Northwestern crows repurposing of my backyard deck; Carrion Crows recombinant traffic intersection into a feeding locale; and the attempted reconciliation of comet goldfish in a water lily pond.

I’ve described how the fragilities and breakdowns that occur throughout the life of biographies, and especially at their end, are often hidden or masked. A recurring theme is that despite these attempts, these qualities that mark the end of biographies cannot be kept from view. This is also true of the remaining quality that signals the end of a biography: waste. Waste is very much an anthropocentric concept with the sole purpose of categorizing things to be removed and excluded from human culture—to be removed from the city. Waste is defined by its exhaustion of

value for humans such that it requires removal. In its desired form, it is a nonhuman ontology in that its world relations are exclusively nonhuman once transformed into waste. In this anthropocentric sense, the end of the biography of the plastic bag is to strip it of its relations that make up the biography by transforming it from a thing into waste. As waste, it is no longer a bag, it is solely seen as waste material, specifically polyethylene. Ideally as waste, removed to a landfill it is expected to fragment into microplastics through photo and thermal oxidation, broken down by sunlight or heat in addition to mechanical movements of soil and various chemical reactions that contribute to its fragmentation (Canopoli, Coulon, and Wagland 2020).

In reality, landfills are not exclusively nonhuman but rather very entangled with being human. Waste is never relieved of its human relations. This is most visible when considering the significant amounts of polyethylene waste that escapes landfills to participate in human and nonhuman ecologies, such as circulatory pathways of wind, rivers, and oceanic currents. Waste material settles alongside roads, shorelines, and gathers offshore and into the oceanic gyres across global transport routes like the Pacific Garbage Patch (Lebreton et al. 2018). Polyethylene and other plastics reach the most remote places like mountaintops (Free et al. 2014; Van Cauwenberghe et al. 2013), though also the most biologically intimate human locales (we can assume nonhuman animals as well) by entering food chains (Barboza et al. 2018) to then enter the human body including placentas (Ragusa et al. 2021), bloodstream (Leslie et al. 2022), and lungs (Amato-Lourenço et al. 2021). Waste and e-waste follow paths of inequity and oppression of being consumed in the Global North to be disposed of in the Global South, what Frey et al. describe as exploitative and unequal ecologies of exchange (Frey, Gellert, and Dahms 2018). Some argue that trade patterns show a lessening of exporting of waste from the Global North to Global South (Lepawsky 2015) when in reality it may signal the rise in illegal trade of waste that goes unrecorded, particularly e-waste that is characterized by illicit, deceptive, and criminal practices of exploitation (Bedford et al. 2022). A practice that includes ontological sleights of hand in which waste is relabeled as ‘second-hand’ goods with some human value so it can be exported widely only to become waste again with no human value on arrival in Asian and African countries (Bedford et al. 2022).

Biographies, seen through a relational understanding of waste in which waste remains entangled as both human and nonhuman, uncover inequities and exploitation as discussed above and can also reveal racial entanglements that are very much a part of biographies through to their end. Michelle Huang sees this relationality through her framework of *ecologies of entanglement* that are networks of circulation that make porous the boundaries between humans and their environment (Huang 2017). The framework shifts attention toward the discursive and material relations that culturally produce forms, including racialized forms like Asian American. She critically examines this transpacific meaning by seriously including the role of the nonhuman Pacific Ocean and its waste that binds the transnationality of Asian Americans: “Viewing the Great Pacific Garbage Patch as an ecology of entanglement means seeing *humans in the gyre* and the *gyre in the humans*” (Huang 2017, 104). In other words, reclaiming the nonhuman ontology of waste into its relational ontology with humans. Huang sees in the ocean’s plastic waste the opportunity to investigate how the racial form of Asian American materializes and circulates in the absence of racially identified human bodies. Things transmuted into the

ontologies of plastic waste are removed from their origins, deracinated, to be seen to proliferate western shores and litter city streets, to migrate from the east in inevitable though unwanted ways. Plastics, like Asian Americans, are feared for their potential ubiquity though desired for their perceived mutability. For Huang, plastic is the model minority like Asians, “foreign menace and diligent” (Huang 2017, 108).

The future of biographies

That cities and things in cities take on racialized entanglements is not new, Langdon Winner long ago pointed out the racist politics of artifacts in city infrastructure (Winner 1980). Rather the contribution of this article is to show that a more-than-human view discloses ecologies of radically generous entanglements, diverse in their agencies, temporalities, and politics. Like the crows in this article, whether Northwestern crows perched on deck railings or Carrion crows on traffic signals, we are involved, certainly more concerned, but we are not the exclusive actors in determining the “future” of cities.

The contribution of extending the idea of biographies, to pay particular attention to their endings, moves designing past the imaginary of progress and innovation. I aimed to make clear the capacities of nonhuman agencies and temporalities in designing. I wanted to detail how biographies inscribe themselves in a multispecies world and what is left behind in an abrupt fashion or slowly unfolding over countless generations of human life. Biographies also reveal the fragility, breakdown, and shifting ontologies of waste that are central to the making and remaking of things. The hope is that these disclosures shift attention toward the endings of what is made. That is to encourage us to start designing at the end, so to speak. To gather, to speak on behalf of a more-than-human assembly that designs endings as much as beginnings. To design an end is not to predict an ending but rather to account for endings at the beginning.

A further contribution is to glimpse the futures of cities by tracing the myriad endings of its biographies of things. Throughout this article I chose to see the city as a braiding of biographies. I aimed to find futures by tracing endings. And by doing so, shifting the understanding of cities from the algorithmic to the ecological. A city that gathers, grafts, grows, decays, breaks down, repairs, and ends. A city that is a political ecology revealed by tracing the endings. What this offers is the possibility to see the making of cities as both development and devolvement, making and unmaking, growth and degrowth, beginnings and endings.

Conclusion

In summary, the chapter offers a view of cities by paying close attention to how the biographies of things end. The hope is that to see the end of things more clearly, that is to privilege the ending of biographies, is a path to move beyond the privileging of human experience and use, as the lens by which things and cities are understood. Whether that means seeing things through the haptically sensitive wet paws of racoons or pandemic induced traffic calming. This decentering of humans is not to erase human relations but to emphasize the more expansive relationality of humans with the more-than-human world.

Another goal of the chapter was to get a glimpse of futures with respect to cities. Here again,

following the ending of biographies is a way to trace possible futures or more specifically, to trace the nonhuman temporalities of things. This means seeing futures as endings, to acknowledge and foreground that all things end but to also open up futures of cities to include nonhuman futures like the thousand years to fragment plastic or residing as waste in deterritorialized gyres of the Pacific Ocean. Additionally, biographies occur alongside each other along different temporalities whether as new, ongoing, or ending. Seeing a city as braided biographies is to see it as different temporalities braided together. In this respect, futures exist in trajectories of nonhuman agencies originating in the past, as well as in the present as futures deferred through successful repair or futures as endings that suddenly arrive as irreparable only to live on as waste.

The boundaries of cities are diffused temporally as well as geographically. They are hard to see and even harder to encapsulate as an abstract entity, which is why I approached cities through the particulars of my water lily pond and a traffic intersection in Bodegraven. This also allowed me to trace the endings of biographies along the dimensions of fragility, breakdown and waste that I saw as performativity, or the ongoing life of the ending and its continuance of matters of concerns, entanglements, and cohabitation.

Ron Wakkary. 2024. More-than-Human Biographies: Designing for their Endings. In *Designing More-than-Human Smart Cities: Beyond Sustainability, Towards Cohabitation*, Sara Heitlinger, Marcus Foth and Rachel Clarke (eds.). Oxford University Press, 305–326. <https://doi.org/10.1093/9780191980060.003.0017>

References

- Alexander, Christopher. 2015. *A City Is Not a Tree: 50th Anniversary Edition*. Portland, Or.: Sustain Press.
- Amato-Lourenço, Luís Fernando, Regiani Carvalho-Oliveira, Gabriel Ribeiro Júnior, Luciana dos Santos Galvão, Rômulo Augusto Ando, and Thais Mauad. 2021. "Presence of Airborne Microplastics in Human Lung Tissue." *Journal of Hazardous Materials* 416 (August): 126124. <https://doi.org/10.1016/j.jhazmat.2021.126124>.
- Arendt, Hannah. 1951. *The Origins of Totalitarianism*. New York: Schocken.
- Barad, Karen. 2003. "Posthumanist Performativity: Toward an Understanding of How Matter Comes to Matter." *Signs* 28 (3): 801–31. <https://doi.org/10.1086/345321>.
- Barboza, Luís Gabriel Antão, A. Dick Vethaak, Beatriz R. B. O. Lavorante, Anne-Katrine Lundebye, and Lúcia Guilhermino. 2018. "Marine Microplastic Debris: An Emerging Issue for Food Security, Food Safety and Human Health." *Marine Pollution Bulletin* 133 (August): 336–48. <https://doi.org/10.1016/j.marpolbul.2018.05.047>.
- Barua, Maan. 2021. "Infrastructure and Non-Human Life: A Wider Ontology." *Progress in Human Geography* 45 (6): 1467–89.
- Batty, Michael. 2020. "The Coronavirus crisis: What will the post-pandemic city look like?" *Environment and Planning B: Urban Analytics and City Science* 47 (4): 547–552. <https://doi.org/10.1177/2399808320926912>
- Bedford, Laura, Monique Mann, Marcus Foth, and Reece Walters. 2022. "A Post-Capitalocentric Critique of Digital Technology and Environmental Harm: New Directions at the Intersection of Digital and Green Criminology." *International Journal for Crime, Justice and Social Democracy* 11 (1): 167–81. <https://doi.org/10.5204/ijcjsd.2191>.
- Bennett, Jane. 2010. *Vibrant Matter: A Political Ecology of Things*. Durham: Duke Univ Pr.
- Birnie-Gauvin, Kim, Kathryn S. Peiman, David Raubenheimer, and Steven J. Cooke. 2017. "Nutritional Physiology and Ecology of Wildlife in a Changing World." *Conservation Physiology* 5 (1): cox030. <https://doi.org/10.1093/conphys/cox030>.
- Braidotti, Rosi. 2013. *The Posthuman*. Cambridge, UK ; Malden, MA, USA: Polity.
- Burgen, Stephen. 2018. "'For Me, This Is Paradise': Life in the Spanish City That Banned Cars." *The Guardian*, September 18, 2018, sec. Cities. <https://www.theguardian.com/cities/2018/sep/18/paradise-life-spanish-city-banned-cars-pontevedra>.
- Canopoli, Luisa, Frédéric Coulon, and Stuart T. Wagland. 2020. "Degradation of Excavated Polyethylene and Polypropylene Waste from Landfill." *Science of The Total Environment* 698 (January): 134125. <https://doi.org/10.1016/j.scitotenv.2019.134125>.
- Coole, Diana. 2005. "Rethinking Agency: A Phenomenological Approach to Embodiment and Agentic Capacities." *Political Studies* 53 (1): 124–42. <https://doi.org/10.1111/j.1467-9248.2005.00520.x>.
- Deleuze, Gilles, and Felix Guattari. 1987. *Thousand Plateaus: Capitalism and Schizophrenia*. 2 edition. Minneapolis, Min: Univ Of Minnesota Press.
- Dooren, Thom van. 2016. "Authentic Crows: Identity, Captivity and Emergent Forms of Life." *Theory, Culture & Society* 33 (2): 29–52. <https://doi.org/10.1177/0263276415571941>.
- Dunkley, L., and M. R. L. Cattet. 2003. "A Comprehensive Review of the Ecological and Human Social Effects of Artificial Feeding and Baiting of Wildlife." *Canadian Cooperative Wildlife Health Centre: Newsletters & Publications*, February. <https://digitalcommons.unl.edu/icwdmccwhcnews/21>.
- Ekbja, Hamid R., and Bonnie A. Nardi. 2017. *Heteromation, and Other Stories of Computing and Capitalism*. Cambridge, MA: The MIT Press.
- Eremia, Mircea, Lucian Toma, and Mihai Sanduleac. 2017. "The Smart City Concept in the 21st Century." *Procedia Engineering*, 10th International Conference Interdisciplinarity in Engineering, INTER-ENG 2016, 6-7 October 2016, Tirgu Mures, Romania, 181 (January): 12–19.

Ron Wakkary. 2024. More-than-Human Biographies: Designing for their Endings. In *Designing More-than-Human Smart Cities: Beyond Sustainability, Towards Cohabitation*, Sara Heitlinger, Marcus Foth and Rachel Clarke (eds.). Oxford University Press, 305–326. <https://doi.org/10.1093/9780191980060.003.0017>

- <https://doi.org/10.1016/j.proeng.2017.02.357>.
- Fieuw, Walter, Marcus Foth, Glenda Amayo Caldwell. 2022. “Towards a More-than-Human Approach to Smart and Sustainable Urban Development: Designing for Multispecies Justice.” *Sustainability* 14 (2): 948. <http://dx.doi.org/10.3390/su14020948>.
- Forlano, Laura. 2016. “Decentering the Human in the Design of Collaborative Cities.” *Design Issues* 32 (3): 42–54. https://doi.org/10.1162/DESI_a_00398.
- Free, Christopher M., Olaf P. Jensen, Sherri A. Mason, Marcus Eriksen, Nicholas J. Williamson, and Bazartseren Boldgiv. 2014. “High-Levels of Microplastic Pollution in a Large, Remote, Mountain Lake.” *Marine Pollution Bulletin* 85 (1): 156–63. <https://doi.org/10.1016/j.marpolbul.2014.06.001>.
- Frey, R. Scott, Paul K. Gellert, and Harry F. Dahms. 2018. *Ecologically Unequal Exchange: Environmental Injustice in Comparative and Historical Perspective*. Cham: Springer International Publishing. <https://doi.org/10.1007/978-3-319-89740-0>.
- Griffiths, Alyn. 2017. “Daylight Filters in through the Roof and Walls of Bangladeshi Mosque by Marina Tabassum.” *Dezeen* (blog). March 5, 2017. <https://www.dezeen.com/2017/03/05/bait-ur-roof-mosque-dhaka-bangladesh-marina-tabassum-brick-aga-khan-award/>.
- Haraway, Donna. 1985. “A Manifesto for Cyborgs: Science, Technology, and Social Feminism in the 1980s.” *Socialist Review* 5 (2): 65–107.
- . 1994. “A Game of Cat’s Cradle: Science Studies, Feminist Theory, Cultural Studies.” *Configurations* 2 (1): 59–71. <https://doi.org/10.1353/con.1994.0009>
- . 2003. *The Companion Species Manifesto: Dogs, People, and Significant Otherness*. 1 edition. Chicago: Prickly Paradigm Press.
- . 2016. *Staying with the Trouble: Making Kin in the Chthulucene*. First Edition edition. Durham: Duke University Press Books.
- Harman, Graham. 2016. *Immaterialism: Objects and Social Theory*. Malden, MA: Polity.
- . 2018. *Object-Oriented Ontology: A New Theory of Everything*. London: Pelican.
- Houston, Donna, Jean Hillier, Diana MacCallum, Wendy Steele, and Jason Byrne. 2018. “Make Kin, Not Cities! Multispecies Entanglements and ‘Becoming-World’ in Planning Theory.” *Planning Theory* 17 (2): 190–212. <https://doi.org/10.1177/1473095216688042>.
- Huang, Michelle N. 2017. “Ecologies of Entanglement in the Great Pacific Garbage Patch.” *Journal of Asian American Studies* 20 (1): 95–117. <https://doi.org/10.1353/jaas.2017.0006>.
- Jackson, Steven J. 2014. “Rethinking Repair.” In *Media Technologies*. The MIT Press. <https://doi.org/10.7551/mitpress/9780262525374.003.0011>.
- Jelbert, S. A., R. J. Hosking, A. H. Taylor, and R. D. Gray. 2018. “Mental Template Matching Is a Potential Cultural Transmission Mechanism for New Caledonian Crow Tool Manufacturing Traditions.” *Scientific Reports* 8 (1): 8956. <https://doi.org/10.1038/s41598-018-27405-1>.
- Jones, Sam. 2018. “‘It’s the Only Way Forward’: Madrid Bans Polluting Vehicles from City Centre.” *The Guardian*, November 30, 2018, sec. Cities. <https://www.theguardian.com/cities/2018/nov/30/its-the-only-way-forward-madrid-bans-polluting-vehicles-from-city-centre>.
- Kimmerer, Robin Wall. 2015. *Braiding Sweetgrass: Indigenous Wisdom, Scientific Knowledge and the Teachings of Plants*. First Paperback edition. Minneapolis, Minn: Milkweed Editions.
- Latour, Bruno. 1999. *Pandora’s Hope: Essays on the Reality of Science Studies*. 1 edition. Cambridge, Mass: Harvard University Press.
- . 2005. “From Realpolitik to Dingpolitik.” In *Making Things Public*, edited by Bruno Latour and Peter Weibel, 14–44. MIT Press.
- . 2007. *Reassembling the Social: An Introduction to Actor-Network-Theory*. 1 edition. Oxford: Oxford University Press.
- Lebreton, L., B. Slat, F. Ferrari, B. Sainte-Rose, J. Aitken, R. Marthouse, S. Hajbane, et al. 2018. “Evidence That the Great Pacific Garbage Patch Is Rapidly Accumulating Plastic.” *Scientific Reports* 8 (1): 4666–15. <https://doi.org/10.1038/s41598-018-22939-w>.
- Lepawsky, Josh. 2015. “The Changing Geography of Global Trade in Electronic Discards: Time to

Ron Wakkary. 2024. More-than-Human Biographies: Designing for their Endings. In *Designing More-than-Human Smart Cities: Beyond Sustainability, Towards Cohabitation*, Sara Heitlinger, Marcus Foth and Rachel Clarke (eds.). Oxford University Press, 305–326. <https://doi.org/10.1093/9780191980060.003.0017>

- Rethink the e-Waste Problem.” *The Geographical Journal* 181 (2): 147–59.
<https://doi.org/10.1111/geoj.12077>.
- Leslie, Heather A., Martin J. M. van Velzen, Sicco H. Brandsma, A. Dick Vethaak, Juan J. Garcia-Vallejo, and Marja H. Lamoree. 2022. “Discovery and Quantification of Plastic Particle Pollution in Human Blood.” *Environment International*, March, 107199.
<https://doi.org/10.1016/j.envint.2022.107199>.
- Lewis, Jason Edward, Noelani Arista, Archer Pechawis, and Suzanne Kite. 2018. “Making Kin with the Machines.” *Journal of Design and Science*, July. <https://doi.org/10.21428/bfefd97b>.
- Llorente-González, Leandro Javier, Xavier Vence. 2020. “How labour-intensive is the circular economy? A policy-orientated structural analysis of the repair, reuse and recycling activities in the European Union.” *Resources, Conservation and Recycling*, 162, 105033.
<https://doi.org/10.1016/j.resconrec.2020.105033>
- Mattern, Shannon. 2021. *A City Is Not a Computer: Other Urban Intelligences*. 1st ed. Places Books. Princeton: Princeton University Press.
- Nihei, Yoshaki, and Hiroyoshi Higuchi. 2001. “Hen and Where Did Crows Learn to Use Automobiles as Nutcrackers?” *Tohoku Psychologica Folia*, no. 60: 93–97.
- Oogjes, Doenja, and Ron Wakkary. 2022. “Weaving Stories: Toward Repertoires for Designing Things.” In *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems (CHI '22)*. New York, NY, USA: Association for Computing Machinery.
<https://doi.org/10.1145/3491102.3501901>.
- Puig de la Bellacasa, María. 2017. *Matters of Care: Speculative Ethics in More than Human Worlds*. 3rd ed. edition. Minneapolis: Univ Of Minnesota Press.
- Ragusa, Antonio, Alessandro Svelato, Criselda Santacroce, Piera Catalano, Valentina Notarstefano, Oliana Carnevali, Fabrizio Papa, et al. 2021. “Plasticenta: First Evidence of Microplastics in Human Placenta.” *Environment International* 146 (January): 106274.
<https://doi.org/10.1016/j.envint.2020.106274>.
- Star, Susan Leigh, and Karen Ruhleder. 1996. “Steps Toward an Ecology of Infrastructure: Design and Access for Large Information Spaces.” *Information Systems Research* 7 (1): 111–34.
<https://doi.org/10.1287/isre.7.1.111>.
- Steinhardt, Stephanie B. 2016. “Breaking Down While Building Up: Design and Decline in Emerging Infrastructures.” In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*, 2198–2208. CHI '16. New York, NY, USA: Association for Computing Machinery. <https://doi.org/10.1145/2858036.2858420>.
- Stevens, E. S. 2001. *Green Plastics: An Introduction to the New Science of Biodegradable Plastics*. 1 edition. Princeton: Princeton University Press.
- Sundberg, Juanita. 2014. “Decolonizing Posthumanist Geographies.” *Cultural Geographies* 21 (1): 33–47. <https://doi.org/10.1177/1474474013486067>.
- Thompson, Charis. 2002. “When Elephants Stand for Competing Models of Nature.” In , edited by John Law and Annemarie Mol, 166–90. North Carolina, USA: Duke University Press.
<http://www.dukeupress.edu>.
- Thulin, Sten Gustaf. 1965. Bag with handle of weldable plastic material. United States US3180557A, filed July 10, 1962, and issued April 27, 1965.
<https://patents.google.com/patent/US3180557/en>.
- Todd, Zoe. 2015. “Indigenizing the Anthropocene.” In *Art in the Anthropocene: Encounters*

Ron Wakkary. 2024. More-than-Human Biographies: Designing for their Endings. In *Designing More-than-Human Smart Cities: Beyond Sustainability, Towards Cohabitation*, Sara Heitlinger, Marcus Foth and Rachel Clarke (eds.). Oxford University Press, 305–326. <https://doi.org/10.1093/9780191980060.003.0017>

among Aesthetics, Politics, Environments and Epistemologies, 241–54. Open Humanities Press London.

Tsing, Anna Lowenhaupt. 2015. *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins*. Princeton: Princeton University Press.

Tuhiwai Smith, Linda. 2021. *Decolonizing Methodologies: Research and Indigenous Peoples*. London: Zed Books.

Van Cauwenberghe, Lisbeth, Ann Vanreusel, Jan Mees, and Colin R. Janssen. 2013. "Microplastic Pollution in Deep-Sea Sediments." *Environmental Pollution* 182 (November): 495–99. <https://doi.org/10.1016/j.envpol.2013.08.013>.

Wakkary, Ron. 2021. *Things We Could Design: For More than Human-Centered Worlds*. Cambridge, MA: MIT Press.

Watts, Vanessa. 2013. "Indigenous Place-Thought and Agency Amongst Humans and Non Humans (First Woman and Sky Woman Go On a European World Tour!)." *Decolonization: Indigeneity, Education & Society* 2 (1). <https://jps.library.utoronto.ca/index.php/des/article/view/19145>.

Winner, Langdon. 1980. "Do Artifacts Have Politics?" *Daedalus* 109 (1): 121–36. Wolfe, Cary. 2010. *What Is Posthumanism?* University of Minnesota Press.

Zee, Renee van der. 2015. "How Amsterdam Became the Bicycle Capital of the World." *The Guardian*, May 5, 2015.

<https://www.theguardian.com/cities/2015/may/05/amsterdam-bicycle-capital-world-transp-ort-cycling-kindermoord>.