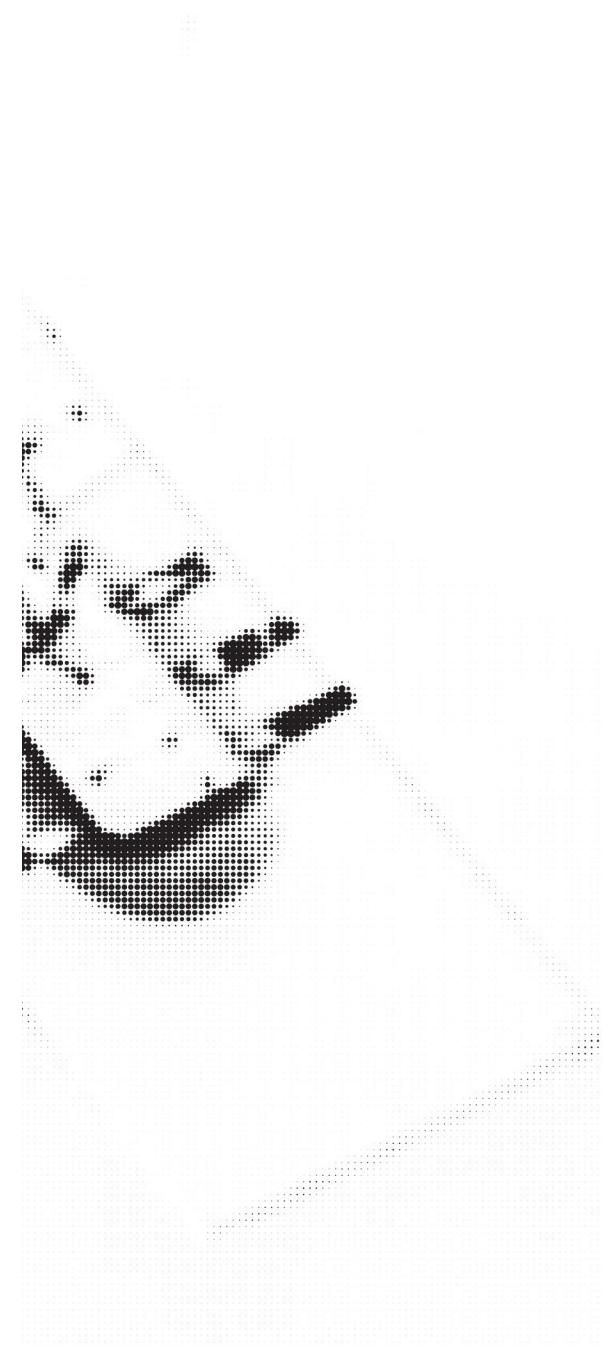


FORWARD  
A MATERIAL  
PHYSICS  
OF COMPUTING

This zine summarizes discussions from a workshop, "Towards a Material Ethics of Computing: Addressing the Uneven Environmental Stakes of Digital Infrastructures," at the 2022 Conference on Human Factors in Computing Systems (CHI), which took place on 1 May 2022.

The workshop was organized by:

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Daniela Rosner  
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FIN

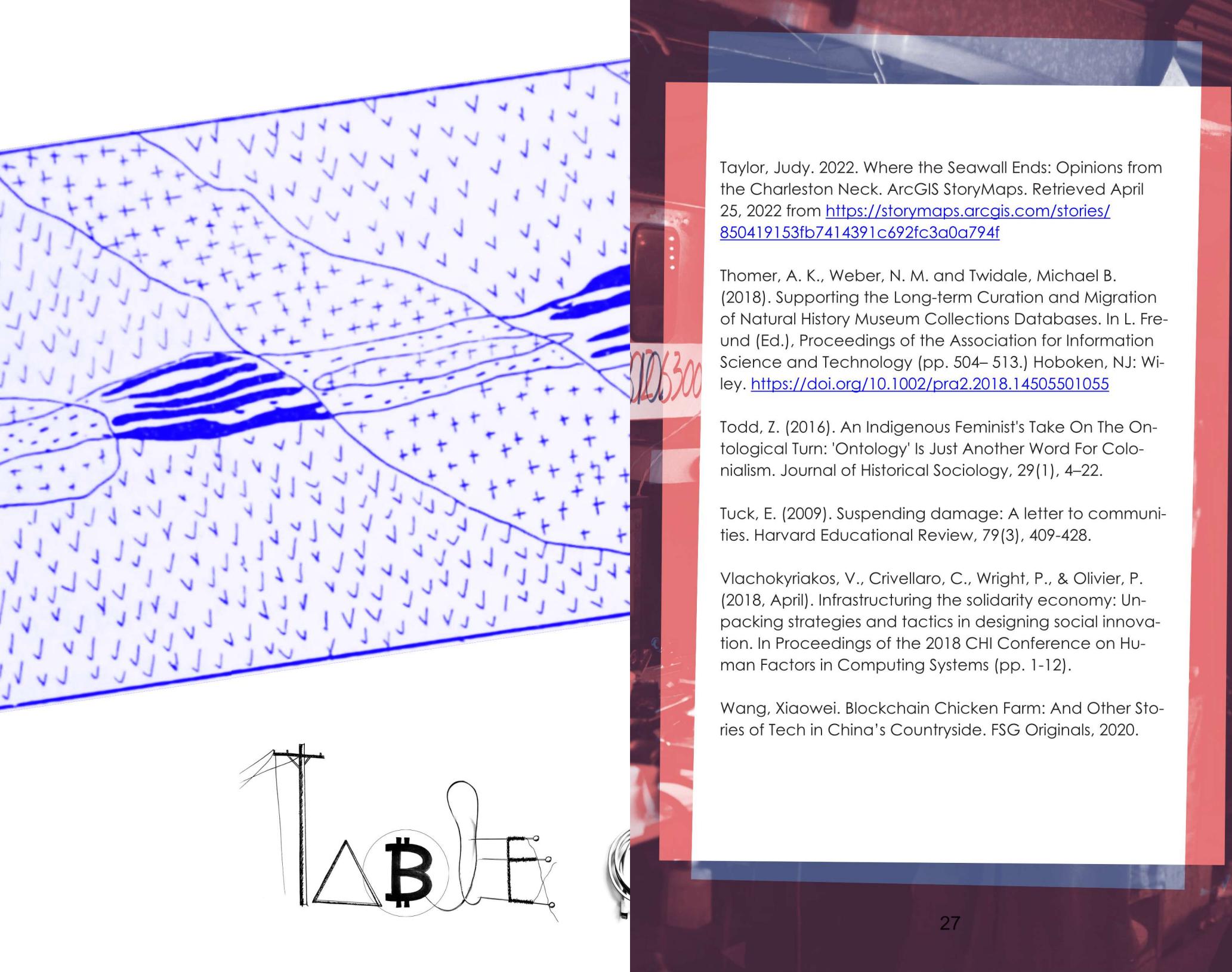


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This zine was compiled, designed, and printed by Anne Pasek, with type design by Arden Stern.

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Taylor, Judy. 2022. Where the Seawall Ends: Opinions from the Charleston Neck. ArcGIS StoryMaps. Retrieved April 25, 2022 from <https://storymaps.arcgis.com/stories/850419153fb7414391c692fc3a0a794f>

Thomer, A. K., Weber, N. M. and Twidale, Michael B. (2018). Supporting the Long-term Curation and Migration of Natural History Museum Collections Databases. In L. Freund (Ed.), Proceedings of the Association for Information Science and Technology (pp. 504– 513.) Hoboken, NJ: Wiley. <https://doi.org/10.1002/pra2.2018.14505501055>

Todd, Z. (2016). An Indigenous Feminist's Take On The Ontological Turn: 'Ontology' Is Just Another Word For Colonialism. *Journal of Historical Sociology*, 29(1), 4–22.

Tuck, E. (2009). Suspending damage: A letter to communities. *Harvard Educational Review*, 79(3), 409-428.

Vlachokyriakos, V., Crivellaro, C., Wright, P., & Olivier, P. (2018, April). Infrastructuring the solidarity economy: Unpacking strategies and tactics in designing social innovation. In Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (pp. 1-12).

Wang, Xiaowei. Blockchain Chicken Farm: And Other Stories of Tech in China's Countryside. FSG Originals, 2020.

Plantin, J-C. Data Cleaners for Pristine Datasets: Visibility and Invisibility of Data Processors in Social Science. *Science, Technology, & Human Values*. 2019;44(1):52-73.  
doi:[10.1177/0162243918781268](https://doi.org/10.1177/0162243918781268)

Rosner, Daniela. *Critical Fabulations : Reworking the Methods and Margins of Design*. The MIT Press, 2018.

Russell, Andrew L; Vinsel, Lee. "After Innovation, Turn to Maintenance." *Technology and Culture*, vol. 59, no. 1, United States: Johns Hopkins University Press, pp. 1–25, doi:[10.1353/tech.2018.0004](https://doi.org/10.1353/tech.2018.0004).

Samuelson, Pamela. "Freedom to Tinker." *Theoretical Inquiries in Law*, vol. 17, no. 2, 2016, pp. 562–600.

Scott, James C. *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed*. Yale University Press, 1998.

Strasser, BJ. The experimenter's museum: GenBank, natural history, and the moral economies of biomedicine. *Isis*. 2011 Mar;102(1):60-96. doi: [10.1086/658657](https://doi.org/10.1086/658657). PMID: 21667776.

Suchman, L. (2002). Located accountabilities in technology production. *Scandinavian journal of information systems*, 14(2), 7.

Takaragawa, S., Smith, T. L., Hennessy, K., Astacio, P. A., Chio, J., Nye, C., & Shankar, S. (2019). Bad Habitus: Anthropology in the Age of the Multimodal. *American Anthropologist*, 2(121).

What are Material Ethics?

Material Ethics: A Constellation

Keywords for Material Ethics in Computing

Infrastructure

Nature

Mining

Transitions

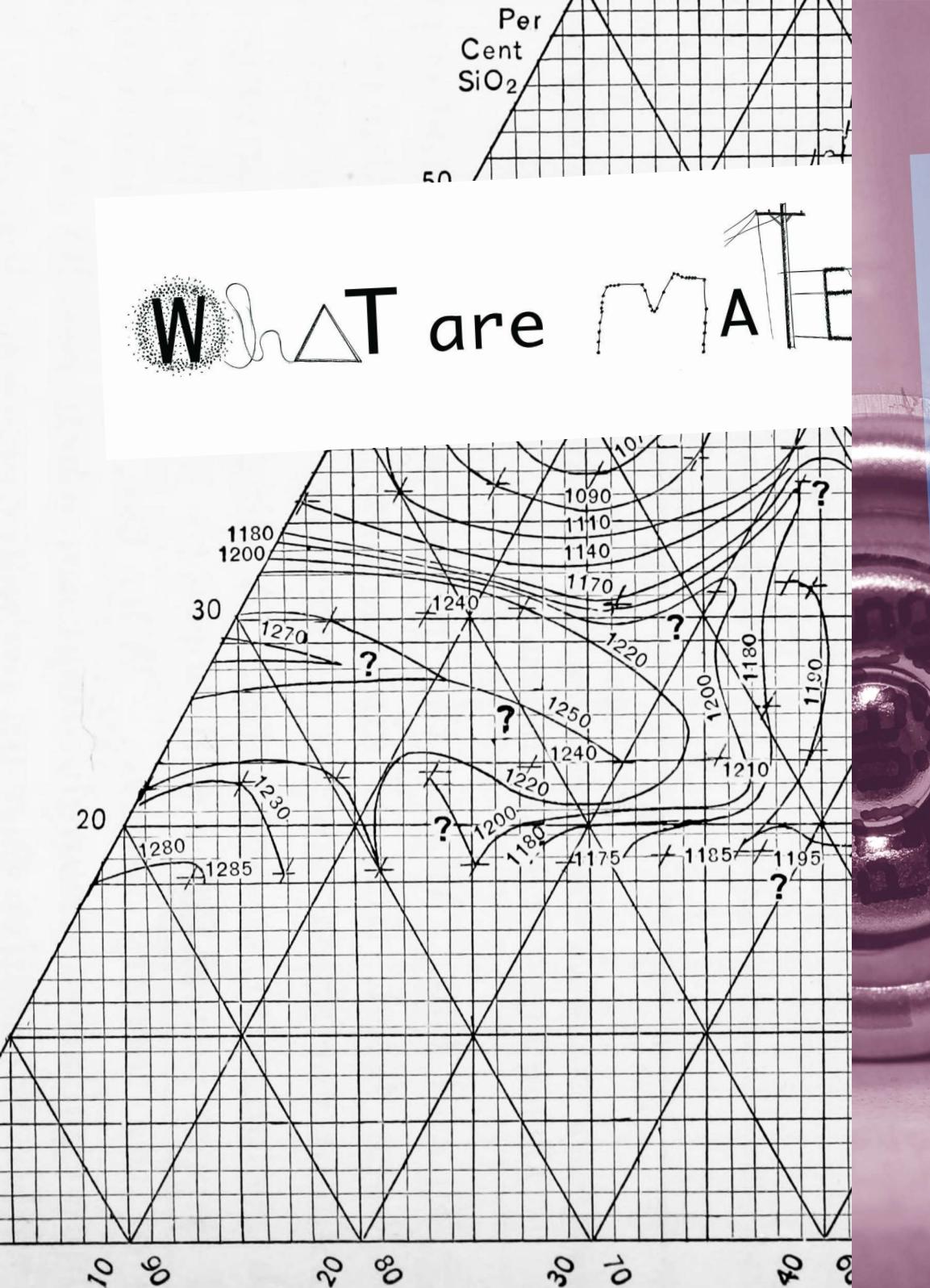
Research

Justice

How Can Researchers Operationalize Material Ethics in Their Work?

Further Reading

OFF CONTENT



[article/view/495](https://archive.nordes.org/index.php/n13/article/view/495)

Lindström, K., & Ståhl, Å. (2019). Caring design experiments in the aftermath. In 8th Bi-Annual Nordic Design Research Society Conference-Who Cares? 2-4th of June 2019 Finland (pp. 1-9). <https://archive.nordes.org/index.php/n13/article/view/495>

Lindtner, S. M. (2020). Prototype Nation. In Prototype Nation. Princeton University Press.

Liu Cixin. 2020. Fire in the Earth. In To Hold Up the Sky. Tor Books, New York, 2020, 78-113.

Liu Cixin. 2020. Fire in the Earth. In To Hold Up the Sky. Tor Books, New York, 2020, 78-113.

Mattern, S. (2021). A city is not a computer: Other urban intelligences (Vol. 2). Princeton University Press.

Loveless, N. (2019). How to make art at the end of the world: a manifesto for research-creation.. Duke University Press.

Mbembe, Achille (2020) The Universal Right to Breathe. Critical Inquiry 47 (Winter 2021)

Mwewa, L. & Bidwell, N.J. (2015) African Narratives in Technology Research & Design. In: Intersections between Indigenous and Traditional Knowledges and Technology Design. Informing Science. (N.J. Bidwell, H. Winschiers-Theophilus, eds).

Oliver, Julian. Harvest. <https://julianoliver.com/projects/harvest/>

Knowles, Bran, Oliver Bates, and Maria Håkansson. 2018. This Changes Sustainable HCI. In Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (CHI '18), Association for Computing Machinery, New York, NY, USA, 1–12. DOI: <https://doi.org/10.1145/3173574.3174045>

Lazaro Vasquez, E. S., Wang, H. C., & Vega, K. (2020, July). Introducing the sustainable prototyping life cycle for digital fabrication to designers. In Proceedings of the 2020 ACM Designing Interactive Systems Conference (pp. 1301–1312).

León, G., Kirabo, L., Wong-Villacres, M., Karusala, N., Kumar, N., Bidwell, N.J., Reynolds-Cuéllar, P., Borah, P., Garg, R., Oswal, S.K., Chuanromanee, T., Sharma, V. (2021) Following the Trail of Citational Justice: Critically Examining Knowledge Production in HCI Proc. CSCW'21

Lewis, J. E., Philip, N., Arista, N., Pechawis, A., & Kite, S. (2018). Making Kin with the Machines. Journal of Design and Science. <https://jods.mitpress.mit.edu/pub/lewis-arista-pechawis-kite/release/1>

Liboiron, Max. "Compromised agency: The case of BabyLegs." Engaging Science, Technology, and Society 3, no. 0 (2017): 499-527.

Liboiron, M. (2021). Pollution is colonialism. Duke University Press.

Lindström, K., & Ståhl, Å. (2019). Caring design experiments in the aftermath. In 8th Bi-Annual Nordic Design Research Society Conference-Who Cares? 2-4th of June 2019 Finland (pp. 1-9). <https://archive.nordes.org/index.php/n13/>



new materialist inquiries into the politics and ecological legacies of toxins, global supply chains, expansive infrastructures, and worsening climate change.

Ethics is an increasingly charged concept in both HCI and wider media industries. Tech giants, scholars, and grassroots coalitions have all attempted to define, delimit, and contest the role of ethics research in the industry, with 'ethics-washing' emerging as a key concern. Our approach here is mindful of these debates, while aiming for less determined ends: we speak of ethics in the plural, acknowledging that the problems we set out to chart will not have a singular answer that can be deduced through abstract moral reasoning, but will instead need to be determined in specific contexts and through grounded struggles. We also include researchers in the remit of material ethics' concerns; in addition to industry and policy actors, our own fields, methods, and community engagement processes also merit scrutiny for the omissions and harms they may enact.

The concept of material ethics is still in formation. It first emerged out of conversations between Daniela Rosner, Steve Jackson, Lara Houston and Jen Liu, and was further developed in this workshop. We began with these two broad questions:

- ▷ How do environments influence and constrain the way computing technologies are designed, produced, maintained, repaired, and circulated?

Fields, D., & Raymond, E. L. (2021). Racialized geographies of housing financialization. *Progress in Human Geography*, 45(6), 1625-1645.

Foster, W. Z. (1936). Organizing methods in the steel industry. <https://www.marxists.org/archive/foster/1936/10/organizing-methods-steel-industry/index.htm> (h/t Amazon Labour Union)

Fouche, Rayvon. "From Black Inventors to One Laptop Per Child: Exporting a Racial Politics of Technology." In *Digitizing Race: Visual Cultures of the Internet*, edited by Lisa Nakamura and Peter Chow-White, 61–83. Minneapolis: University of Minnesota Press, 2008.

Hecht, G. (2014). *Being nuclear: Africans and the global uranium trade*. MIT press.

Iheka, C. (2021). *African Ecomedia: Network Forms, Planetary Politics*. Duke University Press.

Jackson, S. (2014). Rethinking Repair. In P. J. Boczkowski, T. Gillespie, & K. A. Foot (Eds.), *Media technologies: Essays on communication, materiality, and society* (pp. 221–239). MIT Press.

James, J. (2020). Airbrushing revolution for the sake of abolition. *Black Perspectives*, 20. <https://www.aaihs.org/airbrushing-revolution-for-the-sake-of-abolition/>

Jasanoff, S. (2017). Virtual, visible, and actionable: Data assemblages and the sightlines of justice. *Big Data & Society*, 4(2), [2053951717724477](https://doi.org/10.53951717724477).

Lab.

D'Ignazio, Catherine ; Klein, Lauren F. Data Feminism. Cambridge: MIT Press, pp. xii–314, doi:[10.7551/mitpress/11805.001.0001](https://doi.org/10.7551/mitpress/11805.001.0001).

Davis, Heather. 2015. "Toxic Progeny : The Plastisphere and Other Queer Futures." *Philosophia* 5 (2): 231–50.

Davoli, L., & Redström, J. (2014, June). Materializing infrastructures for participatory hacking. In Proceedings of the 2014 conference on Designing interactive systems (pp. 121-130). <https://doi.org/10.1145/2598510.2602961>

Dibbell, Julian. 2002. A Marketable Wonder. Topic Magazine (Autumn 2002). Retrieved from <http://www.juliandibbell.com/texts/cavespace.html>.

Dibbell, Julian. 2002. A Marketable Wonder. Topic Magazine (Autumn 2002). Retrieved from <http://www.juliandibbell.com/texts/cavespace.html>.

Dourish, P. (2010, August). HCI and environmental sustainability: the politics of design and the design of politics. In Proceedings of the 8th ACM conference on designing interactive systems (pp. 1-10).

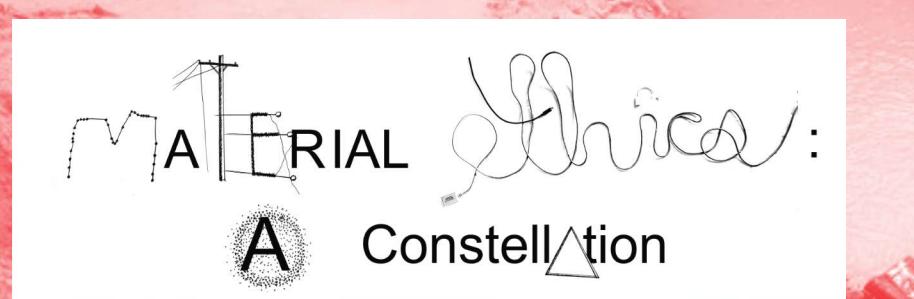
Ekbja, H., & Nardi, B. (2015). The political economy of computing: The elephant in the HCI room. *Interactions*, 22(6), 46-49.

Ensmenger, N. (2018). The Environmental History of Computing. *Technology and Culture*, 59(4), S7–S33



▷ How do digital infrastructures affect our knowledge of environmental and labour developments and dynamics?

Our answers, and the connections we found across the diversity of research interests in attendance, shape what follows.



Bell, J., Kobak, B., Kuipers, J., & Kemble, A. (2018). Unseen Connections: The Materiality of Cell Phones. *Anthropological Quarterly*, 91(2), 465-484.

Cains, M. G. (2021). Integrating Climate Change Vulnerability, Risk, and Resilience for Place-Based Assessment of Socio-Ecological Systems: Charleston Harbor Watershed, SC, USA (Doctoral dissertation, Indiana University).

Calvão, Filipe and Matthew Archer. 2021. Digital Extraction: Blockchain Traceability in Mineral Supply Chains. *Political Geography* 87 (2021), 11 pages. DOI: <https://doi.org/10.1016/j.polgeo.2021.102381>

Calvão, Filipe, and Matthew Archer. 2021. Digital Extraction: Blockchain Traceability in Mineral Supply Chains. *Political Geography* 87 (2021), 11 pages. DOI: <https://doi.org/10.1016/j.polgeo.2021.102381>

Chin, Elizabeth. "Laboratory of Speculative Ethnology: Suits of Inquiry." *E-Misferica* 12, no. 1 (2015). <http://hemi-sphericinstitute.org/hemi/en/emisferica-121-caribbean-rasanblaj/chin>

Caycedo, Carolina, Water Portraits: <http://carolinacaycedo.com/water-portraits-2016>

Cooper, Z. G. T. (2021). Of dog kennels, magnets, and hard drives: Dealing with Big Data peripheries. *Big Data & Society* 8(2) <https://doi.org/10.1177%2F20539517211015430>

Crawford, K., & Joler, V. (2018). Anatomy of an AI System: The Amazon Echo as an Anatomical Map of Human Labor, Data and Planetary Resources. AI Now Institute and Share



## FURTHER READING

This bibliography represents texts that participants submitted in advance of our workshop, representing scholarship that was important to their own development and navigation in these fields, and which they would recommend to others. Repeated entries represent texts that were submitted by more than one participant.

==

Baumer, E. P., & Silberman, M. S. (2011, May). When the implication is not to design (technology). In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 2271-2274).

Belding, Elizabeth, Marisa Duarte, Morgan Vigil-Hayes, Ellen Zegura, PuebloConnect, <https://puebloconnect.cs.ucsb.edu/our-team/>

Where does labor live?

Labor is found in sites of extraction, execution, histories, transnational flows, forms of waste and wasting, repair, specific geographies, launch (i.e. into space), social reproduction, technical standards, and more.

It's labor all the way down.

Yet labor often gets elided—especially in user experiences and the ways we teach digital systems.

This should change. How can design consider the network of material relations that make labor invisible? What's the role of art and creative practices in changing this?

Moments where systems seem to shift from materiality to immateriality (and back again) are particularly useful points of inflection.

## We can offer alternatives without needing to find a ‘complete solution’

Humility is an important counterforce to technoutopian solutionism.

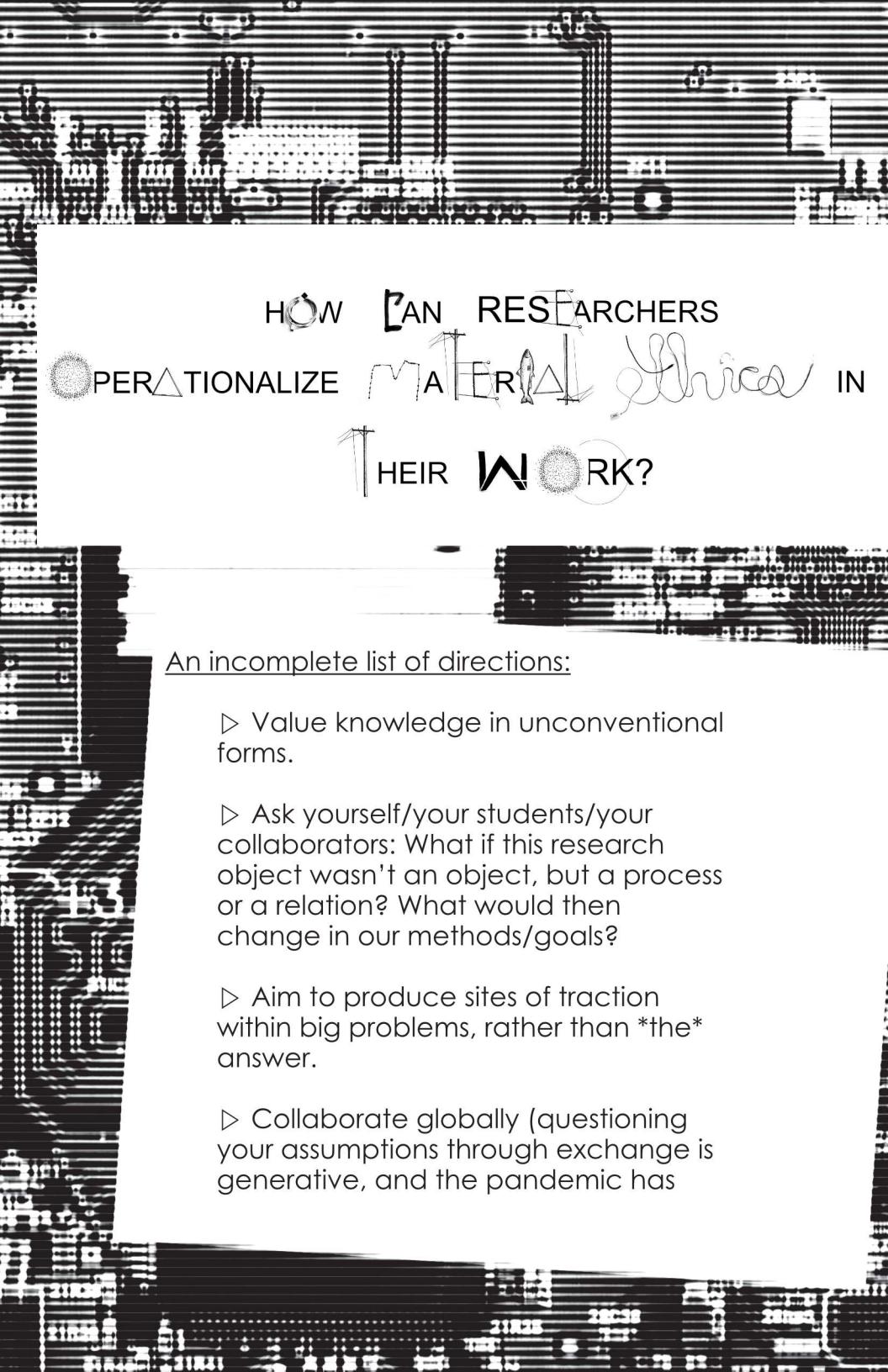
Solutionism is often a way of protecting existing structures and interests by seeking to ‘fix’ critique rather than engaging with its roots. This often ignores intersecting problems, long-lasting legacies, and more radical calls for justice.

It also ignores diverse and sometimes subtle significant ways communities build power and do politics: sometimes persistence is a form of resistance.

So it’s best to ‘stick with the knots’ of a problem and look for ‘collaborative re-storying’ in our approaches.

given us new skills/horizons to this end).

- ▷ Seek legibility to audiences outside your department and academic field.
- ▷ Build public engagement into your research process and wider academic institutions of hiring and review.
- ▷ Share teaching resources, especially those with a perpendicular relation to computing.
- ▷ Ground your ethics in a specific community you want to write both for and with, and to whom you will be accountable.
- ▷ Input these vital perspectives to the HCI community via SIGCHI’s Sustainability Committee. SIGCHI influences HCI research by supporting 25 conferences in the field of HCI (including CHI), facilitating committees on research ethics, HCI education, accessibility, equity, publications etc.
- The Sustainability Committee will shortly have a webpage on the [SigCHI website](#). In the meantime, you can read about the [Sustainability Committee’s formative goals](#).



# HOW CAN RESEARCHERS OPERATIONALIZE MATERIAL THINGS IN THEIR WORK?

An incomplete list of directions:

- ▷ Value knowledge in unconventional forms.
- ▷ Ask yourself/your students/your collaborators: What if this research object wasn't an object, but a process or a relation? What would then change in our methods/goals?
- ▷ Aim to produce sites of traction within big problems, rather than \*the\* answer.
- ▷ Collaborate globally (questioning your assumptions through exchange is generative, and the pandemic has

Sometimes a necessary goal is not to reveal something new, but to find a new way to feel

Data, labor, and technical infrastructures all matter in the environmental and social harms caused by digital systems, as well as the ways we research these harms.

These are broad and expansive categories, which can culminate in a tremendous litany of research objects—more than we can effectively conceive of or think across at once.

Visibility has political limits, and can itself cause harms. Some things are hidden or underplayed for good reasons. If our critical project revolves around the work bringing something new to light, we need to ask: to whom, and to what end?

It's often the case that good solutions to a problem are already known—but not yet easily imagined. Creative practices and research methods can help here. Sometimes what's needed are new ways to feel about an issue, rather than new knowledge that seeks to solve a problem.



# KEYWORD<sup>s</sup> FOR MATERIAL IN COMPUTING

*Ethics*



## Justice

Justice does not have a universal meaning, though its deployment in the Global North often presumes that this is so.

Its use and character shifts depending on audiences and geographies. For many people in the Global Souths, and colonised Global North, terms like reparations, reconciliation, decolonization might be more legible than a universal ‘justice.’

Justice (understood as proximate to legal practices and frameworks) tends to see problems as resolvable, with a distinct solution. This often forecloses questions of historical legacies, the affective dimensions of care, and responsibilities that extend beyond discrete individuals who have experienced especially legible harms.

Against this tendency, we might think towards a justice that is more iterative and process-oriented instead one defined in pursuit of a singular end goal. This form of justice would be one through which we can better articulate political commitments and values.

At the same time, existing Western legal traditions can also be strategically mobilized to more expansive ends. The strategic essentialism—or simple cunning—of using juridical structures to win legal status for non-human entities like rivers is a case in point. Sometimes you don’t get to choose the language through which you can make claims.

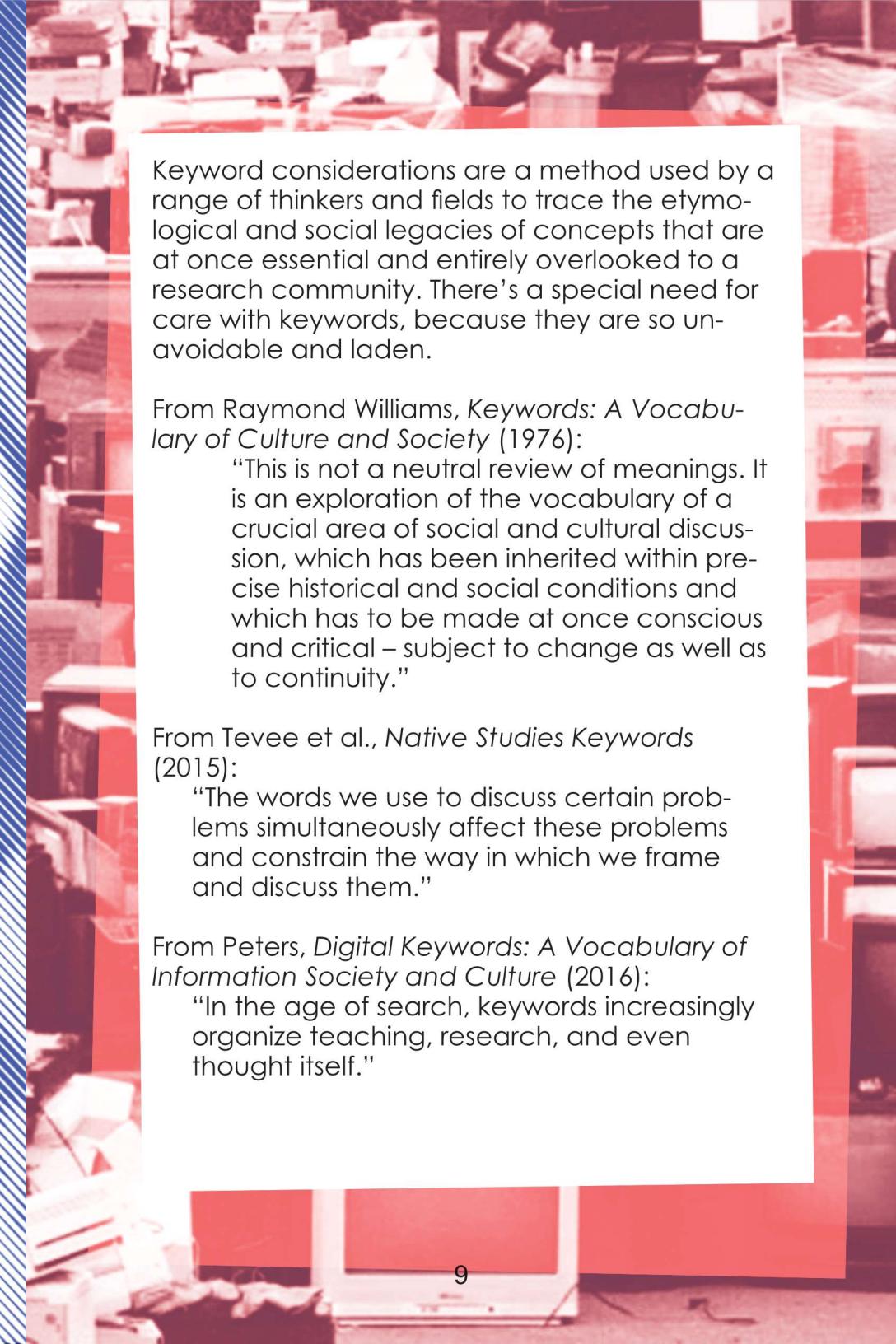
## Research

Research can be thought of as an act of drifting, rather than a solution-seeking process. Often the experience of inquiry involves being pulled towards things—the creative sparks that often come ahead of reasoning.

From the traditions of research-creation/critical making, we can invest in ways of knowing that fall outside of empirical norms.

This orientation to research helps emphasize the materials you work with / that resist you / that disorient you. This helps with reflexivity, disrupting personal sedimentations in your orientation to the world.

Going further, we can orient towards material engagements beyond making, seeking responsiveness to (more than mastery over) our materials.



Keyword considerations are a method used by a range of thinkers and fields to trace the etymological and social legacies of concepts that are at once essential and entirely overlooked to a research community. There's a special need for care with keywords, because they are so unavoidable and laden.

From Raymond Williams, *Keywords: A Vocabulary of Culture and Society* (1976):

"This is not a neutral review of meanings. It is an exploration of the vocabulary of a crucial area of social and cultural discussion, which has been inherited within precise historical and social conditions and which has to be made at once conscious and critical – subject to change as well as to continuity."

From Tevee et al., *Native Studies Keywords* (2015):

"The words we use to discuss certain problems simultaneously affect these problems and constrain the way in which we frame and discuss them."

From Peters, *Digital Keywords: A Vocabulary of Information Society and Culture* (2016):

"In the age of search, keywords increasingly organize teaching, research, and even thought itself."

## Infrastructure

Infrastructures are technical systems that provide the platform for widespread human action. As such, infrastructures are always a question of governance, in durable terms.

Different disciplines define infrastructure differently. For some, it's a very material question of wires, concrete, tubes. For others, an organizational studies perspective brings in the humans, social systems, and labor of coordination across institutions. We like to combine both.

Infrastructure replaced the idea of 'public works' (which is telling, since now so much of it is private).

Infrastructure has obvious ethical stakes, with very unevenly distributed benefits and standards of access. As such, infrastructure is a relational question.

What often gets left out of discussions of infrastructure?

- ▷ The materials that we use to build the infrastructure
- ▷ Scale
- ▷ Non-users
- ▷ Culture

don't know what should replace them. The only ways forward are to be found in iterative experimentation and collation—both technical and social—feeling towards futures that might be more livable.

We find the most cause for optimism in the latter.



## Transition

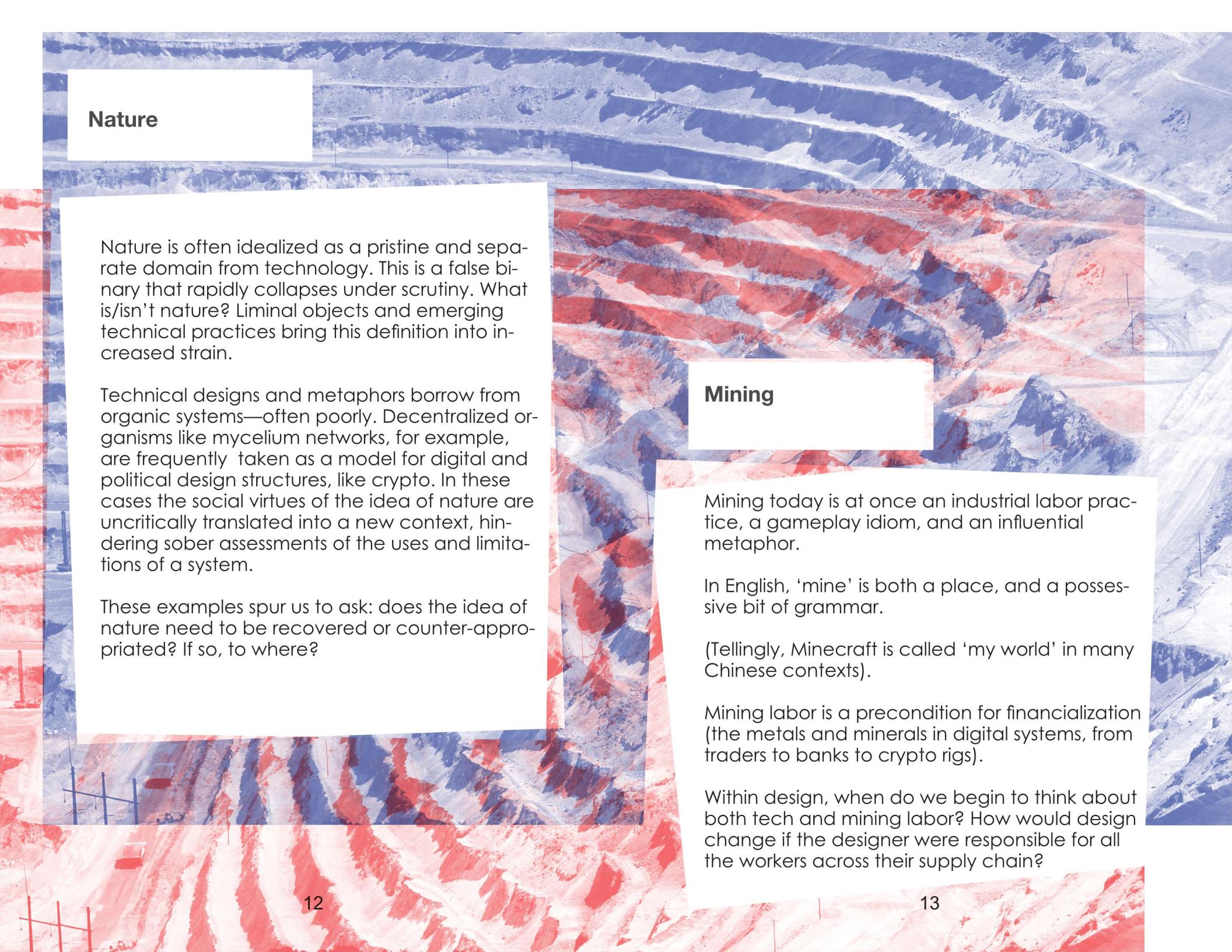
We often presume that transitions signal a clean shift between fundamentally different conditions. This rarely actually happens. From energy to gender to politics to data schema, transitions abound with ghosts, memories, and hidden work that persists, as well as new pressures and continually evolving relations.

Instead of a predefined end to be achieved, it's often most useful to think of transitions as a process of working through. This is often frustrating, as the temporalities and desires of transitions can be acute. The present may be intolerable. Yet futures, invariably, take time to form.

There are 3 models of transitions to consider:

- ▷ **The Revolutionary:** Our big ideologies are bad, and must be entirely transformed with and through massive changes to our technical forms in a big disruptive sweep
- ▷ **The Reformist:** Our big ideologies are fine, but some unfortunate side effects in our technical or social forms require tweaking, in the least disruptive ways possible.
- ▷ **The Emergent:** Our big ideologies are no longer serving a useful purpose, yet we





## Nature

Nature is often idealized as a pristine and separate domain from technology. This is a false binary that rapidly collapses under scrutiny. What is/isn't nature? Liminal objects and emerging technical practices bring this definition into increased strain.

Technical designs and metaphors borrow from organic systems—often poorly. Decentralized organisms like mycelium networks, for example, are frequently taken as a model for digital and political design structures, like crypto. In these cases the social virtues of the idea of nature are uncritically translated into a new context, hindering sober assessments of the uses and limitations of a system.

These examples spur us to ask: does the idea of nature need to be recovered or counter-appropriated? If so, to where?

## Mining

Mining today is at once an industrial labor practice, a gameplay idiom, and an influential metaphor.

In English, 'mine' is both a place, and a possessive bit of grammar.

(Tellingly, Minecraft is called 'my world' in many Chinese contexts).

Mining labor is a precondition for financialization (the metals and minerals in digital systems, from traders to banks to crypto rigs).

Within design, when do we begin to think about both tech and mining labor? How would design change if the designer were responsible for all the workers across their supply chain?