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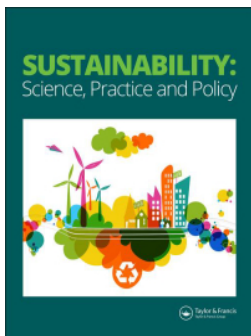
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Sustainability imaginaries by design

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ABSTRACT

As the scale and severity of our multiple environmental crises come into view, the question of digital technologies and how they can be designed sustainably becomes even more pressing. The starting point for this brief commentary is that technology is not just a neutral instrument to achieve sustainability but takes an active part in shaping what sustainability means in the first place. Digital technology, in other words, not only has material consequences but mediates the meaning of sustainability and takes part in the creation and dissemination of sustainability imaginaries: collectively held beliefs about the world and how to act on it in a sustainable manner. On this background, I argue that we are witnessing the emergence of a new sustainability imaginary that stands on three pillars: *ontological entanglements*, premised in the observation that everything is connected and could only be fully understood through those connections; *inclusive epistemologies*, rejecting the reductivism of Western rationalism in favor of "othered," more situated forms of knowledge; and *a politics of mutuality and care* that mobilizes generosity and reciprocity as the basis of social life. I make use of several digital technologies to illustrate how these ingredients lend themselves to new digital sociotechnical practices that, in turn, may shape how we think about and pursue sustainability.

Introduction

There is no small irony in suggesting that more technology is the only solution to problems caused by previous uses of technology. The sheer size of the technosphere – already larger than all biomass (Elhacham et al. 2020) – is powerful testimony to this dilemma. Yet, it is equally naïve to imagine that humanity can address what the World Economic Forum (WEF) recently termed the "polycrisis" (Whiting and Park 2023) without a measure of technological innovation. And so despite the widespread recognition of the significant environmental consequence of technology development, use, and disposal (Comber and Eriksson 2023; Freitag et al. 2021; Istrate et al. 2024; Rehak 2024), as well as the severe harms caused by the neocolonial, extractivist economies by which new technologies are materialized (Chagnon, Hagolani-Albov, and Hokkanen 2021; Crawford 2021), many, including proponents of post-growth and degrowth strategies, remain convinced that technology has an important role to play in sustainability transitions (Digitalization for Sustainability 2023; Kerschner et al. 2018; One Planet Network 2023). What first appears as a binary is actually a range of possibilities: "The real conflict is

not between technology and anti-technology. It is about how technology is imagined and the conditions under which it is deployed" (Hickel 2023). How technology is, or rather how it may be imagined, is the subject of this brief commentary.

As demonstrated by the articles in the Digitalisation for Sustainability Transitions Collection, digital technologies are at the forefront of sustainability transitions. But my point of departure is that technology – digital or analog – is not merely an instrument of sustainability, that is, a set of devices standing ready to serve the aims of sustainability programs, strategies, and policies. Instead, technology actively shapes or refracts what we understand as sustainability to begin with; sustainability co-emerges with the technologies that are used to promote and pursue it (Bendor 2018, 2021). Look at technologies for sustainability and what you may see are sustainability imaginaries given sociotechnical form, and this applies equally to solar panels, AI-powered climate models, games that aim to reduce consumption, and even Tesla cars.

The term imaginaries (often accompanied by "social" or "sociotechnical") describes the influence of worldviews or ideologies on the way we understand the world and, consequently, act on it. Philosopher

Charles Taylor (2004, 23) explains social imaginaries as "the ways people imagine their social existence, how they fit together with others, how things go on between them and their fellows, the expectations that are normally met, and the deeper normative notions and images that underlie these expectations." We can say that imaginaries are those deeply held beliefs about the world, the kind of stories we tell ourselves about who we are, where we came from, and where we should be heading. Importantly, imaginaries are not individual phenomena but are *collectively* held beliefs about the world that are embedded in, and orient the structures, institutions, values, and norms that govern society (Bottici 2019; Castoriadis 1997). In this sense, imaginaries represent a social constructivist perspective and affirm the role of imagination in propelling social change – not the least in the context of sustainability and climate change (Bendor 2018; Milkoreit 2017; Pelzer and Versteeg 2019; Yusoff and Gabrys 2011).

Imaginaries influence, and in turn are influenced by, sociotechnical practices (Jasanoff and Kim 2015). What we do with technology affects how we see the world and vice versa. Design, more specifically that type of design that is occupied with future possibilities ("design futures" in short),[1] plays a crucial role in this dynamic by expressing and mobilizing what Berger and Luckmann ([1966] 1989, 187) describe as "the dialectic between social reality and individual existence." It does so first by making tangible the connections between imaginaries and sociotechnical practices and second by mediating or facilitating the mutual shaping of the two. Design, in other words, holds the potential to surface, concretize, and mobilize alternative social realities. The argument I want to make here, then, is that design futures translate imaginaries into future sociotechnical practices, and when they do so they offer us a glimpse of an emergent sustainability imaginary.

A new sustainability imaginary

Broadly speaking, the emerging sustainability imaginary reflected in the type of design discussed here, moves away from the established truths of modernity – at least that version of modernity that was developed in the Western world (Latour 1993). Some have called this new imaginary the "flourishing" (Dunn, Cruickshank, and Coupe 2024; Ehrenfeld 2008; Ichioka and Pawlyn 2021), significantly distinguishing it from modernist sustainability imaginaries, which tend to promote individualized, efficiency-driven solutions. In my reading, the new sustainability imaginary stands on three pillars: *ontological entanglements*, premised in the observation

that everything is connected and could only be fully understood through those connections; *inclusive epistemologies*, rejecting the reductivism of Western rationalism in favor of "othered," more situated forms of knowledge; and *a politics of mutuality and care* that mobilizes generosity and reciprocity as the basis of social life. The three pillars work in lockstep to produce a new imaginary at the basis of which lies a fundamental recognition of relationality as the key element of life (Escobar, Osterweil, and Sharma 2024).[2]

Ontological entanglements

Western philosophy and science provided humanity with a very particular image of itself, a powerful combination of "human exceptionalism and bounded individualism" as Donna Haraway (2016, 30) writes. Within this paradigm humans understood themselves as an exceptional species made from unique individuals – the perfect outcome of millions of years of natural selection. This image was replicated and propagated through the multiple projects of Modernity, chief among them is liberalism, whose insistence on individual autonomy as the premise of life and liberty (Held 2006, 262) reverberates in the messages of marketers who urge consumers to manifest their uniqueness by purchasing and consuming.

It has since become apparent that many of the neat distinctions, classifications, and dichotomies that floated modernity were more fantasy than a truthful reflection of the world. That intoxicating sense of exceptionalism is no longer tenable as scientists catch up with what was already reflected in many Indigenous cosmologies, that is, that humans are not that different from other organisms, with whom we are essentially entangled. As Lynn Margulis and Dorion Sagan (1997, 16) write, humans should not be understood as "lords" but as "partners": "we are in mute, incontrovertible partnership with the photosynthetic organisms that feed us, the gas producers that provide oxygen, and the heterotrophic bacteria and fungi that remove and convert our waste." Viruses are inscribed into our DNA, and because our diet has epigenetic impacts (Huypens et al. 2016) we literally become what we eat. Traumatic events experienced several generations in the past can make their way into our DNA and affect the way we are today (Yehuda et al. 2016). The world revealed by contemporary natural and social science appears to be made of complex, nested assemblages of entities that support, maintain, attend to, or "care" for each other (Barad 2007; Puig de la Bellacasa 2017). Not independent, autonomous agents whose being precedes the relations they form with others, but the precise opposite: all beings

Figure 1. "Unexpected Growth" augmented reality installation by Tamiko Thiel and /p, 2018. Commissioned by and in the collection of the Whitney Museum of American Art, New York.

become who and what they are in and through their relations with others. We are relational all the way down, and in this we are not much different from a range of small and large entities – from microorganisms and fungi to trees and the planet as a whole (Margulis and Sagan 1997).

We can find a powerful expression of this kind of ontological perspective in Tamiko Thiel's work with augmented reality (AR). Visitors to her exhibitions can use the camera on their mobile phones as a virtual cosmoscope, discovering new kinds of flora and fauna present in the surrounding environment – forms of hybrid "natureculture" (Haraway 1997) that change when encountered. In a piece called Unexpected Growth (Thiel n.d.), AR technology allows viewers to witness a lively coral reef that grows and branches out according to Lindenmayer system principles right in front of their eyes (Figure 1). As they approach the reef, they find, much to their surprise, that the reef is actually made of plastic artifacts including spoons, forks, straws, sandals, and rubber duckies. The more viewers look at the reef. the more it bleaches, as if responding magically to the cumulative effects of electromagnetic exposure or, more simply, to human presence, thus reminding viewers that nature, culture, humans, and nonhumans are inextricably entangled. As microplastics are found in the farthest reaches of Antarctica (Aves et al. 2022) and in the breastmilk of expectant mothers (Ragusa et al. 2022), our planetary reach has come to haunt us. We are everywhere. We are the world, and the world is us.

Inclusive epistemologies

The second pillar or constituent of the new sustainability imaginary has to do with what is considered valid knowledge. In the Western canon, from the Greeks through Descartes and beyond, human reason, essentially different from the human body, was taken to be the source and arbiter of knowledge, that is, only if something is reasonable can it be considered valid knowledge. Calculation, reasoning from cause to outcome, logical explanation, and so forth, became the de facto criteria for knowledge, and whatever did not fall under these criteria was considered folly at best and savagery at worst.

However, through the efforts of cognitive scientists and behavioral economists, human reasoning appears far less logical than assumed (Damasio 1994; Kahneman 2011). Humans are, in fact, prone to all kinds of cognitive mistakes and short circuits, and these are not just accidents nor signs of feeble minds but inherent to how we perceive and act on the world. Furthermore, decolonializing thinkers and Indigenous activists have promoted ways of knowing and being that despite their marginalization appear not only as solid as Western calculative (or instrumental) reason but are often better suited to address the kind of ontological entanglements discussed above (Escobar 2018; Kimmerer 2013; Machado de Oliveira 2021; Viveiros de Castro and Danowski 2020). Perhaps instead of merely thinking, Westerners would do better to adopt what Latin Americans call *sentipensar*: feel-thinking or thinkingfeeling.

A glimpse of such hybrid epistemologies that are distributed along humans, organic, and machinic nonhumans, is offered by Superflux's recent project, The Ecological Intelligence Agency. The project is a speculative proposal to consider what an ecological AI might look like (Figure 2). The designers describe their intentions and process as follows:

> To create a foundation for Ecological AI, we considered an alternate intelligence that does not claim

Figure 2. The Ecological Intelligence Agency by Superflux. Source: Superflux 2024

unlimited access to knowledge systems, does not assume only one way to understand the world, and does not perpetuate dominant extractive paradigms….an intelligence that is accountable and accounts for a multitude of interconnected cosmologies and lived-experiences alongside data sets. (Superflux 2024).

The studio created a specialized language model that combines scientific data, public policy documents, and social media pertaining to the river Roding – a river that flows from Essex through London and into the Thames. Unlike other "black-boxed" models, the ecological AI provides a trace of its sources and uses Indigenous knowledge to fill out gaps in the data. In the visual material that documents the experiment, the moment that best encapsulates epistemological hybridity comes 3:05 min into the video that focuses on sewage. While until this point the voice of the AI expressed a clear scientific perspective, at this juncture the AI shifts mode and starts to speak for the river rather poetically. The result is startling, and not only because this is not what we would have expected from a scientific AI, but because the words spoken by the river (ventriloquized by the AI) appear no less truthful than the collection of facts delivered by the AI just a few seconds before. The impression left by the experiment is striking: no technoscientific intelligence is worth its weight in silicon if it cannot account for the knowledge and wisdom of other beings. Intelligence is not one thing possessed by an individual but "part of a greater wholeness of living and being" (Bridle 2022, 58).

A politics of care

The third stream of thinking that animates the emergent sustainability imaginary has to do with the way politics is considered and pursued, and by politics I do not mean only party-based political systems or electoral processes, but how we organize our life together and address questions of power and opportunity. One of the characteristics of "living in capitalism," to borrow from the great science-fiction author Ursula Le Guin, is that many social relations are transactional: we are socialized to only do something if we get something in return, and this quid pro quo often takes the form of economic reciprocity. Think of all the "services" we get and give, and how this form of interaction threatens to turn communities into an aggregate of individuals consumed by their own self-interest.

What many of us subjects of capitalism are discovering, however, is that the scope of problems we face cannot be sufficiently addressed by contemporary "service society" (Yarmolinsky 1968). One of the most striking lessons of the COVID-19 pandemic, and perhaps the one governments did the least to internalize, is that our individual immunity depends on our collective one, and therefore it is not individualism but mutualism that will increase our chances to survive in the future (Biss 2014). This should not come as news, for as biologists affirm, "Life did not take over the globe by combat, but by networking" (Margulis and Sagan 1997, 29).

When it comes to generosity and reciprocity we can, again, find insightful examples in Indigenous
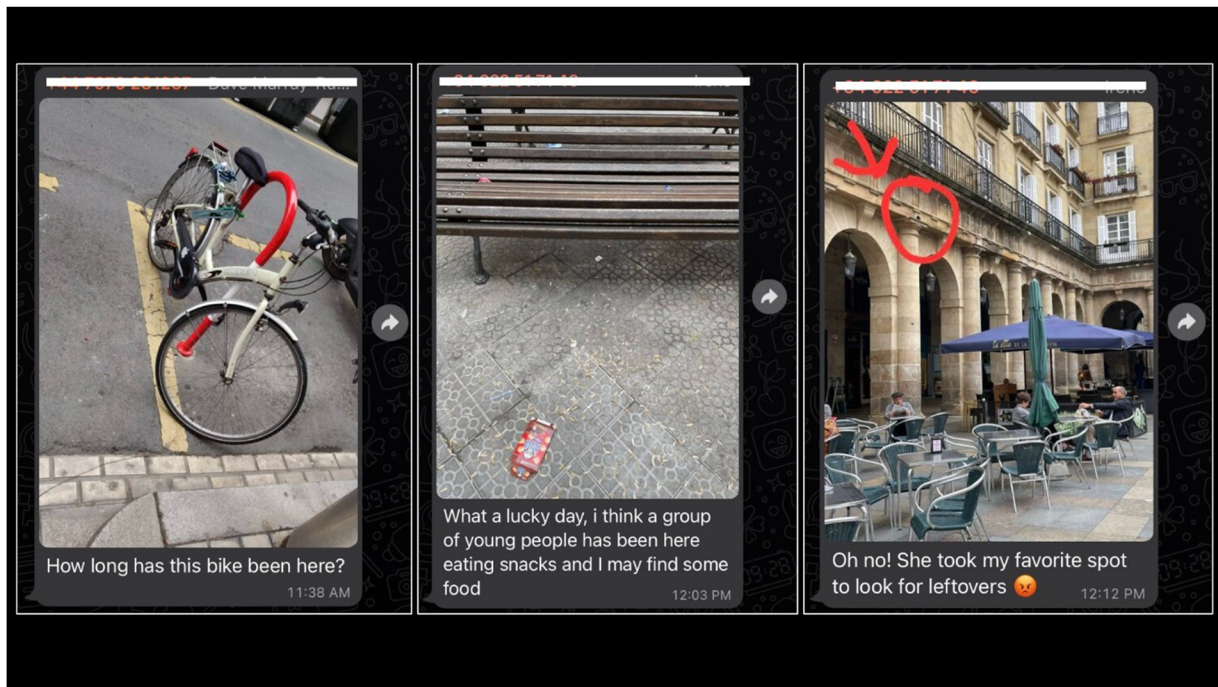
Figure 3. Screenshots of agent reports created during Sensing in the Wild Lab in Bilbao, 2022. Source: Turtle et al., 2022 (CC BY-NC 4.0).

communities and in nature. What Robin Wall Kimmerer (2013) calls "berry teachings" describes the way berries offer nourishment to other beings while relying on those beings to spread their seeds. In Kimmerer's words: "The berries trust that we will uphold our end of the bargain and disperse their seeds to new places to grow," and so, "They remind us that all flourishing is mutual" (382). In this vein, can we speak of individual accomplishments without retrieving the conditions that enabled those achievements – conditions that are often created by the efforts of a collective? Can we be happy and productive without the support of our communities?.

We can get a taste of how value change and system change are interconnected (Meadows 1999) from Sensing in the Wild Lab: a speculative experiment in designing a decentralized urban sensing system (Turtle et al. 2022). During the Lab, organizers asked participants to roam the city, stage "encounters" with different entities, and report what they found by feeding into the system data that reflected their particular perspectives and interests. The twist is that they had to do this while taking on different identities, roleplaying as children but also as moss, as municipal authorities but also as CCTV cameras, as illegal immigrants trying to evade the authorities, but also as pigeons.

What makes Sensing in the Wild Lab relevant for this discussion is not only the way the experiment integrates organic and machinic beings into an urban sensing apparatus, but how it builds mutuality into the data-acquisition model. The data that participants shared, in the form of an image and text uploaded to a dedicated Whatsapp channel (Figure 3), helped reveal both frictions and alignments among actors. Looking at those images and texts it becomes clear how the same data could be interpreted differently by different actors, and how some data could be useful for more than one type of actor, and sometimes for conflicting reasons. For instance, the same trees that birds identified as desirable playgrounds were tagged as obstructions by the CCTV camera, and the location of an abandoned bicycle was helpful for both children looking for a joyride and municipal garbage collectors. The presence of moss helped city cleaners be more effective, but it also disclosed the perfect shady spot for a tired pigeon on a hot summer's day. Through the process of data reporting, and revealed through what facilitators called a "network therapy" session that took place afterward, seemingly conflicting interests and needs were transformed into acts of kindness and community bonding. The distributed nature of the sensing system allowed generosity and mutualism to replace cold calculations of costs and benefits. Sensing agents began to understand their contributions to the system as community building since "all flourishing is mutual" (Kimmerer 2013, 382).

Conclusion

The digital technologies presented here are speculative in nature. They are not products designed for the market but experimental probes into the

conditions of possibility for alternative futures. They were not designed to solve complex problems, nor do they address their own ecological footprint, and in this fail to provide an unequivocal answer to the question that underlies technological society: "Is it worth it?" Nonetheless, I believe these speculative technologies hint at possible answers to that question by foregrounding the frictions, tensions, and conflicts implicated in business-as-usual technoscientific futures. They are, in other words, critical prototypes of future sociotechnical practices oriented by, and contributing to, the formation of new sensibilities and imaginaries.

As forms of socio-material inquiry, these designs signal how digital technologies can help shift how users see and act on the world and, as such, they raise the following questions for those designing, using, and studying the next generation of digital technologies for sustainability. First, how can technology designers ensure that the data and models they choose to work with represent the world with all its messy entanglements? What role can the public play in this? Second, how should evidence-based policy that nourishes a plurality of connections, alliances, and communities be developed in and through digital technologies? How can such processes involve and align a variety of actors not only in implementation but also in co-creating a new "operating system" for society? And lastly, how can sustainability practitioners make use of digital technologies to communicate and advocate for future possibilities that nourish commonalities and foreground and strengthen multiple entanglements? What kinds of knowledge and research approaches (cf. Böhme, Spreitzer, and Wamsler 2024) are needed to allow such applications to flourish?

Those who follow current events and read the scientific literature may find very few reasons to be hopeful. The future looks bleak. But do we really have a choice but to practice a form of "active hope" (Macy and Johnstone 2012)? In this sense, and in contrast to Baldwin's (1991) dichotomy, designers (or technologists in general) should not be seen as either "slaves" to the political-economic system within which they operate (although some certainly exhibit the symptoms), nor "saviors" who possess extraordinary life-altering powers (although some innovations do). What designers are capable of is giving radical ideas momentum in and through acts of form-giving. On its own, this is clearly insufficient to set humanity on a new course, and barring a drastic shrinking of the socio-ecological footprint of digital technologies will likely not make much of a difference in the long term. But it is a good start.

Notes

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Disclosure statement

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References

Auger, J. 2013. "Speculative Design: Crafting the Speculation." *Digital Creativity* 24 (1): 11–35. doi:10.1080/14626268.2013.767276.

Aves, A., L. Revell, S. Gaw, H. Ruffell, A. Schuddeboom, N. Wotherspoon, M. LaRue, and A. McDonald. 2022. "First Evidence of Microplastics in Antarctic Snow." *The Cryosphere* 16 (6): 2127–2145. doi:10.5194/tc-16-2127-2022.

Baldwin, J. 1991. "Design as Savior, Design as Slave." *Whole Earth Review*. https://wholeearth.info/p/whole-earth-review-winter-1991

Barad, K. 2007. *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning*. Durham, NC: Duke University Press.

Bendor, R. 2018. *Interactive Media for Sustainability*. London: Palgrave Macmillan.

Bendor, R. 2021. "Transition or Transformation? The Mediated Meanings of Sustainability." In *The Sustainability Communication Reader: A Reflective Compendium*, edited by F. Weder, L. Krainer, and M. Karmasin, 71–87. Cham: Springer.

Berger, P., and T. Luckmann. 1989 [1966]. *The Social Construction of Reality: A Treatise in the Sociology of Knowledge*. New York: Anchor Books.

Biss, E. 2014. *On Immunity: An Inoculation*. Minneapolis, MN: Graywolf Books.

Bleecker, J. 2009. "Design Fiction: A Short Essay on Design, Science, Fact and Fiction." http://drbfw5wfjlxon.cloudfront.net/writing/DesignFiction_WebEdition.pdf

Böhme, J., E. Spreitzer, and C. Wamsler. 2024. "Conducting Sustainability Research in the Anthropocene: Toward a Relational Approach." *Sustainability Science* 19 (4): 1169–1185. doi:10.1007/s11625-024-01510-9.

Bottici, C. 2019. "Imagination, Imaginary, Imaginal: Towards a New Social Ontology?" *Social Epistemology* 33 (5): 433–441. doi:10.1080/02691728.2019.1652861.

Bridle, J. 2022. *Ways of Being: Beyond Human Intelligence*. London: Penguin.

Candy, S. 2017. "Dreaming Together: Experiential Futures as a Platform for Public Imagination." In *Made Up: Design's Fictions*, edited by T. Durfee and M. Zeiger, 44–48. Barcelona: Actar Publishers.

Castoriadis, C. 1997. *The Imaginary Institution of Society*, translated by K. Blamey. Cambridge, MA: MIT Press.

Chagnon, C., S. Hagolani-Albov, and S. Hokkanen. 2021. "Extractivism at Your Fingertips." In *Our Extractive Age*, edited by J. Shapiro and J.-A. McNeish, 176–188. London: Routledge.

Comber, R., and E. Eriksson. 2023. "Computing as Ecocide." Proceedings of LIMITS '23: Ninth Workshop on Computing within Limits. https://assets.pubpub.org/8ywvpdep/51686070698433.pdf

Crawford, K. 2021. *The Atlas of AI: Power, Politics, and the Planetary Costs of Artificial Intelligence*. New Haven, CT: Yale University Press.

Damasio, A. 1994. *Descartes' Error: Emotion, Reason, and the Human Brain*. New York: Putnam.

Digitalization for Sustainability. 2023. *Digital Reset. Redirecting Technologies for the Deep Sustainability Transformation*. Munich: oekom.

Dunn, N., L. Cruickshank, and G. Coupe, eds. 2024. *Flourish by Design*. London: Routledge.

Dunne, A., and F. Raby. 2013. *Speculative Everything: Design, Fiction, and Social Dreaming*. Cambridge, MA: MIT Press.

Ehrenfeld, J. 2008. *Sustainability by Design: A Subversive Strategy for Transforming Our Consumer Culture*. New Haven, CT: Yale University Press.

Elhacham, E., L. Ben-Uri, J. Grozovski, Y. Bar-On, and R. Milo. 2020. "Global Human-Made Mass Exceeds All Living Biomass." *Nature* 588 (7838): 442–444. doi:10.1038/s41586-020-3010-5.

Escobar, A. 2018. *Designs for the Pluriverse: Radical Interdependence, Autonomy, and the Making of Worlds*. Durham, NC: Duke University Press.

Escobar, A., M. Osterweil, and K. Sharma. 2024. *On Relationality: An Emergent Politics of Life Beyond the Human*. London: Bloomsbury.

Freitag, C., M. Berners-Lee, K. Widdicks, B. Knowles, G. Blair, and A. Friday. 2021. "The Real Climate and Transformative Impact of ICT: A Critique of Estimates, Trends, and Regulations." *Patterns (New York, N.Y.)* 2 (9): 100340. doi:10.1016/j.patter.2021.100340.

Haraway, D. 1997. *Modest_Witness@Second_Millennium. FemaleMan©_Meets_OncoMouse™: Feminism and Technoscience*. London: Routledge.

Haraway, D. 2016. *Staying with the Trouble: Making Kin in the Chthulucene*. Durham NC: Duke University Press.

Held, D. 2006. *Models of Democracy*. 3rd ed. Cambridge: Polity.

Hickel, J. 2023. "On Technology and Degrowth." *Monthly Review* 75 (3)https://monthlyreview.org/2023/07/01/on-technology-and-degrowth/.

Huypens, P., S. Sass, M. Wu, D. Dyckhoff, M. Tschöp, F. Theis, S. Marschall, M. Hrabě de Angelis, and J. Beckers. 2016. "Epigenetic Germline Inheritance of Diet-Induced Obesity and Insulin Resistance." *Nature Genetics* 48 (5): 497–499. doi:10.1038/ng.3527.

Ichioka, S., and M. Pawlyn. 2021. *Fourish. Design Paradigms for Our Planetary Emergency*. Axminster: Triarchy Press.

Istrate, R., V. Tulus, R. Grass, L. Vanbever, W. Stark, and G. Guillén-Gosálbez. 2024. "The Environmental Sustainability of Digital Content Consumption." *Nature Communications* 15 (1): 3724. doi:10.1038/s41467-024-47621-w.

Jasanoff, S., and S.-H. Kim, eds. 2015. *Dreamscapes of Modernity: Sociotechnical Imaginaries and the Fabrication of Power*. Chicago: University of Chicago Press.

Kahneman, D. 2011. *Thinking, Fast and Slow*. New York: Farrar, Straus and Giroux.

Kerschner, C., P. Wächter, L. Nierling, and M.-H. Ehlers. 2018. "Degrowth and Technology: Towards Feasible, Viable, Appropriate and Convivial Imaginaries." *Journal of Cleaner Production* 197: 1619–1636. doi:10.1016/j.jclepro.2018.07.147.

Kimmerer, R. 2013. *Braiding Sweetgrass. Indigenous Wisdom, Scientific Knowledge, and the Teachings of Plants*. Minneapolis, MN: Milkweed Editions.

Latour, B. 1993. *We Have Never Been Modern*. Cambridge, MA: Harvard University Press.

Machado de Oliveira, V. 2021. *Hospicing Modernity. Facing Humanity's Wrongs and the Implications for Social Activism*. Berkeley, CA: North Atlantic Books.

Macy, J., and C. Johnstone. 2012. *Active Hope: How to Face the Mess We're in with Unexpected Resilience and Creative Power*, Rev. ed. Novato, CA: New World Library.

Margulis, L., and D. Sagan. 1997. *Microcosmos: Four Million Years of Microbial Evolution*. Berkeley, CA: University of California Press.

Meadows, D. 1999. "Leverage Points: Places to Intervene in a System." http://www.donellameadows.org/wp-content/userfiles/Leverage_Points.pdf

Milkoreit, M. 2017. "Imaginary Politics: Climate Change and Making the Future." *Elementa: Science of the Anthropocene* 5: 62. doi:10.1525/elementa.249.

One Planet Network. 2023. *Rethinking, Extending, Re-Using. Harnessing Digital Technologies for the Circular Economy*. Paris: One Planet Network. https://www.oneplanetnetwork.org/sites/default/files/2023-11/RETHINKING%2C%20EXTENDING%2C%20REUSING-%20HARNESSING%20DIGITAL%20TECHNOLOGIES%20FOR%20THE%20CIRCULAR%20ECONOMY%20-%205%20%281%29.pdf.

Pelzer, P., and W. Versteeg. 2019. "Imagination for Change: The Post-Fossil City Contest." *Futures* 108: 12–26. doi:10.1016/j.futures.2019.01.005.

Puig de la Bellacasa, M. 2017. *Matters of Care: Speculative Ethics in More Than Human Worlds*. Minneapolis, MN: University of Minnesota Press.

Ragusa, A., V. Notarstefano, A. Svelato, A. Belloni, G. Gioacchini, C. Blondeel, E. Zucchelli, et al. 2022. "Raman Microspectroscopy Detection and Characterisation of Microplastics in Human Breastmilk." *Polymers* 14 (13): 2700. doi:10.3390/polym14132700.

Rehak, R. 2024. "On the (Im)Possibility of Sustainable Artificial Intelligence." *Internet Policy Review* 13 (3) https://policyreview.info/articles/news/impossibility-sustainable-artificial-intelligence/1804.

Superflux. 2024. "The Ecological Intelligence Agency." https://superflux.in/index.php/work/the-ecological-intelligence-agency/#

Taylor, C. 2004. *Modern Social Imaginaries*. Durham, NC: Duke University Press.

Thiel, T. n.d. "Unexpected Growth." https://tamikothiel.com/unexpectedgrowth/index.html

Turtle, G., C. Guerrero Millan, S. Özçetin, M. Patil, and R. Bendor. 2022. "Sensing in the Wild: A DCODE DRS Lab Exploring a More-Than-Human Approach to Distributed Urban Sensing." DRS2022. doi:10.21606/drs.2022.912.

Viveiros de Castro, E., and D. Danowski. 2020. "The Past Is Yet to Come." *e-flux 114*. https://www.e-flux.com/journal/114/364412/the-past-is-yet-to-come/

Whiting, K., and H. Park. 2023. "This is Why 'Polycrisis' is a Useful Way of Looking at the World Right Now." *World Economic Forum*, March 7. https://www.weforum.org/stories/2023/03/polycrisis-adam-tooze-historian-explains/

Yarmolinsky, A. 1968. "The Service Society." *Daedalus* 97 (4): 1263–1276.

Yehuda, R., N. Daskalakis, L. Bierer, H. Bader, T. Klengel, F. Holsboer, and E. Binder. 2016. "Holocaust Exposure Induced Intergenerational Effects on FKBP5 Methylation." *Biological Psychiatry* 80 (5): 372–380. doi:10.1016/j.biopsych.2015.08.005.

Yusoff, K., and J. Gabrys. 2011. "Climate Change and the Imagination." *WIREs Climate Change* 2 (4): 516–534. doi:10.1002/wcc.117.