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Knowing:  
Writing Architectural  
History through  
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Yours very truly,

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*Environmental Histories of Architecture* is a series of essays that, together, rethink the discipline and profession of architecture by offering different understandings of how architecture and the environment have been co-produced. While cross-disciplinary research has focused on the new realities of the Anthropocene, architecture's complex historical relationship to nature—indeed to the very concept of the environment—has yet to be reconsidered in its political, economic, and cultural dimensions. The pragmatic, techno-utopian, or even environmentalist stances that have thus far monopolized this relationship do not equip architectural practices for the challenges ahead. The task now falls to anyone producing historical analyses and theoretical reflections to pursue a more critical, even operative, engagement with environmental relations beyond the themes of energy and climate change. Through unique methodological and conceptual framings, the nine chapters of *Environmental Histories of Architecture* examine the relationship between society and the environment, complicate understandings of architecture and history, and challenge assumptions of modernization and path dependency. In these ways, as highlighted in the concluding essay, the publication suggests sustainable trajectories for architectural thought and action that can overcome dominant narratives of inevitability and apocalypse.

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Undisciplined Knowing:  
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Kim Förster

## Undisciplined Knowing: Writing Architectural History through the Environment

Kim Förster surveys and unfolds three key issues for the architectural humanities: energy and climate; materials and toxicity; and more-than-human and entangled histories. Such narratives of the environment have thus far only played a minor role in architecture and architectural histories, which are still strongly influenced by nineteenth- and twentieth-century notions of innovation, growth, and progress. But beyond mourning or garnering hope in the face of current climate and biodiversity crises, it will be crucial in the years ahead for architecture to productively cope with loss and actively approach a building transition. Taking environment as both a research subject and a category of analysis, this concluding chapter frames *Environmental Histories of Architecture* by sketching prospects for future research and pointing to new perspectives on social relations to nature.

It is no coincidence that environmental history approaches and new types of narration are in demand more than ever in architecture. Urgent subjects such as climate and biodiversity crises of a planetary scale; the end of the fossil age; the Western lifestyle; resource and energy use and their wastefulness; and the ugly face of extractivism, especially in the Global South—all such global challenges are not only current political topics of daily news, they also have long found a foothold in the profession and industry of architecture as subjects of popular and academic debate. The difference, however, between architectural history and historical studies, and the humanities in general, is that architectural history—despite widespread awareness of contemporary environmental issues and debates since the 1970s and 1980s—has only engaged with ecological questions sporadically and unevenly. If the “environment” was thematized in the 1950s or 1960s with a view toward technology and consumption, the major social debates of the era over energy and resource scarcity that affected architecture directly—and other narratives pertaining to pollution, toxicity, risks and contingencies of waste, environmental harm, destruction of habitat, and the like—received limited treatment within architectural history, which at the time was just starting to develop within schools of architecture. ① And while environmental history was establishing itself as a discipline on both sides of the Atlantic during the 1990s, at the same time within architecture concepts such as society’s relationship to nature, conviviality, sustainability, niches, and ecosystems were, despite the accelerating impact of globalization, displaced by then-pressing questions of gender, identity, or power relations. ② When faced with the twenty-first century’s major challenges—of a historiographic and epistemological sort for the humanities as a whole, in all their politics and ethics—it is a new development for architectural history, also for architectural design, given the planetary changes, to grapple with the *undisciplined* environment. ③ This requires reflection on past architectural practice and the themes of historical research, as well as a critique of the obsession with dominating nature. ④ This essay provides an overview of different thematic and argumentative strands and shows that only interdisciplinarity and interscalarity enable us to decentre human beings, their thoughts and actions, or to connect them to concepts of environment and society. ⑤

- 1 The Aggregate Architectural History Collaborative traces the beginnings of architectural history, at least in the United States, to the student reforms of the early 1970s. It points out that architectural history has long been without methodology, and environment plays a minor role. Andrew Leach, on the other hand, argues that architectural history developed as a separate discipline, from art history with Sigfried Giedion in the postwar period, shaping a decidedly modern understanding of nature and the environment. In postwar historiography, environmentalism was used explicitly, for example by Lewis Mumford or Reyner Banham. The emergence of the discipline should thus be seen in parallel with developments of the Great Acceleration, and then, from the 1970s and 1980s onward, in continuation with the focus on commodification of architecture and the city, but not energy and materials with the emergence of neoliberalism. Daniel Abramson, Zeynep Çelik Alexander, and Michael Osman, “Introduction: Evidence, Narrative, and Writing Architectural History,” in *Writing Architectural History: Evidence and Narrative in the Twenty-First Century*, eds. Aggregate (Pittsburgh: University of Pittsburgh Press, 2021), 3–15, esp. 8; and Andrew Leach, *What Is Architectural History?* (Cambridge, UK: Polity, 2010).
- 2 In the United States, for example, a 1990 roundtable on “environmental history”—to which Donald Woster, Alfred W. Crosby, Richard White, Carolyn Merchant, William Cronon, and Stephen J. Pyne contributed—roughly framed the subject area as the transformation of the Earth, particularly the colonial settlement of land in connection with the territorial distribution of certain species, or “ecological imperialism,” and traced its origins to Aldo Leopold. A comparable development to incorporate nature into history took place in Germany, for example, but with respect to the historical nexus of the industrial world and environmental conditions. Joachim Radkau has also devoted himself to the project of a global environmental history. Thus, in addition to questions of topical choice, geographic scope, and historical depth, questions of purpose arise. “A Round Table: Environmental History,” *The Journal of American History* 76, no. 4 (March 1990): 1087–1147; Arne Andersen, ed., “Umweltgeschichte,” *WerkstattGeschichte* no. 3 (1992); Andersen, “Umweltgeschichte: Forschungsstand und Perspektiven,” *Archiv für Sozialgeschichte*, no. 33 (1993): 672–701; Radkau, “Was ist Umweltgeschichte?,” *Umweltgeschichte heute. Neue Themen und Ansätze der Geschichtswissenschaft - Beiträge für die Umweltwissenschaft*, Environmental History Newsletter, no. 1, ed. Christian Simon (The European

Association for Environmental History, 1993): 86–107; and Joachim Radkau, *Nature and Power. A Global History of the Environment* (Cambridge, UK: Cambridge University Press: 2008).

- 3 “Undisciplined” can refer to method and subject matter. The *Undisciplined Environments* blog is the platform of a group of researchers that emerged from the European Network of Political Ecology and understands political ecology as the way “that the ‘environment’ as material and ideological category, is shaped by, and shapes, the political-economic structures and processes in our world, from the local to the global.” “About the platform,” *Undisciplined Environments* (blog), <https://undisciplinedenvironments.org>. See also Ilenia Iengo, “Undisciplined Environments,” *Soft Power* 5, no. 1 (2017): 259–266; and Uwe Luebken, “Undisziplinert: Ein Forschungsbericht zur Umweltgeschichte,” *H-Soz-Kult*, 14 July 2010, 6, <https://www.hsozkult.de/literaturereview/id/fdl-136811>.
- 4 With respect to the Anthropocene, Andrew Leach states that seeing architecture in its environment and as environment is nothing new and refers to the work of Reyner Banham and Bernard Rudofsky. Daniel Barber writes about an interconnectedness of the built environment with anthropogenic climate collapse, of the world system of capital and the Earth system. Leach, “Architectural Historiography in the Anthropocene,” *Architectural Theory Review* 22, no. 2 (2018): 273–276; and Barber, “Architectural History in the Anthropocene. Introduction,” *The Journal of Architecture* 21, no. 8 (2016): 1165–1170. This latter issue, with contributors Jiat-Hwee Chang, Eshter da Costa Meyer, Kenny Cupers, Daniela Fabricius, Timothy Hyde, Kiel Moe, and Albert Narath, negotiates very different aspects like media, risk, and operationality versus criticality.
- 5 For a brief introduction to *Environmental Histories of Architecture*, the publication series that this essay frames, and the Architecture and/or Environment research project from which it originated, see Kim Förster, “Environmental Histories of Architecture,” CCA, 3 October 2022, <https://www.cca.qc.ca/en/articles/87164/environmental-histories-of-architecture>.

### THE ENVIRONMENT AS RESEARCH SUBJECT AND CATEGORY OF ANALYSIS

Within architectural history, it is only in the past decade that it has become possible to notice an opening toward environmental topics and approaches as well as mutual cross-fertilization and further differentiation, in parallel to broader transdisciplinary engagement with the Anthropocene as a new Earth epoch in the natural sciences, social sciences, and the humanities—especially in response to the formation of new disciplines like energy and environmental humanities at first in Canada, the United States, and Australia. While within North America, Europe, and Oceania, environmental historiography initially focused almost exclusively on examples of eco-architecture and solar architecture—whether countercultural or official, urban or rural, technological or community-oriented projects—architectural history found only limited resonance within established environmental history studies and its affiliated academic institutions, research centres, and journals. ⑥ The situation is comparable to the way energy research was handled in literary and cultural studies, as well as the geographic, historical, and political sciences, where recent investigation has focused on the material manifestations and theoretical conceptions of petroleum in particular, and the ambivalences associated with it, but with little focus on the architectural scale. ⑦ Similarly, architecture was already being critiqued and thematized in wide-ranging exhibitions as a subject, representation, and medium related to the historical dominance of, or dependence on, on fossil fuels, as were alternatives to industrially produced energy-intensive building materials, before any historiography of architecture from an environmental perspective had actually emerged. ⑧ Added to this was a research-oriented form of architectural practice, one especially committed to forensic work, which deliberately sought out museums or galleries as a courtroom or laboratory in order to use the tools of architecture to denounce violence against people and the planet as a continuation of the history of imperialism and colonialism, but also resource exploitation, and species extinction, thus shaping a new environmental thinking. ⑨

- 6 Research centres on environmental history and environmental humanities have emerged in the last decade, including the Rachel Carson Center (2009) at LMU Munich, Germany, and the Environmental Humanities Laboratory (2012) at KTH in Stockholm, Sweden; the journal *Environmental Humanities* (2012), founded in Australia, is now published by Duke University Press, and funded and managed by an international network. There has been no comparable institutionalization in architecture. Deborah Bird

- Rose et al., “Thinking Through the Environment, Unsettling the Humanities,” *Environmental Humanities*, no. 1 (2012): 1–5; and Sverker Sörlin, “Environmental Humanities: Why Should Biologists Interested in the Environment Take the Humanities Seriously?” *BioScience* 62, no. 9 (2012): 788–789.
- 7 Stephanie LeMenager, *Living Oil: Petroleum in the American Century* (Oxford and New York: Oxford University Press, 2014); and Imre Szeman, Jennifer Wenzel, and Patricia Yaeger, eds., *Fueling Culture. 101 Words for Energy and Environment* (New York: Fordham University Press, 2017).
- 8 Significant in this regard was the 2007–2008 CCA exhibition *1973: Sorry, Out of Gas*, curated by Mirko Zardini and Giovanna Borasi, which, starting from the oil crisis of the 1970s, addressed the agency of architecture as a form of environmental action, concerning a solar as well as ecological practice. The exhibition was preceded by a symposium on the topic “Sustainable?,” which critically discussed sustainability from the perspective of practice and science. Other exhibitions on an environmental perspective on architecture and architectural history followed, such as *Reduce Reuse Recycle*, curated by Muck Petzet for the German Pavilion at the 2012 Venice Biennale; or *Behind the Greendoor*, curated by the Brussels office Rotor for the Oslo Architecture Triennale of 2014.
- 9 The *Forensis* exhibition took place at the Haus der Kulturen der Welt in Berlin in 2014. Since then, projects on social and environmental justice, which emerged from the office Forensic Architecture, and others belonging to the Research Architecture program, have been shown in very different contexts. Eyal Weizman, ed., *Forensis: The Architecture of Public Truth* (Berlin: Sternberg Press, 2014).

If historical studies today, and the humanities more generally, are devoted to reconceptualizing the environment as a historical phenomenon beyond the definition formulated by the early twentieth-century biologist Jakob Johann von Uexküll, often cited as fundamental, and beyond its oft-cited nineteenth-century invention and episodes of reinvention through approaches such as science and technology studies or environmental humanities, then an environmental history of architecture is still in its infancy. <sup>10</sup> An increasing number of researchers in this young field have devoted themselves to the environment—and environmental attitudes, behaviours, and relations writ large—in what is still a relatively undisciplined manner. They have taken transdisciplinary, even intersectional perspectives, and, following the principle of methodological diversity, examined the promises made by architectural and technological development (and their pitfalls), as well as path dependencies and the environmental consequences of industrial production. <sup>11</sup> A preliminary glance at the diversity, variety, and multiplicity of inclusive and exclusive arguments and examples resulted in the collectively produced field notes project “Architecture and the Environment,” which was published in *Architectural Histories*, the online journal of the European Architecture History Network. <sup>12</sup>

- 10 Etienne S. Benson adopts an archaeological-genealogical perspective in following the concept of environment from those who shaped it to those who were influenced by it, as embodied in practices, technologies, and social relations, as well as in text and language. Sverker Sörlin cited both Rachel Carson and, a century earlier, George Perkins Marsh as pioneers in this regard, but also differentiates that environmental history cannot be so easily periodized and does not necessarily parallel major events and significant turning points in world history. Benson, *Surroundings: A History of Environments and Environmentalisms* (Chicago: University of Chicago Press, 2020); Sörlin, “The Contemporaneity of Environmental History: Negotiating Scholarship, Useful History, and the New Human Condition,” *Journal of Contemporary History* 46 (2011): 610–630; and Jakob Johann von Uexküll, *Umwelt und Innenwelt der Tiere* (Berlin: Springer, 1909).
- 11 This lack of a thematic and methodological profile is somewhat reminiscent of developments in environmental history. Frank Uekötter, *Umweltgeschichte im 19. und 20. Jahrhundert* (Munich: Oldenbourg Verlag, 2007).
- 12 This publication is the result of a joint intellectual investigation, edited by Sophie Hochhäusl and Torsten Lange, which developed from a working group of the European Architecture History Network comprised of Ross Exo Adams, Daniel Barber, Aleksandr Bierig, Kenny Cupers, Isabelle Doucet, Jennifer Ferng, Sabine von Fischer, Kim Förster, Maroš Krivý, Andres Kurg, Ayala Levin, Ginger Nolan, and Alla Vronskaya. The individual contributions are assigned to four categories: Transdisciplinarity, Environment as Perspective, (Re)turn to Theory, and Architectural Epistemologies of the Environment. The texts are not final discussions, but preliminary transcripts on which further research can build. Ultimately, dialogue was sought with the environmental humanities, under which environmental history, and also architectural history, were subsumed. With Lange, Doucet, and Nolan, individual authors presented their approaches in a panel on 28 July 2017, moderated by Daniel Barber at the Rachel Carson Center for Environment and Society. Sophie Hochhäusl, Torsten Lange, et al., “Architecture and the Environment,” *Architectural Histories* 6, no. 1 (2018): 1–13.

Given the urgency and entanglement of overlapping climate, environment, and health breakdown today, there exists a heterogeneity and diversity of academic and activist approaches to text production,



environmental research, and calls to environmental consciousness. The breadth of evidence and narratives ranges from the clash of technology and environmental histories, the sequence of decline and recovery narratives, to the replacement of narratives of apocalypse with those of post-apocalypse. <sup>(13)</sup> In architectural history, the environment is now not only a subject matter and an interpretation framework, but above all a critical concept and an analytical category that unites environmental and social history; and although architecture, the environment, and history are taught in many places today on the basis of individual initiatives, the rapid growth of economic, postcolonial, or feminist critique has hardly been reflected institutionally within research on environmental history. <sup>(14)</sup> If building and living are always also a practice of surrounding, this means, according to the argument being elaborated here, that architectural history and the architectural humanities at large should be approached regarding both environmental and social justice, and thereby becoming interesting for environmental history and the environmental humanities as well.

- 13 Like environmental history, architectural history cannot be assigned to one branch due to its environmental perspective, but encompasses gender, economic, legal, imperialism/colonialism, social, and labour, as well as urban history. Sörlin, "The Contemporaneity of Environmental History"; and Radkau, *Nature and Power*.
- 14 The environmental perspective is now shaping the broader field of architecture, changing historical analysis and contributing to the larger climate debate. Daniel Barber et al., "Architecture, Environment, History: Questions and Consequences," *Architectural Theory Review* 22, no. 2 (2018): 249–286, esp. 274. This text, advocating for a revision of Australian architectural history, emerged from the workshop Environmental Histories of Architecture: Case Studies and Consequences, March 2017, The University of Sydney.

Today, there is broad scholarly consensus that the accelerating climate catastrophe can no longer be denied. Nevertheless, the environment, and society's awareness of it, pose major challenges for historiography, not least on account of its transdisciplinarity and transscalarity. <sup>(15)</sup> What architectural history has to offer, and what unites it, is a well-formulated critique that reveals the paradoxes of sustainability thinking and approaches, illustrated by several developments. Since nineteenth-century industrialization, architecture has assumed that the indoor climate could be controlled and optimized to manage pollution. This was based on concepts such as space, form, technology, and media, which has resulted in projects that claim to be sustainable by relying on technological fixes and yet are intended to be seen in relation to the outdoor climate. <sup>(16)</sup> More recently, even sustainable approaches that counter the twentieth-century paradigm of obsolescence and demolition, such as conversion, preservation, or eco-design, have been co-opted. Since the 1990s, sustainability has become the prevailing new paradigm in the construction industry, architecture, urban planning, and real estate business, largely due to the flexibility of capitalism, and is thus central for the understanding and implementation of change. <sup>(17)</sup> Meanwhile, the bureaucracy, management, and governance of the environment have become practically indistinguishable from neoliberal practice and rhetoric. <sup>(18)</sup> Additionally, the rediscovery of approaches like "tropical architecture," which are considered sustainable for developments in the Global South, are inseparable from the colonial past and the associations that underlie the implementation of Western standards. <sup>(19)</sup> Even buildings that undergo various certification processes to assess their sustainability often exhibit high energy and material expenditure, and the social and environmental costs are typically externalized. <sup>(20)</sup> These are just a few examples from architectural history that demonstrate obstacles. With the abstraction, alienation, and commodification of nature, of the plant and animal world, it is not just the entanglements and fundamental groundings that were lost; from an anthropological perspective, it is unclear, as Anna Lowenhaupt Tsing points out, whether it is possible to leave behind a habitable, species-rich

world for posterity at all. <sup>(21)</sup> Yet despite this critique, or perhaps precisely because of it, there are grounds for reasserting the concept of sustainability in a positive light, namely, when it is not built on externalities, but on ecological awareness and action, focusing on the renewable and regenerative, and aiming at a different relationship with the Earth. <sup>(22)</sup>

- 15 By way of comparison, see Abramson, Alexander, and Osman, "Introduction," 3–15, esp. 6 and 8.
- 16 David Gissen, "A Theory of Pollution for Architecture," in *Imperfect Health: The Medicalization of Architecture*, eds. Giovanna Borrasi and Mirko Zardini (Montréal; Zurich: CCA and Lars Müller Publishers, 2012), 117–132.
- 17 Daniel Abramson, *Obsolescence: An Architectural History* (Chicago: University of Chicago Press, 2016), 135–138, esp. 138.
- 18 Daniel Barber, *A House in the Sun: Modern Architecture and Solar Energy in the Cold War* (Oxford: Oxford University Press, 2016).
- 19 Jiat-Hwee Chang, *A Genealogy of Tropical Architecture: Colonial Networks, Nature and Technoscience* (London: Routledge, 2016).
- 20 Kiel Moe, "Metabolic Rift, Gift, and Shift," *e-flux Architecture*, September 2020, <https://www.e-flux.com/architecture/accumulation/345105/metabolic-rift-gift-and-shift>.
- 21 Anna Lowenhaupt Tsing, *The Mushroom at the End of the World. On the Possibility of Life in Capitalist Ruins* (Princeton: Princeton University Press, 2015), 3.
- 22 Anthony Powis (on behalf of Mould), *Extraction* (London: Mould, 2022), 13, <http://mould.earth/wp-content/uploads/2022/03/MLD020-extraction.pdf>.

For the architectural humanities, treating the environment as a research subject and category of analysis means a profound reorientation. Writing architectural history through the environment, a major historiographical and epistemological project, thus encompasses, at a baseline level, the "technosphere," that is, the nexus of human culture, natural environments, and global technologies (which thus integrates architecture) as today's precondition. <sup>(23)</sup> This means a history of aesthetics and function, and a sociology of science and technology to address the historical conditions, limits, and constraints of this writing, with the ultimate goal of decarbonization beyond the technological fix, and thus decolonization in all its social and cultural dimensions—a goal of demonstrating alternatives beyond traditional evidence and narratives, countering the existing museums and archives. In the typical material and cultural reading, the environment, like nature, basically does not exist, but is only invented or constructed by people and their relationships, interactions, structures, and knowledge. <sup>(24)</sup> Today, the dualism of culture and nature that defined Western culture, values, and society is challenged in terms of the global and the planetary, whether in relation to globalization as a continuation of the colonial and imperial past, or else in relation to capitalism, or the Capitalocene, as a hegemonic, causative, and ultimately to-be-overcome system; or sometimes also the knowledge of the risks and side-effects associated with environmental and economic crisis, as a matter of establishing a new relationship to nature. <sup>(25)</sup> If planet Earth has the capacity to house life in all its diversity, architectural research would have to be fundamentally dedicated to mediating, to promoting a metabolism between humans and the planet in terms of material, energy, and material flows—especially that of carbon—through construction and deconstruction. For the historian Dipesh Chakrabarty, anthropogenic global warming since the beginning of industrialization poses serious challenges to humanity, not only in terms of political decisions and economic rethinking, but in telling human history and determining responsibility for polluting the atmosphere. <sup>(26)</sup> The interconnection of natural, social, and intellectual history, for him, offers a gain in knowledge and a reorientation: toward the conditionality of climate and economic history, with awareness of the uncertainties, thresholds, and tipping points that define it, which includes thinking in different time periods and scales; toward an interweaving of histories of populations, civilizations, and the evolution of the human species with the history of Earth, without omitting the struggle for equality and justice between rich and poor, or the right to develop despite the knowledge of greed; and toward a way of thinking, despite the

inevitability of anthropocentrism, that doesn't give priority to humans, but recognizes that survival of all depends on the planet.

- 23 From 2015 to 2019, the research project Technosphere was carried out at the Haus der Kulturen der Welt in Berlin, in the context of which scientists, artists, and social actors entered into conversation with each other. The key topic was the dilemma of globally effective technologies and their identity. Haus der Kulturen der Welt, "Technosphere Magazine," <https://technosphere-magazine.hkw.de>.
- 24 The social construction of nature has been interpreted in different ways: Raymond Williams pointed out that the conquest, domination, and exploitation of nature by humans is connected. Ilya Prigogine and Isabelle Stengers have understood nature as something manifold, time-conditioned, complex due to developments in the sciences, and have attributed autonomy—meaning agency—to it. Ulrich Beck saw nature not as something external to networked society, but integral. Lucius Burckhardt integrated existing approaches and asked whether nature could be found in the city. Williams, "Ideas of Nature," *Problems in Materialism and Culture* (London: Verso, 1980), 67–85, esp. 84; Prigogine and Stengers, *Order Out of Chaos: Man's New Dialogue with Nature* (Toronto: Bantam Books, 1984); Beck, *Risk Society: Towards a New Modernity* (London: Sage, 1992); and Burckhardt, "Aesthetics and Ecology," in *Rethinking Man-made Environments: Politics, Landscape & Design*, eds. Jesko Fezer and Martin Schmitz (Vienna: Springer, 2021), 212–224, originally published in German under the title "Ästhetik und Ökologie" (1990).
- 25 Jennifer Wenzel, "Planet vs. Globe," *English Language Notes* 52, no. 1 (2014): 19–30; Dipesh Chakrabarty, "The Planet: An Emergent Humanist Category," *Critical Inquiry* 46 (Fall 2019): 1–31; Bruno Latour and Dipesh Chakrabarty, "Conflicts of Planetary Proportion – A Conversation," *Journal of the Philosophy of History*, no. 14 (2020): 419–454; and Christina Pauls et al., "Das Planetarische Politisch(e) Denken," *Politische Vierteljahresschrift*, no. 63 (2022): 703–728.
- 26 Dipesh Chakrabarty argues that his classical dialectic, which thinks climate and capitalism together, is insufficient and that systemic change would take decades—too long to have an impact on the current climate crisis. Chakrabarty, "Verändert der Klimawandel die Geschichtsschreibung?," *Transit* 41 (2011): 143–163; and Chakrabarty, *The Climate of History in the Planetary Age* (Chicago: University of Chicago Press, 2021).

Writing environmental histories of architecture, complicated by the realization and experience of global heating, embraces the fact that, when it comes to "undisciplined knowing," it is not just a matter of the historiographic epistemology of building and living beyond the dualism of critical and/or operative historiography. This task also comprises theoretical exploration, studies of pedagogy, and even research architecture, especially since it is about a grounded critique of conquest, domination, and exploitation of nature and beings. Entering into this are other forms of knowledge and practice—including Indigenous ones—to which Western sciences have long been closed. Such forms address human relationships with the biosphere, where everyday life takes place with plants, animals, and microorganisms, as the basis of survival in the face of climate change, biodiversity loss, and the ecological crisis. Beyond this, there is also research in the architectural humanities that transcends disciplinary boundaries and levels of scale; environmental approaches, which, despite differing constitutions and orientations, have been quite productive in contributing to an understanding of the relationship between society and the environment, facilitation and inhibition, human action and the social structure, and the archival and the speculative. This thrust of current research has made its mark in monographs, journal issues, conference panels, and exhibitions. The goal of this essay therefore is not only to give an overview of concepts and methods that goes beyond the geography of North America and Europe and to encompass the perspectives of researchers from the Global South, but also to actively locate architectural research within environmental history and the environmental humanities. If the Anthropocene literature of the humanities, as a revision of modernist narratives, deals primarily with the epistemological, ethical, and political challenges facing us in view of the contemporary polycrisis, then it is here, on the basis of three central fields of research, each having been worked over in the last decade from global perspectives in dialogue with other disciplines, where we can see which academic, pedagogical, practical, and cultural perspectives have come about. <sup>(27)</sup> One clearly delineated subject area is that of energy and climate histories that address the complexities and nestedness of indoor, urban, and planetary climates in relation to design practice and teaching. A second, increasingly focused-on subject area

is that of material and pollution histories that address the ambiguities of architecture, resource exploitation, and toxicity. Finally, a third, less-pursued but equally important subject area is that of more-than-human entanglement histories that focus on new, multi-species forms of coexistence, in particular practices of “building with” and “living with.”

27 For an overview, see Eva Horn and Hannes Bergthaller, *The Anthropocene: Key Issues for the Humanities* (London: Routledge, 2020).

## ENERGY AND CLIMATE HISTORIES

One of the most articulate positions that seeks to rethink architectural history and architectural humanities emerged from an energy and climate perspective. The energy humanities as a new field of scholarship which works through the cultural, socioeconomic, and political aspects of society’s dependence on fossil energy, exerts a significant influence on the development of this position. <sup>(28)</sup> While disciplines such as history and geography examined mining and the use of coal as a driving force of industrialization and urbanization in the nineteenth century, it is recently primarily North American and European literary and cultural studies that elaborate the dominance of petroleum in the twentieth century, while at the same time working through the absence or concealment of this dominance within literature and culture, under the term “energy unconsciousness.” <sup>(29)</sup> Through conferences, anthologies, and journal issues the terms “petrocultures” and “petromodernity,” in turn, as championed by among others the cultural theorist Imre Szeman, formulate a critique of North American-style capitalism, so-called carbon democracy. <sup>(30)</sup> From the perspective of architecture and urban planning, and cultural studies as well, an effort is made to chart the palimpsest-like nature of “global petroleumscapes,” that is, central infrastructures and marketplaces driven by the flow of crude oil and money—for instance, drilling rigs, refineries, fuel depots and pipelines, roads and railway networks, but also headquarters, industrial areas, and even gas stations, as well as the persistent presence of oil within culture and everyday life. <sup>(31)</sup> These new narrative and hermeneutic analyses of representations and perceptions of fossil capitalism find their counterpart in the transdisciplinary Anthropocene debate of the twenty-first century, relying on evidence in the sciences that highlights a great acceleration of production, consumption, and mobility that emerged after 1945 due to increased petroleum extraction, and included two spatially constituted, primarily relational aspects with suburbanity and automobility, particularly in countries with Western, in other words imperial, lifestyles. <sup>(32)</sup>

- 28 Energy Humanities draw on a range of disciplines: literature, film and media studies, anthropology, environmental studies, philosophy, critical Indigenous studies, history, and art history, among others. Casey Williams, “Energy Humanities,” *Johns Hopkins Guide to Critical and Cultural Theory*, 6 October 2020, <https://www.energyhumanities.ca/news/energy-humanities-casey-williams>; and Imre Szeman and Dominic Boyer, eds., *Energy Humanities: An Anthology* (Baltimore: Johns Hopkins University Press, 2017).
- 29 E. A. Wrigley, *Energy and the English Industrial Revolution* (Cambridge, UK: Cambridge University Press, 2010); Andreas Malm, *Fossil Capital: The Rise of Steam-power and the Roots of Global Warming* (London: Verso, 2016); Patricia Yaeger, ed., “Editor’s Column: Literature in the Ages of Wood, Tallow, Coal, Whale Oil, Gasoline, Atomic Power, and Other Energy Sources,” *PMLA / Publications of the Modern Language Association of America* 126, no. 2 (2011): 305–326; Amitav Ghosh, “Petrofiction,” *New Republic* (2 March 1992): 29–34; and Ghosh, *The Great Derangement: Climate Change and the Unthinkable* (Chicago: University of Chicago Press, 2016).
- 30 Imre Szeman, *On Petrocultures: Globalization, Culture, and Energy* (Morgantown: West Virginia University Press, 2019); Szeman, Sheena Wilson, and Adam Carlson, eds., *Petrocultures. Oil, Politics, Culture* (Montréal: McGill-Queen’s University Press, 2017); and Timothy Mitchell, *Carbon Democracy: Political Power in the Age of Oil* (London: Verso, 2011).
- 31 The palimpsest nature of the metropolitan hinterland was first discussed in the history of architecture and urban planning by André Corboz, who, however, made little reference to urban energy landscapes. Corboz, “The Land as Palimpsest,” *Diogenes*, no. 12 (1983): 12–34. See also Carola Hein, “Oil Spaces: The Global Petroleumscape in the Rotterdam/The Hague Area,” *Journal of Urban History* 44, no. 5 (2018): 887–929; and several works by Benjamin Steininger: “Pipeline,” *Tumult – Schriften zur Verkehrswissenschaft*, no. 38 (2012): 22–27; “Pipeline: Am Puls der fossilen Moderne,” in *Stoffe in Bewegung. Beiträge zu einer Wissensgeschichte der materiellen Welt*, eds. Kijan Malte Espahangizi and Barbara Orland (Zurich: Diaphanes, 2014); “Petromoderne Petromonströs,”



- 32 From the point of view of the energy humanities, certain architectures and structures such as the single-family house and the garage take on a new significance. Ulrich Brand and Markus Wissen, *Imperial Mode of Living. Everyday Life and the Ecological Crisis of Capitalism* (London: Verso, 2021). See also Will Steffen et al., “The Trajectory of the Anthropocene: The Great Acceleration,” *Anthropocene Review* 2, no. 1 (2015): 81–98.

Similar to environmental history, architectural history initially attributed society’s dependence on petroleum as its predominant cheap source of energy to a moment of crisis, and the social change and revolt that accompanied that moment. A pioneering work in this regard was the CCA’s exhibition *1973: Sorry, Out of Gas* (2007–2008). The exhibition, using selected examples primarily from North America, as well as a few from Europe, addressed the consequences of the oil shock on architecture in the wake of the embargo initiated by oil-producing countries. In so doing, the exhibition thematized not only resource scarcity, “peak oil,” and the reduction of energy consumption, but already the climate impact of carbon emissions. <sup>(33)</sup> The case studies, for example, dealt with passive as well as active solutions for spatial heating (less so for cooling) or electricity generation. They also addressed alternative materials for construction and insulation that had been tested and planned within countercultural, scientific, as well as highly institutional contexts. Overall, the focus was on the integration of building and living into ecological cycles, including water purification, waste utilization, and food cultivation, for example in the case of The Ark on Prince Edward Island. <sup>(34)</sup> The research interest at the time, fueled partly by the exhibition and catalogue, was on approaches and expressions of the counterculture, the transatlantic dialogue, and the mobility of architectural practitioners, ideas, and approaches from the 1970s, treated as the high point of environmentalism and the turning point for environmental history. In the context of further research based on case studies from North America, Oceania, and Europe, differentiations were drawn regarding political and social dimensions, in addition to the energy and environmental potential of alternative technologies, processes, and materials, both for rural and urban space. <sup>(35)</sup> By demonstrating that earlier solar alternatives were quickly made obsolete and later ineffective with the “Great Acceleration—that is, the increase in production and consumption based on fossil fuels—the difficulties of periodizing the dominant energy sources became apparent; economic interests prevailed, making the implementation of solar impossible, and the political will was not sustained in the end. <sup>(36)</sup> If oil is to be regarded as a historical phenomenon, one important research task is to uncover how architecture and ultimately architectural history have promoted the oil unconscious or obscured oil capitalism since the 1950s—and to undertake this reading globally.

- 33 Research for the exhibition *1973: Sorry, Out of Gas*, conducted by Pierre Eduard Latouch and others, focused initially on the city without cars, but included early solar projects in the United States, the MIT Solar Houses of the 1930s and 1940s and the Peabody Sun House (1948) in Dover with links to the Harvard Graduate School of Design, as well as European projects in the Weimar Republic, the United Kingdom, and France. Research was based on the publications in the CCA Collection and the knowledge of solar energy harvesting attested there. Giovanna Borasi and Mirko Zardini, eds., *Sorry, Out of Gas: Architecture’s Response to the 1973 Oil Crisis* (Montréal; Montova: CCA and Corraini Edizioni, 2007).
- 34 Steven Mannell, “Living Lightly on the Earth,” in *Building an Ark for Prince Edward Island, 1974–76* (Dalhousie: Dalhousie Architectural Press, 2018).
- 35 See several texts by Simon Sadler, Caroline Maniaque, and Lee Stickells: Sadler, “Drop City Revisited,” *Journal of Architectural Education* 59, no. 3 (2006): 5–14; Sadler, “An Architecture of the Whole,” *Journal of Architectural Education* 61, no. 4 (2008): 108–129; and Sadler, “Appropriate Technology’s Prompt to ‘Architectural Thinking,’ c. 1976,” *arq: Architectural Research Quarterly* 24, no. 2 (2020): 117–128. Maniaque, *Go West - Des architectes au pays de la contre-culture* (Paris: Edition Parentheses, 2014); and Maniaque, *French Encounters with the American Counterculture 1960–1980* (London: Routledge, 2016). Stickells, “Negotiating Off-Grid: Counterculture, Conflict and Autonomous Architecture in Australia’s Rainbow Region,” *Fabrications* 25, no. 1 (2015): 104–129; Stickells, “Journeys with the Autonomous House,” *Fabrications* 27, no. 3 (2017): 352–375; and Stickells, “Living in the Future Now,”

*Architectural Theory Review* 22, no. 2 (2018): 267–270. My own research was on the eco-exhibition *Umdenken Umschwenken* at the ETH Zurich (1975), as well as on existing and new building projects of the “Ecology” Research Department in the context of the International Building Exhibition Berlin (1984–1987). Kim Förster, “Umdenken Umschwenken: Environmental Engagement and Swiss Architecture,” in *Routledge Companion to Architecture and Social Engagement*, ed. Farhan Karim (New York: Routledge, 2018), 271–288; and Förster, “The Green IBA. On a Politics of Renewal, Ecology, and Solidarity,” *Candide*, no. 11 (2019): 9–50.

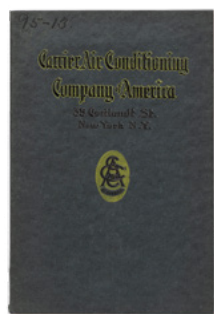
36 Yaeger, “Editor’s Column”; Szeman, *On Petrocultures*; and Barber, “Architectural History in the Anthropocene.”

It is significant, in this respect, that dependencies on fossil fuels within architecture and urban planning were perpetuated by the development and consolidation of the 1973 energy regime in terms of façade design, floorplan organization, and heating and ventilation technology—not only in the fully air-conditioned corporate office skyscrapers that became nodes of global capitalism and projection surfaces of faith in the market, but in new-build urban development projects and property formations, even those that were ostensibly designed to promote solar energy.<sup>(37)</sup> The fact that the energy converted and materialized into buildings, and the built environment more generally, played a critical role in more profound social and political transformations required further historical analysis: whether in relation to neoliberalism, as expressed in new visions of resource management and population governance exemplified in the conclusions of the early computer simulation that underpinned the 1972 publication *Limits to Growth*; or in relation to a new world order oriented toward development but ultimately perpetuating the global exploitation of resources following the 1972 UN Conference on the Human Environment in Stockholm, which produced the UN Environment Program; or in relation to digital capitalism with its origins in California, which would be inconceivable without the contribution of former social dropouts.<sup>(38)</sup> Biopolitics, neo-extractivism, and digitalization—these are all those loose ends of the Green New Deals of the Western world today, with their energy-efficient and climate-protecting yet business-friendly agenda.

37 In my research, I study solar housing or solar urbanism in Milton Keynes, then addressed by Martin Pawley, which should be seen in the context of innovation-based, ultimately neoliberal urban planning and property development, such as the promotion of the construction, real estate, and natural gas industries. Pawley, “Energy, The Great White Hope,” in *Theory and Design in the Second Machine Age* (London: Blackwell, 1990), 95–113.

38 Quinn Slobodian, *Globalists: The End of Empire and the Birth of Neoliberalism* (Cambridge, MA: Harvard University Press, 2020); Felicity D. Scott, *Outlaw Territories: Environments of Insecurity. Architectures of Counterinsurgency* (New York: Zone Books, 2016); Dietrich Dietrichsen and Anselm Franke, *The Whole Earth: California and the Disappearance of the Outside* (Berlin: Sternberg Press, 2013); and Fred Turner, *From Counterculture to Cyberculture: Stewart Brand, the Whole Earth Network, and the Rise of Digital Utopianism* (Chicago: University of Chicago Press, 2006).

Against the backdrop of coming to terms with climate emergency narratives, the architecture and architectural history of the twentieth century itself, as a practice and object in its intensity and self-advertising, needs to be interrogated. Architects, engineers, and historians are jointly responsible for the current state of affairs, yet at the same time they are the ones who offer visions, ideas, and imaginaries to actively approach the energy transition. Perhaps the most significant contribution to environmental histories of architecture in recent times is the revision, “resetting,” or “retrofitting” of modernism toward an environmental consciousness framed in terms of energy and climate, especially because a different relationship with the sun is, in principle, possible, and because building, structure, and construction can make a difference in this regard. fig. 1 fig. 2 In North America, responding to buildings, knowledge, profession, and education, an energy and climate focus has been most directly pursued by Daniel Barber and Kiel Moe, both of whom, in numerous essays and monographs, have addressed specific developments since the early twentieth century with an explicitly historical perspective on solar buildings, in Barber’s case, and building insulation, in Moe’s, and the cultural values, political notions, and social ideals bound up with them.<sup>(39)</sup>



- 39 Daniel Barber's monograph *A House in the Sun* and other essays are based on his doctoral research. Barber, "The Modern Solar House: Architecture, Energy, and the Emergence of Environmentalism, 1948–1959" (PhD. Diss., Columbia University, 2010). See also Kiel Moe, *Insulating Modernism: Isolated and Non-Isolated Thermodynamics* (Basel: Birkhäuser Verlag, 2014).

From an architectural history perspective, Barber was notably active in studying early American architectural experiments in solar energy production during the immediate postwar period, when solar energy was a serious alternative to fossil fuels. He was also active in tracing the intersection of architecture and technology, as well as US foreign, economic, and resource policy through the late 1950s—explicitly, for instance, via the example of research initiatives and the political opportunity that arose when energy scarcity was an issue. <sup>(40)</sup> The short-lived history of the 1950s solar house in the United States—in its historical contingency, a history of implementation, investment, maintenance, and advocacy—sheds light on the beginnings of a technocultural utopia and a scientific understanding of the environment, even though it was ultimately unsuccessful. A historical perspective, moreover, on American solar research, on its uptake and reconstitution, offers an occasion to highlight the simultaneous strategic development of a global oil regime, and thus of a North American-style economic model based on fossil energy—no longer on gold—whose torch was lit with the founding of OPEC in 1960. <sup>(41)</sup> The solar house as a technological, cultural, and political project, explicitly the modernist single-family household of postwar America, made it possible to attribute to architecture a central agency with regard to a definitive social and ecological dynamic. <sup>(42)</sup>

- 40 Barber's examples include the early suburban homes of George Fred Kecks, the solar houses of the Massachusetts Institute of Technology, and later variants, including the Dover Sun House in collaboration with Eleanor Raymond and Maria Telkes. Obviously, in the postwar United States, concerns about scarce resources, and the lack of knowledge about Arab oil reserves until 1951, led to research funds being invested in the development of alternative energies. Petroleum was accompanied by the expansion of heating and electricity generation by coal, natural gas, and ultimately nuclear power, all of which rivaled solar energy. Barber, "World Solar Energy Project, ca. 1954," *Grey Room*, no. 51 (2013): 64–93; Barber, "Tomorrow's House: Solar Housing in 1940s America," *Technology and Culture* 55, no. 1 (2014): 1–39; and "Energy Explained: Your guide to understanding energy," U. S. Energy Information Administration (EIA), <https://www.eia.gov/energyexplained>.

- 41 Mitchell, *Carbon Democracy*.

- 42 Barber, "Architecture and Environmentalism," in *A House in the Sun*, 249–255.

From a design-research perspective, Moe, on the other hand, arrived at a different history, namely the historical preoccupation with certain energy forms at the expense of others, here insulation theories and practices regarding heat transfer (opposing thermal resistance in North America, as measured by R-value, and thermal conductivity in the United Kingdom, as measured by U-value), still evident in building codes, curricula, and checklists of certification programs for sustainably understood "green" construction. <sup>(43)</sup> Understanding insulation, the performance of differently heat-transferring materials, as an independently physical, conceptual, and ultimately historical actor in its own right alongside practitioners in architecture and engineering, scientists, entrepreneurs, and consumers, offers opportunities to deconstruct the strict separation of inside and outside, especially in climatic terms, as well as the paradoxes entailed by the interplay of market and research in terms of design, building practice, and education. <sup>(fig. 3)</sup> Above all, this network analysis—of this reductionist framing of thermal insulation—opens possibilities for another form of contextualization, one that encompasses a web of adherence to principles of scientific work and care, the formulation, issuance, and application of national standards, guidelines, and laws, as well as subordination to the laws of the market, corporate influence, and consumer financial interests. Insulation provides Moe an occasion to regard a building not only as an isolated (and insulated) object, but to consider energy (and also material) flows of building with regard to volumes, dynamics, and feedback. <sup>(44)</sup>



- 43 Kiel Moe offers a survey of the history of science and technology. He covers, among other things, the basic thermodynamic experiments of Jean Baptiste Joseph Fourier (1768–1830) and others; the development of conduction heat in the refrigeration industry in the early twentieth century; the first standard setting societies, including American Society for Refrigeration Engineers (ASRE), American Society of Heating and Ventilating Engineers (ASHVE), and American Society for Testing and Materials (ASTM); and the transfer to practice and the development of proprietary products, such as the difference of conductivity to convection and radiation. Moe, “Insulating North America,” *Construction History*, no. 27 (2012): 87–106.
- 44 Moe, *Insulating Modernism*, 288–309.

Despite these different, divergent views, in terms of understanding and unpacking the complicity and responsibility of architecture and architectural history, what both positions share is that political and socio-economic, ultimately cultural factors of the age of cheap and abundant fossil fuels, and the belief in the market, or the promise of perpetual growth, conditioned architecture and urbanism in the United States, with all the known profound consequences for the system, which includes not only the energy industry but also the construction sector (and thus the building-materials industry). In their narratives and analyses of operational energy, the thwarting of solar energy, and energy-efficient building, Barber and Moe both picked up on Reyner Banham’s legacy of a technophilic, engineering-celebrating historiography of modern architecture, as well as Lewis Mumford’s legacy of radical critique, though with different thrusts in terms of geopolitics and geophysics. <sup>(45)</sup> In the face of climate anxiety and the challenges and uncertainties of today’s energy crisis, other future conceptions of energy emerge: a history of solar architecture opens up possibilities for thinking through new ways of harnessing renewable energy, and for reshaping social and political relations (as well as environmental relations) on the basis of almost infinitely available and directly usable solar radiation; a history of building insulation, on the other hand, points to the interests involved in the tendency toward stationarity and the solidification and materialization of the dichotomy of inside and outside, if the dynamics of heat exchange are also seen in relation to other factors (climate, orientation, diurnal or seasonal variations, and use). <sup>(46)</sup> Ultimately, energy, especially in relation to the accumulation of solar radiation in architecture and architectural history, should be seen as an enrichment, not a limitation.

- 45 Barber exposes his own motivations, asking “Why were these houses not known to Banham, Mumford and other critics and historians in the period? Or if they were, why did they not comment on and even celebrate them?” Barber, *A House in the Sun*, 251. The merit of Barber’s revisionist historical work, therefore, was to insert these houses, as manifestations of the convergence of modernism and environmentalism, into American architectural history, thereby contributing to the architectural-cultural, technical-engineering, and political-bureaucratic debate itself. Michael Osman, referring to the afterlife of Banham’s intervention in architectural history, points out that he was concerned with elaborating an ecology of mechanical systems and making technologies of environmental control visible in drawings of historic buildings. When it comes to the legacy of thermal modernity and energy futures, there is no way around slaving away on Banham. Osman, “Banham’s Historical Ecology,” *Neo-avant-garde and Postmodern: Postwar Architecture in Britain and Beyond*, eds. Mark Crimson and Claire Zimmerman, (New Haven: Yale University Press, 2010), 231–251; and Daniel J. Ryan, “Environmental Materialism,” *Architectural Theory Review* 22, no. 2 (2018): 256–259.
- 46 In ecological and architectural terms, Moe fundamentally distinguishes three factors, or types of convergence: building materials, in terms of “form and formations of energy,” energy systems in terms of “complicatedness of contemporary construction,” amortization in terms of “role of program and duration as ecological functions.” Moe, *Convergence: An Architectural Agenda for Energy* (London: Routledge, 2013).

Moreover, the central concern of architectural history in climatic and energy terms—alongside scarcity and conservation, efficiency, and containment—has long been the issue of maximizing thermal comfort, creating a uniform indoor climate through heating and cooling, and values associated with this goal such as productivity and performance. Banham, whose 1969 book *The Architecture of the Well-Tempered Environment* quickly became a mainstay of university curricula and thus influenced generations of architecture practitioners, first made air conditioning an internationally accepted topic. <sup>(47)</sup> While for a long time it remained unnoticed, unmentioned, and misunderstood that air conditioning, which consumes the predominant share of



a structure's operational energy, is dependent on electricity—in the United States and China, still largely produced from fossil fuels (coal and natural gas)—this has only recently been problematized within architectural research. Yet there's a close relationship between alterations in the indoor and planetary climate, as environmental sociologist Elizabeth Shove, who researches energy cultures and the energy transition, once remarked. <sup>(48)</sup> A history of science and technology perspective is instructive for a better understanding of our definition of comfort—conceptions of architecture and the environment—since at the end of the nineteenth century and especially the beginning of the twentieth century, the control of indoor air quality in terms of various parameters such as temperature, humidity, air circulation, and purification of air, was the focus of architecture and engineering, science and industry, manifesting itself in the fact that mechanical systems became the operative norm. <sup>(49)</sup> A cultural history perspective, on the other hand, highlights the politics and ideology that underlined the design of interiors, especially in the United States (since the beginning of the twentieth century, after the New York Stock Exchange, movie theatres, and department stores in particular were air conditioned throughout the country; and then in the postwar period mainly corporate office towers), as well as the spatial, energetic, and climatic configurations underlying the HVAC standards (Heating, Ventilation and Air Conditioning) established by institutions such as ASHRAE (American Society of Heating, Refrigerating and Air Conditioning Engineers). <sup>(50)</sup> It was Banham who ennobled not just the engineering component, but above all the marketing and commercial exploitation of technological achievements such as those made by William Carrier and his company: the fabrication of a “man-made weather,” that is, what is ultimately the industrial air-conditioning complex. <sup>(51)</sup>

47 Reyner Banham, *The Architecture of the Well-Tempered Environment* (London: Architectural Press, 1969).

48 Elizabeth Shove et al., “Comfort in a Lower Carbon Society,” *Building Research & Information* 36, no. 4 (2008): 307–311.

49 Gail Cooper, *Air Conditioning America. Engineers and the Controlled Environment, 1900 to 1960* (Baltimore: Johns Hopkins University, 1998).

50 Marsha E. Ackerman, *Cool Comfort: America's Romance with Air-Conditioning* (Washington, D.C.: Smithsonian Institution Press, 2002).

51 Banham, *The Architecture of the Well-Tempered Environment*, 172; and Jiat-Hwee Chang, “The Air-Conditioning Complex: Histories and Futures of Hybridization in Asia,” in *Environmental Histories of Architecture*, ed. Kim Förster (Montréal: CCA, 2022).

In view of a modern, architecturally as well as technologically formulated separation of indoor and outdoor climate, based on the impermeability of the exterior wall, it is possible to date an archaeology of the discourse of energy and climate (with a stop at Michel Foucault), and thus of the politics of human comfort in architecture, even further back. Infrastructure and technology shouldn't be regarded separately: as Foucault made clear, even an archaic cultural and environmental technology such as the fireplace always had human, social, and cultural significance beyond its intended purpose to provide heat. <sup>(52)</sup> The origins of central heating then became the subject of an architectural story that followed Banham's, and which Robert Brueggemann located in a hospital in Derby, England <sup>(53)</sup>—an air-conditioning technology that was subsequently refined parallel to industrialization and spread throughout Victorian England, starting with the Houses of Parliament in London. <sup>(54)</sup> Even Sir Joseph Paxton's Crystal Palace, built for London's Great Exhibition of 1851—a classic example of greenhouse architecture, its architectural body shaped by the interplay of transparency and opacity that controlled all its environmental parameters—was unusable in winter without heating. <sup>(55)</sup> The invention and application of the thermostat can then be used to vividly trace the beginnings of climate technology in relation to the transformation of both national and domestic economies, as the technology travelled from public buildings in Britain in the mid-nineteenth century to

suburban single-family homes of North America in the early twentieth century. <sup>(56)</sup> As Michael Osman showed, it was in experimental homes, developed in the context of the US Reform Movement, where the thermostat became prevalent; it not only enabled indoor temperature regulation to a precise degree, but also a socially relevant alignment of gender roles, as home economics became formalized and wholly controlled, much like factory or office work had previously been.

- 52 Paul Rabinow, "Space, Knowledge and Power. Interview: Michel Foucault," *Skyline* (March 1982): 16–20. Fire then became the subject of architectural and environmental history, for instance in Luis Fernandez-Galiano's work, which is considered a counterpoint to *The Architecture of the Well-Tempered Environment* and saw architecture as a matter of energy from the perspective of thermodynamics. Fernandez-Galiano, *Fire and Memory: On Architecture and Energy* (Cambridge, MA: MIT Press, 2000), first published in Spanish under the title *El fuego y la memoria: Sobre Arquitectura y energia* (Madrid: Alianza Editorial, 1991). On the thermal experiences around various pre-modern fireplaces, see Lisa Hescong, *Thermal Delight in Architecture* (Cambridge, MA: MIT Press, 1979); and on fire and the fireplace, see also Sébastien Marot, "Hearthbreaking," in *Fireplace: Elements of Architecture*, eds. Sébastien Marot, Rem Koolhaas, AMO, Harvard Graduate School of Design, Irma Boom (Venice: Marsilio, 2014), 106–123.
- 53 Robert Bruegmann, "Central Heating and Forced Ventilation: Origins and Effects on Architectural Design," *Journal of the Society of Architectural Historians* 37, no. 3 (1978): 143–160. For a media history of central heating by water, steam, and air, see Moritz Gleich, "Vom Speichern zum Übertragen. Architektur und die Kommunikation der Wärme," *Zeitschrift für Medienwissenschaft* 7, no. 12 (2015): 19–32.
- 54 Henrik Schoenefeldt, "The Temporary Houses of Parliament and David Boswell Reid's Architecture of Experimentation," *Architectural History* 57 (2014): 175–215; Schoenefeldt, "The Lost (First) Chamber of the House of Commons," *AA Files* 72 (2016): 161–173; and Schoenefeldt, "The Historic Ventilation System of the House of Commons, 1840–52: Revisiting David Boswell Reid's Environmental Legacy," *The Antiquaries Journal* 98 (2018): 245–295.
- 55 On Paxton, see Reyner Banham, "The Environmentalist," *Program* 2 (1962): 57–64; on the Crystal Palace, see Peter Sloterdijk, *In the World Interior of Capital: Towards a Philosophical Theory of Globalization* (Cambridge, UK: John Wiley & Sons, 2013), first published in German under the title *Im Weltinnenraum des Kapitals: Für eine philosophische Theorie der Globalisierung* (Frankfurt: Suhrkamp, 2005); and Philip Ursprung, "Phantomschmerzen der Architektur: Verschwindende Körper und Raumprothesen," *Kritische Berichte* 2 (2006): 17–28.
- 56 Michael Osman, *Modernism's Visible Hand: Architecture and Regulation in America* (Minneapolis: University of Minnesota Press, 2018), 1–43.

In relation to issues of comfort and air conditioning beyond the temperate zone, and to extend beyond a purely Anglophone historiography, what a postcolonial perspective shows, on the other hand, is that the physical and psychological experience of indoor climate has been, at best, overlooked in the modern world, so that the once scientifically supported definition is, today, morally problematic, socially untenable, or politically contentious. <sup>(57)</sup> Groundbreaking for a critique of the Western concept of comfort, as well as the social and environmental consequences associated with it, was Jiat-Hwee Chang's tropical architecture, a concept elaborated from a genealogical perspective with relation to colonial architectures in colonies of the British Empire in Southeast Asia and West Africa. <sup>(58)</sup> With regard to the history of climate and environmental management, following from Foucault's concepts of "biopower" and "governmentality," it can be shown that the history of building and constructing "tropicality" concerned not only the private bungalow, but also public projects, typologies such as military barracks, hospitals, and also housing, which were based on passive means of climate control (e.g., natural ventilation, shading) at the interface of nature and technology, and thus always reproduced colonial and imperial relations of domination. <sup>(59)</sup> Accordingly, a global architectural history of climatization that is neither ahistorical nor apolitical highlights the default settings associated with vernacular techniques of temperature control, often treated as laboratories for the imperial centres. <sup>(60)</sup> Such a history contextualizes and complicates the extent to which this involved translating the relationship of architecture and climate into a system of science and technology, with the introduction of mechanical air conditioning in the wake of industrialization and globalization in the twentieth century. This was the case, for example, in Singapore, where air conditioning was once propagated by the state. In other words, the sovereign power creates dependency, accompanied

by notions of productivity, efficacy, and efficiency. <sup>61</sup>

- 57 Jiat-Hwee Chang and Daniel J. Ryan, "Editorial: Historicizing Entanglements of Architecture and Comfort Beyond the Temperate Zone – Part I," *Architecture Beyond Europe* 17 (2020): n.p.
- 58 Jiat-Hwee Chang, *A Genealogy of Tropical Architecture* (London: Routledge, 2016), based on his PhD dissertation (UC Berkeley, 2009); and Anita Bakshi, "Climate, Colonial Technoscience, and Architectural History: An Interview with Jiat-Hwee Chang," *Architectural Histories* 9, no. 1, (2021): 1–14.
- 59 Anthony D. King, "The Colonial Bungalow-compound Complex: A Study in the Cultural Use of Space," *Journal of Architectural Research* 3, no. 2 (1974): 30–43.
- 60 For a global history of vernacular architecture and its translation since modernism from a Western perspective, see Sascha Roesler, *Weltkonstruktion: Der außereuropäische Hausbau und die moderne Architektur - ein Wissensinventar* (Berlin: Gebr. Mann Verlag, 2013).
- 61 Cherian George, *Singapore: The Air-Conditioned Nation: Essays on the Politics of Comfort and Control, 1990–2000* (Singapore: Landmark Books, 2000).

With the recognition of energy and climate emergency and looming tipping points as a new planetary reality, historical epistemology in architectural research has become far more complex, if not more complicated. As a prominent response, architectural history has recently been working most notably through the history of air conditioning in the twentieth century, especially in the postwar period. <sup>62</sup> Thus Chang traces how, in the so-called American century, with the emergence of the United States as a superpower in political, economic, and cultural terms, certain notions of comfort were developed by science under laboratory conditions, which were carried around the world by the air-conditioning industry through the dissemination of products, with architecture becoming the handhold for creating markets and selling comfort as a commodity. <sup>63</sup> Moe adds to this the evidence that architecture and architectural history, research, and pedagogy were also complicit in this process. <sup>64</sup> In contrast, contemporary architectural history, responding to socio-technical approaches beyond the European-American context, has engaged critically with comfort and climate control in times of climate instability and the transformation to a low-carbon society in relation to the architectural entanglements of late modernism, postmodernism, and neoliberalism, respectively, often thinking of energy and carbon balance as a process, driver, and consequence. In the meantime, what has been highlighted is the influence of oil capitalism upon architecture and urban planning, in particular upon the form of the corporate skyscraper of the American-style organizational complex, which continues to be based on the thermodynamic principle of a refrigerator (for Barber, the Seagram Building is an inglorious example when it comes to its environmental and climate balance, while for Moe it is equally as important not to overlook its very materiality), eating up vast amounts of energy (mostly from fossil fuels) for air conditioning. <sup>65</sup> However, not least because of the unequal distribution of environmental resources and environmental costs, only a comparative view of different regions and developments allows for a better relational understanding.

- 62 Laurent Stalder, "Air, Light, and Air-Conditioning," *Grey Room*, no. 40 (2010): 84–99.
- 63 Chang, "The Air-Conditioning Complex," 2022.
- 64 Kiel Moe, "The Equipmental Tradition: Architecture's Environmental Pedagogies," in *Environmental Histories of Architecture*. Jiat-Hwee Chang and Daniel J. Ryan also demonstrate this understanding of thermal comfort not only in James Marston Fitch's *American Building: The Forces That Shape It* (1947), but also with the brothers Victor and Aladar Olgyay, who were doing research at Princeton University in the postwar period. Chang and Ryan, "Editorial," esp. paragraphs 8 and 9.
- 65 Reinhold Martin, *The Organizational Complex. Architecture, Media and Corporate Space* (Cambridge, MA: MIT Press, 2003); Daniel Barber, "Modes of Concealment: Architecture, Oil, and Historical Method," in *Environmental Histories of Architecture*; and Kiel Moe, *Unless: The Seagram Building Construction Ecology* (Barcelona: Actar, 2021).

Contemporary architectural climate research is increasingly taking a more differentiated look, beyond operational (and also embodied) energy, at the effect that the climate, knowledge of global warming, and the experiences of our own bodies exert on shared visions of the future, on our lives and actions. Leading the way here was *Climates* (2016), a volume that proposed a comprehensive overview of how new

notions of climate and collapse (atmospheric disruption, geological fault lines, ecological disruption, social unrest, and economic upheaval) not only shape new analyses of buildings as enclosures, but fundamentally require a new relationship to the Earth at all scales, producing new regimes of knowledge in ecological terms and producing new ways of being embodied in relation to the environment. <sup>66</sup> Reinhold Martin's contribution, for example, takes an architectural-theoretical perspective toward the Bank of America Tower, One Bryant Park in Manhattan, the first LEED Platinum-certified (i.e., classifiable as "sustainable") office tower, relating it to the manageability of incalculable factors, in particular air conditioning as a purification technology, with reference to further forms of enclosure, postwar megastructures, and other high-rise bank buildings. Channelling the sociologist Ulrich Beck, Martin discussed to what extent the social construction and negotiation of risk discernible in the typology—here framed in relation to globalization and border-spanning environmental problems—produces new transnational divisions of labour along lines of gender, class, and race, which can be traced by the separation of inside and outside. <sup>67</sup> Gökçe Günel's contribution similarly discusses Masdar City in Abu Dhabi, a showcase urban development project in the United Arab Emirates, part eco-city, part corporate headquarters, part university campus, financed with oil money, intended to lay the groundwork for an economic and governmental future after fossil energies, but ultimately only partially realized. On the basis of field research, Günel shows how certain groups of people, mostly students and employees, inhabit this "Spaceship in the Desert," a mixture of research institute and living lab; how they perceive its underlying understanding of technology and architecture; how they judge its functionality and feasibility; and how they ultimately question its replicability in other places (whether on Earth or in outer space). <sup>68</sup> Both cases testify above all to the current materialization and reification of the sustainability paradigm, which, combined with the obsolescence paradigm, turns out to serve the demolition-and-rebuild ideology.

- 66 The *Climates* anthology gathers essays that previously appeared in *The Avery Review* of the Temple Hoyne Buell Center for the Study of American Architecture at Columbia University, following an open call to explore climate thinking in architecture and neighbouring disciplines. James Graham et al., eds., *Climates: Architecture and the Planetary Imaginary* (New York; Zurich: Columbia Books on Architecture and the City and Lars Müller Publishers, 2016).
- 67 Reinhold Martin, "Risk: Excerpts from the Environmental Division of Labor," in *Climates*, 349–359, previously published in *The Avery Review* 16 (May 2016).
- 68 Gökçe Günel, "Inhabiting the Spaceship: The Connected Isolation of Masdar City," in *Climates*, 361–371, previously published in *The Avery Review* 13 (February 2016). On a large-scale social experiment in Masdar City on student energy and water use by researchers, see Günel, "Masdar City's Hidden Brain," *ARPA Journal* no. 1 (15 May 2014); and on the major anthropological study, see Günel, *Spaceship in the Desert: Energy, Climate Change, and Urban Design in Abu Dhabi* (Durham, NC: Duke University Press, 2019).

Furthermore, from an anthropological perspective, it becomes apparent here the extent to which "thinking like a climate" has had concrete effects not only at the governmental and executive levels, but also at the scale of architectural and urban planning solutions. Within architecture, when it comes to scientific research and social benefits, the imperative is toward rethinking the environment between the poles of the global and the planetary. <sup>69</sup> Whereas climate control was once demonized as an outgrowth of globalization's universalist impulse, climate, as it has manifested itself in various ways in the twenty-first century in relation to transnational systems of division of labour, resource exploitation, and capital accumulation, has become a central, if not *the* central, subject for writing environmental histories of architecture; especially when looking to the future, in terms of, for example, the recommendations for architecture and urban planning of the Intergovernmental Panel on Climate Change (IPCC), and its twin strategies of mitigation and adaptation, concerning not just solar and wind



energy, but more generally material substitution.<sup>(70)</sup> Yet in view of the gloomy forecasts that entire regions of the Earth could soon no longer be habitable, and the unpredictability of impending climate migration, it is simplistic—and once again reflective of a privileged position—to merely think about architecture “after comfort.”<sup>(71)</sup> As necessary and inevitable as approaches such as post-growth and degrowth are, it is not enough to portray the fully air-conditioned high-rise as the villain, to generally criticize the steel and glass boxes (with their concrete cores!) as a symbol of growth ideology, and, on the other hand, to once again design a viable solution by simply resorting to the flat-roof, low-rise dwellings of Western modernism.

69 Hannah Knox, *Thinking Like a Climate: Governing a City in Times of Environmental Change* (Durham, NC: Duke University Press, 2020).

70 IPCC, Synthesis Report, Sixth Assessment Report (AR6), 19 March 2023, [https://report.ipcc.ch/ar6syr/pdf/IPCC\\_AR6\\_SYR\\_SPM.pdf](https://report.ipcc.ch/ar6syr/pdf/IPCC_AR6_SYR_SPM.pdf). Over the years, the IPCC reports have become subject of architectural debate, most recently one held by *The Avery Review of Architecture*. Accordingly, architectural research today should be addressing itself to issues such as less heating and cooling though more electrification (and at the same time more photovoltaic, wind, and geothermal installations), wasting less electricity in the process, employing less concrete (as well as other modern construction materials such as steel, glass, and plastic), producing less living space, less resource use in general, and so forth, to reduce the emission of carbon compounds. Daniel Barber, Elisa Iturbe, and Elise Misao Hunchuck, “What Comes After the ‘Green’ Building?” *New York Review of Architecture* 31 (September/October 2022), <https://nyra.nyc/articles/what-comes-after-green-building>.

71 Daniel Barber, “After Comfort.” *Log*, no. 47 (2019): 45–50.

Instead, at the interface of architecture, environment, and history, an energy and climate history takes into account the situation and perspective of the Global South, rather than simply revisiting canonized works and masters of modernism.<sup>(72)</sup> Accordingly, more and more voices acknowledge that in the face of global warming, air conditioning, once a technical solution for the production of commercially exploitable interior space in twentieth-century capitalism, has long since ceased to be a luxury for people living in countries of the Global South and become a sheer necessity at the intersection of (sub)tropicality, technoscience, and governmentality.<sup>(73)</sup> On the other hand, meanwhile, Jennifer Ferng, Jiat-Hwee Chang, Erik L’Heureux, and Daniel J. Ryan stress the (sub)tropical as a significant paradigm, reassessing the heritage of vernacular Asian architecture to challenge northern, temperate perspectives.<sup>(74)</sup> In the face of rising global temperatures, Chang and others demand hybrids—borrowing from Bruno Latour, who suggests blending and fusing the cultural and natural<sup>(75)</sup>—for climatizing interiors (and exteriors), a combination of cooling through active and passive technologies, including vernacular architectures, unconcerned with energy intensity, to say nothing of extraction.<sup>(76)</sup> From an Anthropocene perspective, it may make sense to see “air conditioning” as an example of the role of technology in environmental history, and simultaneously to think of technological history as environmental history.<sup>(77)</sup> The role of architecture in terms of climatization as an object and tool remains ambivalent: on the one hand, it has the capacity to redefine the political and thus generate new forms of publicness; on the other hand, it is important to consider its contribution to the spatial and social separation of populations and, on a planetary scale, its complicity in the construction and composition of the atmosphere.

72 Daniel Barber, *Modern Architecture and Climate: Design before Air Conditioning* (Princeton, PA: Princeton University Press, 2020); and Hannah le Roux, “Review,” *Journal of the Society of Architectural Historians* 80, no. 2 (June 2021): 332–334.

73 Bakshi, “Climate, Colonial Technoscience, and Architectural History.”

74 Their research sketches a counter-history of climate design, using three case studies—early climate diagrams from Australia, gross floor area calculations in the Singapore building code, and the Malay house in Southeast Asia—and discussing three design models—climate diagrams, gross floor area calculations, and architectural sections to represent passive air flows. Jennifer Ferng et al., “Climatic Design and Its Others: ‘Southern’ Perspectives in the Age of the Anthropocene,” *Journal of Architectural Education* 74, no. 2 (2020): 250–262.

75 Bruno Latour, *We Have Never Been Modern* (Cambridge, MA: Harvard University Press, 1991).

- 76 Sascha Roesler worked on hybrids of air conditioning at the Future City Laboratory in 2013–2015. Roesler, “Man-Made Weather: Toward New Climatic Research in Architecture,” *FCL Magazine* (2015): 8–13.
- 77 For Sarah Pritchard, hybridity as an influential concept, like multiplicity of meanings of an object or building when viewed ecologically, economically, or socially, respectively. Pritchard, “Toward an Environmental History of Technology,” in *Oxford Handbook of Environmental History*, ed. Andrew C. Isenberg (New York: Oxford University, 2014), 227–258, esp. 241.

In recent times, in the context of the project of decarbonization—that is, reversing the social and political processes that Aleksandr Bierig has investigated with a focus on coal as a large-scale traded object or thing in a Latourian sense from a cultural history perspective<sup>(78)</sup>—design-oriented approaches toward architecture and urban planning have been developed.<sup>(79)</sup> Significantly, these approaches—not just a critique of fossil fuels via conversion to renewable energies—go beyond the individual building, the energy hunger of climate technology, and the airtightness of the building envelope, and deal with associated norms, traditions, and beliefs. Meanwhile, the built environment of the twentieth century as a whole is being scrutinized in its reciprocity with energy, in terms of the emergence of building typologies such as the urban morphologies of the modern metropolis and its hinterlands (e.g., company towns, global trade networks, highway networks, suburban settlements, and megacities), to imagine developing something other than the carbon-dependent form we have attained so far.<sup>(80)</sup> When it comes to architectural design, Elisa Iturbe elaborated on the social dependencies on oil, and on the habits of thought, value systems, and lifestyles associated with cultures of abundance—which were reproduced through architecture and urbanism—using two of Le Corbusier’s flagship projects, both of which, in their promotion of car culture, but also in their formal design (the fundamental principle of modernism), propagated the use and production of oil: the Plan Voisin (1922–1925), a tabula rasa planning for the centre of Paris, ultimately funded by the automobile and aircraft industry; and the architectural floor-plan for the Villa Savoye (1928–1931), with its driveway and access to an integrated garage. The goal would be to make this interrelationship with the petroleum and kerosene industry conscious, if not undo it, for example by historicizing the guiding principle of a compact and mixed-use city in an environmental perspective.

- 78 Aleksandr Bierig, “Building on Ghost Acres: The London Coal Exchange, circa 1849,” in *Environmental Histories of Architecture*—developed from Bierig “The Ashes of the City: Architecture, Environment, and the Spatial Economy of Coal in Britain (1700–1849),” (PhD diss., Harvard University, 2022).
- 79 Vaclav Smil, “Decarbonization: Progress So Far,” *Energy Transitions. Global and National Perspectives* (Santa Barbara, CA: Praeger, 2017), 147–173.
- 80 Elisa Iturbe, “Architecture and the Death of Carbon Modernity,” *Log*, no. 47 (2019): 10–23.

Architectural research, on the other hand, aims at a more complex and conscious climatization on different scales, and a change of perspective from efficiency to sufficiency as a contribution to energy transition and sustainability. With regard to sustainable urban design, Sascha Roesler—starting from the hypothesis that today both the outdoor climate, formerly understood as a fixed quantity, as well as the indoor climate, often relying on airtight envelopes, are both produced by humans—has highlighted the virtues of naturally ventilated architecture, and especially urbanism of twentieth-century Europe—coming from Berlin, for example, or Vienna.<sup>(81)</sup> With regard to urban microclimates, the energetic and synergetic interplay of architectural scale and urban scale, interior and exterior, energy and climate, can be elaborated, as is evident from international comparisons, through a consistently historical and contextual reading. And equally, Singapore-style hybrid climatization (a combination of natural ventilation and air conditioning based on the staggering of differently climate-controlled spaces and semi-permeable façades, nested court yards and green spaces) may well be considered as a model for when the formerly temperate latitudes heat up to subtropical temperatures without

immediately falling prey to North America's air-conditioning mania. The situation is definitely delicate: there are warnings against reducing the climate to a design, while at the same time acknowledging that any talk of emergency also undermines the possibility of politics.<sup>(82)</sup> It shouldn't be forgotten that the very emphasis on the urban scale means that the sun gets harvested not only from an economic or ecological point of view, but also with the political goal of achieving "solarity."<sup>(83)</sup> Despite all the hope that needs to be maintained, it cannot be taken for granted that the energy transition will happen at the scale and pace that is necessary; therefore innovative, forward-looking architectural research looks equally at the two existing modes of carbon sequestration: achieving this, on the one hand, through the natural system, via massive reforestation; and, on the other, through active carbon capture and storage within bio-based buildings on an industrial scale.<sup>(84)</sup>

- 81 At the Accademia di Architettura in Mendrisio, Roesler led the research project Architecture and Urban Climates from 2015 to 2021, which resulted in two volumes of the new KLIMA POLIS series. Featured here are designs using both active and passive means, a permeable façade design with simultaneous climatic stratification of the floor plan, especially customized thermal practices, the active design of urban microclimates. Roesler, *City, Climate, and Architecture: A Theory of Collective Practice*, KLIMA POLIS, vol. 1 (Basel: Birkhäuser 2022); Roesler, Madlen Kobi, and Lorenzo Stieger, eds., *Coping with Urban Climates: Comparative Perspectives on Architecture and Thermal Governance*, KLIMA POLIS, vol. 2 (Basel: Birkhäuser 2022); and Roesler and Kobi, eds., *The Urban Microclimate as Artifact* (Basel: Birkhäuser, 2018).
- 82 Anthony Powis (on behalf of Mould), *Climate* (London: Mould, 2022), esp. 4 and 8, <http://mould.earth/wp-content/uploads/2022/03/MLD040-climate.pdf>.
- 83 Oxana Timofeeva, *Solar Politics* (London: Polity, 2022); for an energy humanities and energy justice perspective on "solarity," see After Oil Collective, Ayesha Vemuri, and Darin Barney, eds., *Solarities: Seeking Energy Justice* (Minneapolis: University of Minnesota Press, 2022); for a new material perspective on "solarities," see Cymene Howe, Jeff Diamanti, and Amelia Moore, eds., *Solarities: Elemental Encounters and Refractions* (Goleta, CA: Punctum Books, 2023).
- 84 For Holly Jean Buck, humanity must view carbon as a design task in terms of landscape, land use, and the built environment. However, Buck advocates industrial CCS, as sought by the building material industry, which is considered unlikely from today's perspective. Buck, "On Carbon Spaces by Design," *Log*, no. 47 (2019): 51–55.

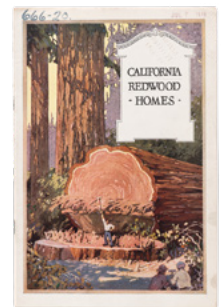
Until recently, the history and theory of architecture (and their teaching) could safely ignore energy and climate, the costs to society and the environment, but times have changed. The task and responsibility of environmental histories of architecture now is to examine canonized (but also supposedly alternative) knowledge through the environmental perspective; to determine to what extent, since the modern age, oil as a cheap fuel (and natural gas and coal) has determined all building and living according to the formula "form follows fuel," making all architects and also all architectural historians and theorists fossil-fuel workers. At the same time, this acknowledgement also entails determining how this dependency can be reimagined.<sup>(85)</sup> Given our current situation, where narratives oscillate between apocalypse and post-apocalypse, the decisive question of leaving the modern past behind, or rather ecologizing, composing everything anew, as Latour once summed up the societal discord, is about nothing less than how we want to build and live, and in extreme cases the survival of various species, including humanity.<sup>(86)</sup> As is generally the case in the study of history, this does not mean that we can simply learn from history by referring to proven (or merely unproven) solutions, methods, and procedures as a repository of experience. Instead, in view of the change of era at hand, it is important to bear in mind that dominant energy regimes and the respective energy mix are not historically fixed entities that never change; and to recall that complex socio-ecological, political, socio-economic, and ultimately cultural transformations took place under certain conditions, in the interplay of state and market, and extended over several decades in the process. Environmental histories of architecture thus fundamentally question the promise of innovation and sustainability, helping us to rethink concepts such as the technological system without denying architecture and urbanism the potential to develop viable visions of the future in the face

of atmospheric change and geopolitical uncertainty. Unlearning fossil fuels, not only in terms of operational energy but especially in terms of embodied energy over the course of a life cycle, overcoming the dependencies of the twentieth century—including energy-intensive, petroleum-based materials—and establishing criteria that make the good life possible for humans and non-humans pertains once more to all institutions, norms, and behaviours related to the research, teaching, practice, and culture of architecture.

- 85 Barnabas Calder, “Form Follows Fuel: Energy-Hungry Architecture,” *Architectural Review* (6 October 2022), <https://www.architectural-review.com/essays/keynote/form-follows-fuel-energy-hungry-architecture>.
- 86 Bruno Latour, “To Modernize or to Ecologize? That’s the Question,” in *Remaking Reality: Nature at the Millennium*, eds. Bruce Braun and Noel Castree (London: Routledge, 1998), 221–242.

## MATERIAL AND POLLUTION HISTORIES

In addition to energy, defined in a narrower sense as fuel, environmental histories of architecture, given the consumption, resource, and waste problematic, increasingly focus on building materials—industrially produced bulk commodities of the nineteenth and twentieth centuries and alternatives that are both part of a larger metabolism.<sup>87</sup> After all, in the Anthropocene, modern building materials, the foundation and very function of modern building culture, are characterized by a heightened energy turnover (for extraction, production, transport, etc.), so that construction itself contributes significantly to global carbon emissions.<sup>88</sup> Recently within architectural research, with the “material turn,” that is, the increasing emphasis on objects of material culture in the humanities and cultural studies, materials—matter as well as materiality—and related social and aesthetic (but less so environmental) concerns have also been examined.<sup>89</sup> At the same time, the relational and circular dynamics of supply chains and commodity chains were historicized, drawing on William Cronon’s *Nature’s Metropolis* (1991), a prototypical environmental history, focusing on the nineteenth-century development of Chicago and its hinterland, which includes a chapter on the shaping of a territory for the supply of lumber.<sup>90</sup> In addition to the spread of professionalized logging and the employment of timber in vernacular wooden buildings, Cronon’s focus was on the development of the market and especially the mill, on processing and distribution, amounting to an ecological and economic critique of the building materials needed to construct urban and rural areas.<sup>91</sup> A similar historical analysis can be written for the geographies of brick using the example of Berlin and Prussian architecture in general.<sup>92</sup> fig. 4 Compared to territories of timber or brick in earlier modern days, material histories of the second half of the nineteenth and then twentieth century illustrate the emergence and development of relationships as dependencies between the building material industry and the building sector. Industrial building materials (iron and steel, glass, concrete, later aluminum, and also plastic) became impactful in terms of all the aesthetic and technical, economic and also ecological distortions, overlaps, and noise involved.<sup>93</sup>



- 87 Although in her introduction to *Material Matters*, Katie Lloyd Thomas refers to “a complex history of development, extraction, technique, transportation and exchange,” this geography, in contrast to philosophical considerations and social and political constructions beyond “environmental concerns,” is not further developed. Lloyd Thomas, “Introduction: Architecture and Material Practice,” in *Material Matters: Architecture and Material Practice*, ed. Lloyd Thomas (London: Routledge, 2006), 2–12, esp. 2; see also Tilo Amhoff, Nick Beech, and Lloyd Thomas, “Industries of Architecture,” in *Industries of Architecture*, eds. Lloyd Thomas, Amhoff, and Beech (London: Routledge, 2015), 1–10.
- 88 David Benjamin, ed., *Embodied Energy and Design: Making Architecture between Metrics and Narratives* (New York; Zurich: Columbia University GSAPP and Lars Müller Publishers, 2017).
- 89 Recent publications, varied as they may be in terms of their treatment or non-treatment of aspects of work, have once again approached matter, material, and materiality through the history of building and construction, art, and philosophy, but less so through ecology (versus economy), culture, landscape, and climate. And approaches to the history of materials, like those to the

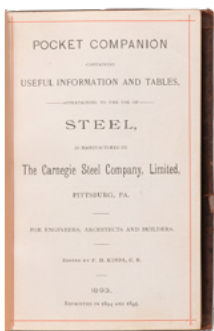


history of energy, assume that architecture serves humans, even reshapes humans. Antoine Picon, *The Materiality of Architecture* (Minneapolis: University of Minnesota Press, 2020); and Thomas, *Building Materials: Material Theory and the Architectural Specification* (London: Bloomsbury Visual Arts, 2022). For reflections on an environmental perspective, questions of ignorance, risks, and ethics, see Ryan, “Environmental Materialism.”

- 90 More than thirty years ago, Cronon thus established a significant strand in American environmental history. William Cronon, *Nature's Metropolis: Chicago and the Great West* (New York: W. W. Norton, 1991), 148–206.
- 91 Something similar could be said about an environmental history of iron and glass constructions, such as the early reinforced concrete constructions of the nineteenth century. Sigfried Giedion had already framed these developments, if only selectively, in terms of the misuse of “men [sic], materials, and human thought” and had written in this context about “one of the most wretched periods,” only to speak of the unfolding of new possibilities. Giedion, *Space, Time and Architecture* (Cambridge, MA: Harvard University Press, 1941), 161. See also, Giedion, *Bauen in Frankreich. Bauen in Eisen, Bauen in Eisenbeton* (Leipzig: Klinkhardt & Biermann, 1928), eventually published in English under the title *Building in France, Building in Iron, Building in Ferroconcrete*, trans. J. Duncan Berry (Los Angeles: Getty Center for the History of Arts and the Humanities, 1995).
- 92 As a contribution to the project Curatorial Design: A Place Between, Laila Seewang draws on Karl Friedrich Schinkel's Bauakademie in Berlin to create the larger arc and address the urban landscapes of quarrying and brickworks. Seewang, “Landscapes of Clay,” *Total Reconstruction: Re-enacting the Design of Karl Friedrich Schinkel's Bauakademie*, n.d., <https://www.curatorialdesign.org/landscapes-of-clay>.
- 93 Mark Jarzombek, “Quadrivium Industrial Complex,” *e-flux Architecture*, November 2019, <https://www.e-flux.com/architecture/overgrowth/296508/the-quadrivium-industrial-complex>. On plastic, see Ingrid Halland, “Being Plastic” *Log*, no. 7 (2019), 35–44; and on aluminum, see Mimi Sheller, *Aluminum Dreams: The Making of Light Modernity* (Cambridge, MA: MIT Press, 2014).

The metabolism of building materials changed with modern urbanization of European metropolises, and Hausmann's Paris (1853–1871) may serve as an example of material exchange and mass-scale construction following violent demolition, mainly in stone (also cast iron and plate glass), as capitalist instruments. <sup>(94)</sup> Le Corbusier's Plan Voisin, on the other hand, applying principles of obsolescence to the urban scale, called for a tabula rasa approach to the redevelopment of Paris (soon translated into English, German, Japanese, and Russian), proposing to utilize urban design as enterprise, based on the possibilities of steel and ferrocement high-rise construction. <sup>(95)</sup> fig. 5 fig. 6

The classical modern historiography of building with iron and steel, which propagated new things in the service of technological innovation, economic growth, and social progress, did differentiate the agency of industry and science respectively, and of structural engineering and architecture as new professions. <sup>(96)</sup> The availability of fossil fuels for the industrial production of building materials has long been, and still is, taken for granted and is worth at most a passing mention; yet coal mining was in some cases even part of the very corporate structure. Looking at the history of science and technology, there is a connection between economic history, design, and construction history. In this context it is possible to distinguish areas of material use that go back to the development of urban centres and the introduction of steel skeleton construction in North America (1865–1914). This can be attributed to market and manufacturing advances, as well as the dynamics between producers and consumers. <sup>(97)</sup>



- 94 Philippe Panerai, Jean Castex, and Jean-Charles Depaule, *Formes urbaines: De l'îlot à la barre* (Paris: Parenthèses, 1997); and David Jordan, *Transforming Paris: The Life and Labour of Baron Haussmann* (Chicago: University of Chicago Press, 1995).
- 95 Le Corbusier, *Urbanisme* (Paris: Éditions G. Crès, 1925).
- 96 Giedion, *Space, Time and Architecture*; and Mario Rinke and Joseph Schwartz, *Before Steel: The Introduction of Structural Iron and its Consequences* (Sulgen: Niggli, 2010).
- 97 Thomas J. Misa, *A Nation of Steel, The Making of Modern America, 1865–1925* (Baltimore: John Hopkins University Press, 1995).

Meanwhile, from an environmental history perspective, in terms of building materials, it is not just about buildings but the larger geographies of “management strategies, labour conditions and natural resources,” on a national and international scale. <sup>(98)</sup> Exemplary for material geographies and a commodity and supply chain analysis in architecture and landscape architecture are two research projects on the material cultures centred on New York City: <sup>(99)</sup> Kiel Moe using the example of the Empire State Building as the most emblematic construction site for elucidating the energetics of the materials used

in a building over a 150-year span; <sup>(100)</sup> and Jane Mah Hutton using the example of Central Park (and other green spaces and parks) to examine the reciprocity of origin and use of materials involved in the design of landscape. <sup>(101)</sup> Once again, it is capital and labour that reshape and consume the natural environment; and it is the dialectical relationship between energy, material, and food that contributes to periodization and our understanding of larger shifts regarding the relationship between people and the planet. <sup>(102)</sup> The concept of embodied energy, on the other hand, allows us to take a critical view of labour, as well as the very bodies involved in mining and quarrying that are necessary for architecture and urbanism—in Europe, often migrant workers, and in the Americas, often BIPOC subjects. <sup>(103)</sup> It took studies in (in)human geography to expose the white colonial practices of labour exploitation, especially in the coal and iron ore mines and, in turn, on construction sites, as well as various forms of indentured servitude. <sup>(104)</sup> With respect to new histories and narratives critical of construction and extraction more broadly, it shouldn't be forgotten that the analysis and representation of the commodity form and value chains, which constitute an established field of research in anthropology, geography, as well as in history—that is, in studies of modernity, globalization, and neoliberalization—raise quite different questions in architectural and urban studies than the traditional narratives that focus on styles and movements <sup>(105)</sup>—for example, by paying attention to details, politicizing elements, and following materials to where they come from, rather than taking them for granted, questioning the political economy, ecology, geology of raw material extraction and reciprocities, labour-in-construction, and socio-spatial relations. <sup>(106)</sup> In addition, education and practice, design and communication are now based on an intensification of digital technology and indeed digital cultures, which are themselves extractive and material- and energy-intensive. Architectural research driven by the material question would thus anchor the built environment precisely and conscientiously in the historical context, within flows of energy, material, labour, and ultimately capital, with regard to the production of buildings as well as of subjects, unlike in a classical history of architecture or art.

- 98 Exemplary for supply chain analysis is the work of Anna Lowenhaupt Tsing on developments in Japan's timber industry in the twentieth century, which, according to this work, produced both heterogeneity and ruination. Tsing "What Is Emerging? Supply Chains and the Remaking of Asia," *The Professional Geographer* 68, no. 2 (2015): 330–337.
- 99 In the mid-2010s Jane Mah Hutton and Kiel Moe pursued research on material geographies at the Energy, Environments & Design Research Lab at Harvard GSD.
- 100 Kiel Moe, *Empire State & Building* (Barcelona: Actar, 2017); Moe, "Empire, State and Building," 24 September 2018, *Night White Skies*, produced by Sean Lally, [https://nightwhiteskies.libsyn.com/ep-049\\_-kiel-moe\\_-empire-state-and-building](https://nightwhiteskies.libsyn.com/ep-049_-kiel-moe_-empire-state-and-building).
- 101 Jane Mah Hutton, *Reciprocal Landscapes: Stories in Material Movement* (London: Routledge, 2020); Hutton, "Reciprocal Landscapes," 20 April 2020, *Night White Skies*, produced by Sean Lally, [https://nightwhiteskies.libsyn.com/ep\\_072\\_-jane-hutton\\_-reciprocal-landscapes](https://nightwhiteskies.libsyn.com/ep_072_-jane-hutton_-reciprocal-landscapes).
- 102 Barnabas Calder and G. A. Bremner, "Buildings and Energy: Architectural History in the Climate Emergency," *Journal of Architecture* 26, no. 2 (2021): 79–115.
- 103 Kevin Bernard Moultrie Daye, "The Missing Bodies in Architecture's Talk of Embodied Energy," *Failed Architecture*, 25 September 2019, <https://failedarchitecture.com/the-missing-bodies-in-architectures-talk-of-embodied-energy>.
- 104 Kathryn Yusoff, *A Billion Black Anthropocenes or None* (Minneapolis: University of Minnesota Press, 2018).
- 105 Arjun Appadurai, *The Social Life of Things: Commodities in Cultural Perspective* (Cambridge, UK: Cambridge University Press, 1986), 3–63; and Anna Lowenhaupt Tsing, "Supply Chains and the Human Condition," *Rethinking Marxism* 21, no. 2 (2009): 148–176.
- 106 Charlotte Malterre-Barthes, "The Devil Is In the Details: Who Is It That the Earth Belongs To?" in *Non-Extractive Architecture: On Designing without Depletion*, vol. 1, eds. Space Caviar (Berlin: Sternberg Press, 2021), 85–96; and Swarnabh Ghosh, "Toward a Critique of Labor-in-Construction," in *Non-Extractive Architecture*, 157–178.

If it is a matter of expanding the history of architecture and technology by taking into account an environmental history perspective against the backdrop of capitalist and global developments—especially considering that mines, pits, and quarries, as fundamental technological systems of construction material extraction, processing,

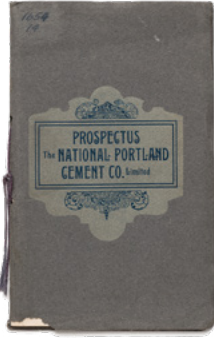
and production, as well as forms of processing or even mastering nature, not only enable urbanization, but shape the environment—architectural history would have to deal comprehensively and critically with the production conditions of the profession and the discipline, because materials are inevitably the basis of building and thus living. Unlike energy histories, material histories were not excluded from classic architectural histories of modernity. Fundamentally, however, with the focus on the constructive foundations of certain building typologies and on the figure of the architect-engineer, what was taken for granted when materials became proprietary was the availability of resources (as well as fossil fuels, mainly coal, later oil and gas, which were increasingly vital for industrial production), while industrial production was driven by efficiency, and thus profit. Additionally, extraction, means of production, and externalities—labour and nature, factory and machines, the enduring effect of colonial and imperial relations—were excluded in favour of the perpetuation of modern materials in the history of building and construction (based on the interests of the building-materials industry and the building industry and their associated path dependencies). <sup>(107)</sup>

- 107 Giedion, *Space, Time and Architecture*, esp. “The Evolution of New Potentials,” 161–208, and “Ferroconcrete and its Influence upon Architecture,” 320–331.

In contrast to Sigfried Giedion’s classic *Space, Time and Architecture* (1941), the architecture critic, sociologist, historian of technology, and urbanist Lewis Mumford had already formulated an argument about the relationship between architecture, urbanism, extraction (in the extension of the railroad network), and the environment—in this case as the only representative of his discipline at “Man’s Role in Changing the Face of the Earth,” the 1955 conference held in Princeton, New Jersey. <sup>(108)</sup> Only an urban, regional, and ultimately national perspective in relation to the development of the large industrial city allowed us to think together through the *Abbau* (the German word used by Mumford), that is, “unbuilding” together with the *Bau*, or “building”—in other words, to consider building material, matter, and materiality in connection, which is the basis for a political, economic, ecological, and ultimately also geological understanding of architecture and urban planning. <sup>(109)</sup> But in general, the history of the built environment of the postwar period, even with the “ecological turn” of the 1970s and 1980s, showed little interest in the different dimensions of material culture, whether the use of primary materials or the recycling of industrial waste as secondary materials. Only intermittently at that time, for example in the case of Martin Pawley, with the end of cheap energy, and the housing crisis with the expansion, deepening, and acceleration of globalization and the rise of neoliberalism, was reference made to a failed policy of limiting embodied energy and an example drawn from the wasteful material consumption of postmodernism. <sup>(110)</sup> At the same time, the tradition and use of natural materials, wood and earth, was historicized during this period.

- 108 Lewis Mumford, “The Natural History of Urbanization,” in *Man’s Role in Changing the Face of the Earth*, eds. William L. Thomas, with Carl O. Sauer, Marston Bates, and Lewis Mumford (Chicago: University of Chicago Press, 1956), 382–398. On Mumford’s environmentalism, see Ramachandra Guha, “Lewis Mumford: The Forgotten American Environmentalist: An Essay in Rehabilitation,” *Capitalism, Nature, Socialism* 2, no. 3 (1991): 67–91.
- 109 The industrial city dominated by coal is the starting point, but Mumford uses the German terms, drawing attention to the planetary scale, the global economy of production and food chains. *Abbau* for him also includes deforestation and extinction. Lewis Mumford, *The City in History: Its Origins, Its Transformations, and Its Prospects* (New York: Harcourt, 1961), 446–481, esp. 450.
- 110 Pawley refers to the aestheticization of solar panels and windmills “that undoubtedly helped to pave the way for the first decorative excesses of postmodernism.” “Energy,” III.

If, today, the carbon footprints and wastefulness of both the construction and the construction-materials industries are taken as a baseline, and the critical revision of building culture and the goal of contributing to the reduction of negative environmental effects (in global as

global as well as planetary terms) serves as a starting point and framing narrative, this has far-reaching consequences for architectural research in every respect: revisionist history, cultural critique, and future imaginary. <sup>(111)</sup> Meanwhile, histories of both steel and concrete, or reinforced concrete, told through narratives of nation (if not empire) building, are framed from an environmental perspective. <sup>(112)</sup> The case of cement as a commodity demonstrates how architectural history once limited itself to highlighting how concrete, over the course of the twentieth century, became the “modern material” par excellence, especially since it was considered to be universally applicable or at least ubiquitously available, thus playing into the hands of a rhetoric of inevitability. <sup>(113)</sup>  It is in this regard that the interests associated with the development and worldwide distribution of the material are named, and scientific thinking, entrepreneurial calculation, and design or construction knowledge—ultimately viewed in relation to the capitalist as well as the socialist system—are distinguished. <sup>(114)</sup> It is true that concrete has been attributed a modernizing, even identity-forming role during the whole of the last century (similar to “petroleum modernism” and “petroleum culture,” in fact, one could speak of “cement modernism” and “cement culture”). <sup>(115)</sup> However, within architectural research, its social effects—separate from the reappraisal initiated by economic studies on the concentration of power, the overlap of finance and industry, and central role of the state as being instrumental, as well as classic economic-historical aspects such as corporate structure or land ownership, cartel formation and pricing <sup>(116)</sup>—and likewise its environmental effects, have been neglected due to the great economic and cultural significance of cheap building materials. <sup>(117)</sup>

- 111 John Aspdin’s first patent for industrially produced Portland cement in 1824 already named the carbonic acid content of limestone and the chemical process of calcination. Dylan Dixon, “From the Transactions of the Institute of British Architects,” *The Journal of Architecture* 22, no. 1 (2017): 153–183. On the multiple tasks of the architectural humanities considering cement as an object of study, see Kim Förster, “Triangular Stories: Cement as Cheap Commodity, Critical Building Material, and a Seemingly Harmless Climate Killer,” in *Beyond Concrete: Strategies for a Post-Fossil Baukultur*, eds. FHNW Institut Architektur, Annette Helle and Barbara Lenherr, (Zurich: Triest Verlag, 2022), 35–65.
- 112 Peter Christensen, *Precious Metal: German Steel, Modernity, and Ecology* (University Park: Pennsylvania State University Press, 2022); and Sarah Nichols, “Pollux’s Spears,” *Grey Room*, no. 71 (2018): 141–155.
- 113 Until recently, the achievements of concrete construction were even celebrated by architectural history in the name of sustainability. However, Adrian Forty fundamentally sees concrete as a resource (and a medium) rather than a modern building material, assigning it more to nature rather than culture because of its origin and production. Forty, *Concrete and Culture: A Material History* (London: Reaktion Books, 2012), esp. “One: Mud and Modernity,” 13–42, and “Two: Natural or Unnatural,” 43–78.
- 114 Forty, “Introduction,” *Concrete and Culture*, 7–12; and Forty, “Myths of the Origin of Modern Concrete,” *gta papers*, no. 3 (2020): 69–77.
- 115 Salvatore Aprea, Nicola Navone, and Laurent Stalder, eds., *Concrete in Switzerland. Histories from the Recent Past* (Lausanne: EPFL Press, 2021).
- 116 Nichols, “Pollux’s Spears.” On cheapness, but not of building materials, see Jason Moore and Raj Patel, *A History of the World in Seven Cheap Things* (London: Verso, 2018).
- 117 Michael Osman, “Managerial Aesthetics of Concrete,” *Perspecta*, no. 45 (2012): 67–76; and Sergio Ferro (with Silke Kapp, Katie Lloyd Thomas, and João Marcos de Almeida Lopes), “Concrete as Weapon,” *Harvard Design Magazine*, no. 46 (2018): n.p.

On the other hand, in the debate over the recognition of the Anthropocene as a new geological era, and in the course of the so-called geological turn and other cross-disciplinary narratives, concrete has long been discussed as a “technofossil,” as the material now most frequently used and therefore as the world’s most traceable geological marker, its stratification (combined with steel, glass, plastic, but also with brick and ceramics) being particularly noticeable in the city. <sup>(118)</sup> The geologist Jan Zalaciewicz has visually summed up this sedimentary deposition through the concept of The Anthropocene Square Meter, a snapshot of all human made material objects, as sediments scaled to a square meter (actually a cubic meter). <sup>(119)</sup> From the perspective of environmental, energy, and climate history, however, what remains neglected is that precisely in tandem with the Great Acceleration, a



phenomenon which climate historian Christian Pfister and others previously discussed under the term “1950s Syndrome”—the production and use not just of oil, but of cement—also increased exponentially, a development that accelerated on an international scale with the new world order after the fall of the Berlin Wall. <sup>(120)</sup> The starting point for a critical and yet forward-looking historiography would have to be that industrially produced cement—as a commodity, as a building material, and as a climate-impacting substance—makes a decisive contribution to altering the composition of the atmosphere due to the processes undergone in the kiln, namely both the combustion of fossil fuels and the calcination and sintering of limestone into cement clinker. <sup>(121)</sup> A global history of cement, following a forensic line of thinking, would address the economic, ecological, geological, and political, as well as cultural with reference to societies’ relationship to nature materialized in cement production and consumption <sup>(122)</sup>—effects that can be seen in the example of homes as well as experimental buildings, built on poured foundations, and, quantitatively even more significant, in large residential buildings and infrastructural construction of the boom years during the postwar period; or the revival of concrete since the 1990s. Beyond this, both architectural and environmental history would need to locate all of their blind spots: for example, the naturalization of industrial and commercial processes, and the consequences of this for the sciences, including architecture and architectural history; the selection and investment in technological and even architectural solutions to air pollution; or the political support and social acceptance of corporate communication sustainability strategies. <sup>(123)</sup>

- 118 Jan Zalasiewicz et al., “The Technofossil Record of Humans,” *Anthropocene Review* 1, no. 1 (2014): 34–43; and Jan Zalasiewicz, Colin N. Waters, and Mark Williams, “City-Strata of the Anthropocene,” *Annales: Histoire, Sciences Sociales*, 72, no. 2 (2017): 225–245. On the geological turn, see Christophe Bonneuil, “The Geological Turn: Narratives of the Anthropocene,” in *The Anthropocene and the Global Environmental Crisis*, eds. Clive Hamilton, François Gemenne, and Christophe Bonneuil (London: Routledge, 2015), 17–31.
- 119 The Anthropocene Square Meter is a meaningful image. Landscape architect Alexandra Arenes has visualized it in an axonometric drawing, animated as a GIF. And the team of Sarah Nichols, at the THEMA (Theory of Environment, Material and Architecture) lab at EPFL, has recreated it as an architectural model. Jan Zalasiewicz, “The Anthropocene Square Meter,” in *Critical Zones: The Science and Politics of Landing on Earth*, eds. Bruno Latour and Peter Weibel (Cambridge, MA: MIT Press and ZKM | Center for Art and Media, Karlsruhe, 2020), 36–43.
- 120 Christian Pfister, ed., *Das 1950er Syndrom: der Weg in die Konsumgesellschaft* (Berne: Klett-Cotta, 1995); and Christian Pfister, “The ‘1950s Syndrome’ and the Transition from a Slow-going to a Rapid Loss of Global Sustainability,” in *Turning Points in Environmental History*, ed. Frank Uekötter (Pittsburgh: Pittsburgh University Press, 2010), 90–117.
- 121 Kim Förster, “The Kiln,” in *Solarities: Elemental Encounters and Refractions*, eds. Cymene Howe, Jeff Diamanti, and Amelia Moore (Goleta, CA: punctum books, forthcoming).
- 122 On a global history of commodities, see Sven Beckert, *Empire of Cotton: A Global History* (New York: Alfred A. Knopf, 2014).
- 123 Kim Förster, “Reden wir über Zement: Blinde Flecken in der Architektur- und Umweltgeschichte,” *Werk, Bauen + Wohnen* no. 5 (2022): 32–36.

For an architectural history of the Anthropocene, the modern cement plant together with the mechanized quarry and the rotary kiln (not to mention the coal mine, the oil field, and the nuclear power plant for the supply of fuels and electricity), is a central site and object of investigation. While the humanities and cultural studies have thus far focused primarily on descriptions, analyses, and interventions concerning the refinery, oil field, and pipeline, from an architectural perspective it is also necessary to historicize the geography and territory, economy and ecology, materiality and representation of construction materials that have shaped modernity. The architectural and built evidence here would go beyond just the cement plant and include the steel plant, the glass plant, and the chemical plant, respectively in terms of mining, production, distribution and use, that is, what Christopher Jones calls the “sacrifices zones.” <sup>(124)</sup> <sup>fig. 8</sup> In addition, there are all the social and cultural, embodied and lived aspects of this history; the building materials as products surround us (privileged consumers). <sup>(125)</sup> Accomplishing this, however, cannot only be a matter of just



tracing networks and recognizing expertise. From the perspective of environmental history, what is important now is to avoid repeating the mistakes of the history of technology—which, while counteracting technological determinism by exploring the social underpinnings of large technological systems such as those underlying electricity generation, building materials, and construction industries, whether East or West, American or Chinese—nevertheless made nature into a passive background for these narratives. <sup>(126)</sup>

- 124 Christopher F. Jones, *Routes of Power: Energy and Modern America* (Cambridge, MA: Harvard University Press, 2014); David Farrier, *Anthropocene Poetics: Deep Time, Sacrifice Zones, and Extinction* (Minneapolis: University of Minnesota Press, 2019); and Ryan Jukus, “Sacrifice Zones: A Genealogy and Analysis of an Environmental Justice Concept,” *Environmental Humanities* 15, no. 1 (2023): 3–24.
- 125 On the steel plant, see Peter Christensen, *Precious Metal: German Steel, Modernity, and Ecology* (University Park: Pennsylvania State University Press, 2022); and on the chemical plant, see Jessica Varner, “Chemical Desires: Dyes, Additives, and Foams; Making the Architectural Materials of Modernity (1870–1970)” (PhD diss., Massachusetts Institute of Technology, 2020).
- 126 Pritchard, “Toward an Environmental History of Technology.”

For a politics and culture of sustainability, the architectural humanities would need to look at materials through the lens of extraction and extractivism, as done primarily in relation to minerals and fossil fuels (but also to plant and animal life), as the dominant principle of capitalism in the early twenty-first century. Imre Szeman points out that the link between extraction and the environment is nothing new in itself; what is new is our understanding of the extent and significance of this link to the state of our planet. <sup>(127)</sup> Rather than conceptualizing terraforming, the Anthropocene, and the Earth as an architectural project, architectural research could apply and extend Szeman’s analysis and critique, treating extraction as both a concept and object: by seeing construction as a continuation of extractive practice; by understanding extraction in a broader physical *and* digital sense; by recognizing extraction as a principle and practice of neo-liberalism; and thus by describing a fundamental societal relationship to the environment. Typically, extraction runs in one direction: what is mined is then used in construction, and all that is left behind is hazardous waste, environmental destruction, and climate-damaging substances. Corresponding to this, theories of wasting see urbanization as a process of stratification that disrupts material flows, and thus as part of the larger metabolism. Despite its effort in urban mining and recycling, metabolism literature appears to disregard the significance of pollution, including air, water, or soil contamination as well as drastic alteration in the atmospheric composition. <sup>(128)</sup> However, with a view to the climate crisis, knowledge within the arts, architecture, and media is currently being reexamined under the concept of “accumulation.” <sup>(129)</sup> Accumulation is nowadays understood more broadly—and in a transdisciplinary perspective as a response to extraction—than it was in the time of Karl Marx’s classical critique of political economy, as far as the accumulation of surplus value as capital is concerned, because this originally meant the double exploitation of labour power and nature along the urban-rural divide. Now, accordingly, the critique of accumulation and growth, thinking of “raw, often unruly material,” encompasses the architectural scale, too, which includes all buildings and infrastructures. <sup>(130)</sup> Moe, for example, in view of the “metabolic rift”—that is, between the metropolises and their meanwhile global hinterlands, as theorized otherwise under the term “planetary urbanization” <sup>(131)</sup>—it is not only a matter of conceiving the flows of energy and material more broadly (with reference to energetics), but also of a different relationship to capital. <sup>(132)</sup> When it comes to the metabolism between humans and the planet, architectural research involves establishing different links between the affordances and constraints of the building systems and the imperatives of building and living cautiously. This includes, above all, an altered understanding of the sun from

a material perspective, which includes not only solar energy but also solar resource metabolism, and thus regenerative building materials.

- 127 Imre Szeman, "On the Politics of Extraction," *Cultural Studies* 31, no. 2-3 (2017): 440-447; and Pierre Bélanger, *Extraction Empire: Undermining the Systems, States, and Scales of Canada's Global Resource Empire, 2017-2017* (Cambridge, MA: MIT Press, 2018).
- 128 Mazen Labban, "Rhythms of Wasting / Unbuilding the Built Environment," *New Geographies*, no. 10 (2019): 33-41.
- 129 Nick Axel et al., "Accumulation," *e-flux Architecture*, 2017, <https://www.e-flux.com/architecture/accumulation/>; then published as "Introduction," in *Accumulations: The Arts, Architecture and Media of Climate Change*, eds. Nick Axel et al. (Minneapolis: University of Minnesota Press, 2021), 9-12. Contributions from architecture were made by Jennifer Ferng, Lindsay Bremner, Beth Cullen, Kiel Moe, Hannah le Roux with Gabrielle Hecht, and Nerea Calvillo.
- 130 Nick Axel et al., *Accumulations*, 9. In the twenty-two essays collected here, the term "accumulation" refers to all sorts of things, not just "capital" but "air conditioners," "migrant workers," "snow," "matter," "energy," "landfills," "data," and so forth. Newly added to the book's introduction as a result of the COVID-19 pandemic were "people" and "viral load in the air and in the lungs." Notably absent from this broad concept, however, are the role of architecture and building in accumulation.
- 131 Neil Brenner and Christian Schmid, "Planetary Urbanization," in *Urban Constellations*, ed. Matthew Gandy (Berlin: Jovis, 2011), 10-13; Brenner, "Debating Planetary Urbanization: For an Engaged Pluralism," *Environment and Planning D: Society & Space* 36, no. 3 (2018): 570-590; and Schmid, "Journeys through Planetary Urbanization: Decentering Perspectives on the Urban Pluralism," *Environment and Planning D: Society & Space* 36, no. 3 (2018), 591-610.
- 132 Moe, "Metabolic Rift, Gift, and Shift." For an earlier version, see "Conclusion: The Metabolic Rift, Gift, and Shift of Architecture's Necessary Excess," in Moe, *Insulating Modernism*, 288-309.

Given the vital critique of resource exploitation and waste issues, within a material historiography and a new environmental-architectural epistemology, it is concerning that extraction continues to occur predominantly in the periphery, to the detriment of Indigenous populations. <sup>(133)</sup> The dilemma for practitioners and researchers alike is that architecture is difficult to separate from industry, and that new narratives and concepts are immediately co-opted. The material impasse in architecture and architectural studies becomes evident in the quantitative approach to embodied energy calculation as pursued in the material sciences, perpetuating the technological idea of progress. <sup>(134)</sup> The industry-driven consumption of materials that dominates architecture, research, and development also affects the areas of circular construction and its digitization, which is reflected in the lifespans, labour costs, and the reorganization of the construction industry under neoliberal globalization. <sup>(135)</sup> A fundamental conflict is evident in the debate over sustainable construction, whereby architects bring timber into play as an alternative to concrete, presenting it as a renewable and thus supposedly sustainable material, arguing with datasets about its global warming potential. <sup>(136)</sup> Two Swiss exhibition and publication projects have recently scrutinized both building materials, revealing the cultural, social, and economic role of the cement industry for architecture—including the construction of national identity—and the phenomenon of addressing wood as a resource, object, and commodity in the other. <sup>(137)</sup> Although this juxtaposition of concrete and timber might fall short in the end, because causes and effects are multi-layered and complex, and new construction is inherently problematic in itself, material reform toward bio-based materials is needed, and this is being promoted and demanded in both the architectural humanities and architectural culture. <sup>(138)</sup> Ultimately, the market might once again decide. Switzerland is the most important trading centre for gold, and other ores and metals (namely steel), not to mention fossil fuels (40 percent of the global coal trade). It is thus a workplace for various traders, freight handlers, banks, insurance companies, and inspectors, and also the headquarters of the world's largest cement company, with its own department for research and development, and a foundation for sustainable construction financed internally. <sup>(139)</sup>

- 133 Martin Arboleda, "Planetary Mine as an Archaeology of Labor Futures," *Harvard Design Magazine*, no. 48 (2018): 86-93.
- 134 Benjamin, ed., *Embodied Energy and Design*, especially the essays by Daniel Barber, "Considering Two Episodes in the History of Energy and its Architectural Embodiment," 211-219; and Kiel Moe, "Not-Zero Architecture," 142-149.
- 135 Adrian Forty writes about the fact that with digitalization the meaning of materials is changing while the dependence on modern materials continues to grow. Forty, "Forget Material," in *Expanding Fields of Architectural Discourse and Practice: Curated Works*

from *P.E.A.R. Journal*, eds. Matthew Butcher and Megan O'Shea (London: UCL Press, 2020), 357–361. See also Ilka Ruby and Andreas Ruby, eds., *The Materials Book* (Berlin: Ruby Press, 2021).

- 136 Efstathios Kakkos et al., “Towards Urban Mining—Estimating the Potential Environmental Benefits by Applying an Alternative Construction Practice: A Case Study from Switzerland,” *Sustainability* 12, no. 12 (2020): 5041.
- 137 Sarah Nichols and Andreas Ruby, curators, *Beton*, Swiss Architecture Museum (SAM), Basel, 20 November 2021 to 24 April 2022; and Carla Ferrer, Thomas Hildebrand, and Celina Martinez-Cañavate, curators, *Touch Wood*, Zurich Architecture Centre (ZAZ), Zurich, 9 June to 30 October 2022. In a 28 October 2022 conversation at ZAZ, philosopher Michael Hampe and architect Gion Caminada discussed wood as part of the world and part of ecological cycles under Latour's premise that nature does not exist.
- 138 Material Cultures, *Material Reform* (London: Mack, 2022).
- 139 Adrià Budry Carbó and Robert Bachmann, “Traders: The Ecosystem of Coal,” *Public Eye*, 7 November 2022, <https://www.public-eye.ch/en/topics/commodities-trading/switzerland-and-its-mountain-of-coal/traders-the-ecosystem-of-coal>.

In the end, narrating is also always about naming, archiving, and making visible. The research performed by Barnabas Calder and Alex Bremner uses the example of different world constellations to show that building has always been shaped by context—not only energy sources, but also material stocks such as food supplies. Scenarios they present for describing and analyzing historical processes alongside corresponding social, governmental, and economic structural changes are the Roman Empire, Victorian England, and the industrialized modernity of the twentieth century. <sup>(140)</sup> <sup>fig. 9</sup> At the outset of the twenty-first century, with global heating and species extinction looming, overpopulation and the effects of factory farming as well, new uninhabitable areas and climate flight, the conditions and opportunities have changed. The stakes are high when, on the one hand, architectural history and materials research make common cause under the banner of fact-based research and employ persuasive storytelling to accuse concrete construction of false promises, arguing that its life cycle of a maximum of one hundred years is at odds with strength and durability—traditionally essential criteria for material selection. On the other hand, architectural, material, and environmental theory—in order to address concrete buildings as objects of maintenance and care—proposes to denaturalize weathering processes (which, however, should not be an excuse for further building with concrete). <sup>(141)</sup> The historiography of wood as a building material, to which “Timber Constructed,” a double issue of *Architecture Theory Review* was dedicated, then recommends a different direction. <sup>(142)</sup> In this regard, Laila Seewang's essay “Timber Territory,” about the transition of industrial lumber production to new wood products in the Pacific Northwest, critiques the architectural history of regionalism while arguing for a new understanding of commodity and supply chains that nonetheless promotes stewardship. <sup>(143)</sup> Ultimately, new materialism takes a radical turn when building materials are conceived as actors in their own right, in the case of wood not only because of the processes of weathering, but because of the traditional knowledge that accompanies the practices of its processing and working. <sup>(144)</sup> The connection between the history of the Earth and the history of humankind, the deep past and the deep future, is revealed when Bauhaus Earth recognizes the performance of wood in the fact that mass-produced timber could serve as a carbon storage in the near future, and thus once again reminds architecture and architectural history of its task. <sup>(145)</sup>



- 140 Calder and Bremner, “Buildings and Energy”; and Calder “Form Follows Fuel.”
- 141 Lucia Allais and Forrest Meggers, “Concrete is 100 Years Old: The Carbonation Equation and Narratives of Anthropocenic Change,” in *Writing Architectural History*, eds. Aggregate (Pittsburgh, PA: University of Pittsburgh Press, 2021), 75–89; and Sarah Nichols, “Matters of Care,” *Arch+: The Great Repair*, no. 250 (2022): 86–89.
- 142 Laila Seewang and Irina Davidovici, “Timber Constructed: Towards an Alternative Material History,” *Architecture Theory Review* 25, no. 1–2 (2021): 1–6.
- 143 Laila Seewang, “Timber Territory: Salvaging a Resilient Timber Architecture in the Pacific Northwest,” *GAM*, no. 17 (2021): 170–189.
- 144 Carla Ferrer, Thomas Hildebrand, and Celina Martinez-Cañavate, eds., *Touch Wood: Material, Architecture, Future* (Zurich: Lars



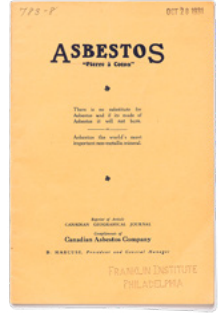
Müller Publishers, 2022), esp. Philip Ursprung, “Touched by Wood,” 14–19; and Albena Yaneva, “The Good Partner: Designing with Wood in the New Climate Regime,” 20–23.

- 145 Chris Foges, “Timber Construction is a Silver Bullet for Climate Change,” *RIBA Journal*, 5 September 2022, <https://www.ribaj.com/culture/profile-joachim-schellnhuber-bauhaus-earth-climate-emergency-trees>.

In addition to atmospheric carbon dioxide concentrations, a related and increasingly important theme in architectural history is another form of pollution, namely material properties of toxicity—that is, the toxic effects on humans from modern structures and building materials, whether in extraction, construction, or use, as the downside of development. Within environmental history, the history of pollution or contamination—an exposure to industrial fumes, effluents, and wastes through the air, water, or soil—has a longer tradition, revolving around the interpretation, analysis, and reclamation of brownfields and post-industrial landscapes. <sup>(146)</sup> A critical view at an architectural scale, particularly in terms of social and environmental injustice, was then taken over by science and technology studies. Michelle Murphy’s study of the “sick building syndrome,” which focused on unequally distributed risks, was groundbreaking in this regard, taking a feminist perspective to consider off-gassing from interior furnishings, office equipment, and machinery, including office furniture and carpets. <sup>(147)</sup> The objects under investigation were surveys and actions taken among female office workers, which made the office tangible and comprehensible within “the organizational complex” (Reinhold Martin) of late capitalist America, a multiply toxic world of work—emotional, relational, entrepreneurial, and administrative—and aimed at empowerment. <sup>(148)</sup> While Murphy formulated a critique of the biopolitics of toxic, harmful substances, later writing about the “chemical regimes of living,” architecture concentrated itself on an aesthetic attitude toward pollution, more curatorial than curative. <sup>(149)</sup> Within a forensic research context, in contrast, arsenic exposure has been investigated at different levels, for example in the radiant green English wallpaper of the nineteenth century, or in the mass poisoning in Bangladesh in the 1970s that was initiated by, of all things, an international campaign for safe drinking water. <sup>(150)</sup>

- 146 Gregg Mitman, Michelle Murphy, and Christopher C. Sellers, *Landscapes of Exposure: Knowledge and Illness in Modern Environments* (Chicago: University of Chicago Press, 2004); Susanne Hauser, “Zurückgelassen: Verseuchte Böden – Saubere Luft,” in *Schrumpfende Städte. Band 1: Internationale Untersuchungen*, ed. Philip Oswalt (Ostfildern: Hatje Cantz, 2004), 166–169; and Susanne Hauser, *Metamorphosen des Abfalls: Konzepte für alte Industrieareale* (Frankfurt: Campus, 2001), 57–82.
- 147 Michelle Murphy, *Sick Building Syndrome and the Problem of Uncertainty: Environmental Politics, Technoscience, and Women Workers* (Durham, NC: Duke University Press, 2006).
- 148 Michelle Murphy, “Toxicity in the Details: The History of the Women’s Office Worker Movement and Occupational Health in the Late-Capitalist Office,” *Labor History* 41, no. 2 (2000): 189–213; and Martin, *The Organizational Complex*.
- 149 Michelle Murphy, “Chemical Regimes of Living,” *Environmental History* 13, no. 4 (2008): 695–703; and Gissen, “A Theory of Pollution for Architecture.”
- 150 Nabil Ahmed, “The Toxic House,” in *Forensis*, 614–633; and Nabil Ahmed, “Earthly Poison: Arsenic in the Bengal Delta,” in *Architecture and the Paradox of Dissidence*, ed. Ines Weizman (London: Routledge, 2013), 194–205.

Recently, architectural research has increasingly addressed the issue of toxicity, with the focus of analysis shifting both thematically and geographically and becoming more complicated with regard to pollution and vulnerability. In dialogue with urban political ecology, Nerea Calvillo’s architectural history of hay fever conceives of nature in the city itself as toxic, focusing on the moment ragweed invaded the human urban milieu in non-built-up areas, or rather vice versa, and became medicalized—a history of urban planning paired with a history of environmental racism. The discussion about exposure to industrial products, however, is something different. The best example of this is the history of asbestos, which fascinated Bruno Latour because for him it was “a perfect substance” as a building material, due to its inertia, its effectiveness, and its commodity form; that is, until cases of asbestos-related cancers became widespread, compensation payments

demand, and bans imposed.<sup>(151)</sup> For a long time, asbestos remained a subject of environmental history, most recently in connection with, for example, open-pit mining in Quebec, transatlantic supply chains, or processing in, among other places, Manchester factories.<sup>(152)</sup>  Hannah le Roux has moreover investigated the global circulation of asbestos products in the postwar period as a known harmful building material, as a continuation of the history of colonialist and imperialist power relations, related to the mediating, even legitimizing role of architectural practitioners and historians, using the example of *ac: International asbestos-cement review*. As part of this larger research, le Roux has also traced the historical mining and corporate geographies of the asbestos industry, and the links between South Africa and the United Kingdom; and, together with Gabrielle Hecht, she has dug into housing projects for working people on the African continent.<sup>(153)</sup> Concepts such as “slow violence” (Rob Nixon), which emphasize the “great divergence” or vulnerability of people from the Global South in relation to the environmental and inequality crisis, are used here not only to describe the mine and the factory as a workplace, but also to characterize housing for disadvantaged and marginalized populations that is constructed from mining waste.<sup>(154)</sup>

- 151 Bruno Latour, *Politics of Nature: How to Bring the Sciences into Democracy* (Cambridge, MA: Harvard University Press, 1999), 23.
- 152 Jessica van Horssen, *A Town Called Asbestos: Environmental Contamination, Health, and Resilience in a Resource Community* (Vancouver: UBC Press, 2016); and van Horssen, “Locality and Contamination Along the Transnational Asbestos Commodity Chain,” in *Histories of Technology, the Environment and Modern Britain*, eds. Jon Agar and Jacob Ward (London: UCL Press, 2018), 62–75.
- 153 Hannah le Roux, “Northern/Cape: The Fibrils of an Asbestos History,” *Perspecta*, no. 52 (2019): 258–262; and le Roux and Gabrielle Hecht, “Bad Earth,” *e-flux Architecture*, August 2020, [www.e-flux.com/architecture/accumulation/345106/bad-earth](http://www.e-flux.com/architecture/accumulation/345106/bad-earth).
- 154 Hannah le Roux, “Circulating Asbestos: The International AC Review, 1956–1985,” in *Environmental Histories of Architecture*; and Rob Nixon, *Slow Violence and the Environmentalism of the Poor* (Cambridge, MA: Harvard University Press, 2011). Nixon took Kenneth Pommeranz’s term “Great Divergence” and reformulated it as a collateral term with “Great Acceleration.” Nixon, “The Great Acceleration and the Great Divergence: Vulnerability in the Anthropocene,” *MLA Profession*, 11 March 2014, <https://profession.mla.org/the-great-acceleration-and-the-great-divergence-vulnerability-in-the-anthropocene>.

Recently, the Aggregate Architectural History Collaborative even dedicated an independent research and publication project led and edited by Meredith TenHoor and Jessica Varner to the topic of toxins and toxicity.<sup>(155)</sup> The impossibility but also the necessity of the undertaking is particularly evident in the fact that it amounts to demonstrating the presence of substances that are not visible or otherwise perceptible. In the disciplinary intersection of architectural and environmental history, science and technology studies, social and scientific history, anthropology, Black and critical geography, and cultural studies, their focus is on how, starting from industrial processes and, increasingly, composite materials, toxins make themselves felt in processes of consumption, production, regulation, and disposal.<sup>(156)</sup> If the environmental justice movement focused on the unequal distribution of costs and benefits, differentiated by race, class, and ethnicity, then buildings, not just urban space, and the exposure of bodies within them, should be seen from an intersectional perspective as part of the “chemosphere.”<sup>(157)</sup> On a larger scale, when it comes to land, pollution is now understood as a form and continuation of colonialism.<sup>(158)</sup> In spite of the variety of themes and narratives, Aggregate suggests a need to explore the difference between toxic and non-toxic, the normal state of affairs and social as well as environmental justice. Through narrative strategies that expose materiality and bring material to life, the experience, embodiment, and positioning of individuals and—in a decolonial perspective—communities in a toxic world can be told as a political, economic, and ecological story.

- 155 The essays that are part of the *Toxics* project are organized around three themes: “Materials: From Pipes to Pipelines,” “Grounds: Lands and Legacies,” and “Life: From Bodies to the Embodied.” Individual contributions address different meanings of toxicity—scientific, medical, legal, cultural—and forms of toxic knowledge—physical, material, and bodily. The overall publication delineated an area of research that had not been addressed before, initially taking a very broad interpretation

- and then asking how the history of architecture and landscape might be seen and told through the history of toxins. TenHoor and Varner, "Mattering Toxics and Making Toxics Matter in Architecture and Landscape Histories," *Aggregate*, 11 May 2023, <http://we-aggregate.org/piece/mattering-toxics-and-making-toxics-matter-in-architecture-and-landscape-histories>.
- 156 The approaches, theories, and methods are broad, ranging from the scientific world to legal systems and social geographies; and from the production of plywood, to the handling of industrial waste and the processing of scrap metal. According to TenHoor and Varner, the authors cover "late-industrial landscapes, complex chemical alliances, uneven disease risks, corporate influence, colonial networks, transnational land disputes, material effects, ruined landscapes, combustion aftermaths, and production violence." Here, architectural research deliberately goes beyond the building and integrates different levels of scale. TenHoor and Varner, "Mattering Toxics."
- 157 Nicholas Shapiro, "Attuning to the Chemosphere: Domestic Formaldehyde, Bodily Reasoning, and the Chemical Sublime," *Cultural Anthropology* 30, no. 3 (2015): 368–393; and Shapiro and Eben Kirksey, "Chemo-Ethnography: An Introduction," *Cultural Anthropology* 32, no. 4 (2017): 481–493.
- 158 Max Liboiron, *Pollution Is Colonialism* (Durham, NC: Duke University Press, 2021).

If the Anthropocene as reality and narrative brings about the heightened and ultimately toxic material exchange, an architectural history which is sensitive to bio- and geopolitics would need to address modern building materials—not just raw materials—and the underlying geological knowledge, ecological imaginaries, economic interests, and the social impacts associated with the exploitation, processing and distribution of minerals, as well as rocks and soils alongside global value chains, the politics of architecture and technology, and their embeddedness in natural worlds. The historico-epistemological interest is thus to understand the emergence and propagation of objects of material culture and the value systems of our contemporary construction regime, with its industrially produced building materials (and resulting toxicities), especially as this all pertains to the carbon dioxide pollution of the atmosphere. <sup>(159)</sup> A research prospect for architectural humanities then is to create and contribute to the conceptual, political, legal, and ethical foundations for a reorganization of the profession and discipline. This reorganization would be centred around practices and economies of maintenance, repair, and care for existing building stock, as well as renovation, extension, and addition. <sup>(160)</sup> The aim then is to continue building from a standpoint of non-extraction and non-demolition. <sup>(161)</sup> Instead, circular architecture emphasizes re-using materials, elements, and entire buildings (merely recycling would simply be too energy-intensive) coupled with reducing building. <sup>(162)</sup> On the other hand, other biogenic building materials and techniques besides timber, especially clay and rammed earth, as well as straw, are once again receiving attention in architectural history and in architectural practice that is locally embedded. <sup>(163)</sup> Once the new-build construction no longer represents the default solution, a decoupling of progress from exploitation can take priority, along with a corresponding notion of preservation that is socially as well as environmentally responsible, a reduction of avoidance along the commodity and supply chain, and a composting at the end of a building's life span. <sup>(164)</sup>

- 159 Anna Lowenhaupt Tsing understands the new materialism historically rather than vitalistically, in comparison to Jane Bennett. See Tsing, "When the Things We Study Respond to Each Other: Tools for Unpacking 'The Material,'" in *Anthropos and the Material*, eds. Penny Harvey, Christian Krohn-Hansen, and Knut G. Nustad (Durham, NC: Duke University Press, 2019), 221–244; and Bennett, *Vibrant Matter: A Political Ecology of Things* (Durham, NC: Duke University Press, 2010).
- 160 While maintenance and care are contingent on each other, what is it that eventually is maintained: a building, a community, or an ecology (even architecture and also architectural history itself)? On this question, see Shannon Mattern, "Maintenance and Care," *Places Journal*, November 2018, <https://placesjournal.org/article/maintenance-and-care/#0>; and Jay Cephas, Igor Marjanovic, and Ana Miljački, "On Trees, Libraries, and Other Forms of Urban Care Work: In Conversation with Shannon Mattern," *Journal of Architectural Education* 76, no. 2 (October 2022): 109–117.
- 161 In 2021, Charlotte Malterre-Barthes, following Bruno Latour's suggestion to pause in the midst of the COVID-19 pandemic and to relocate society, launched a fundamental polemic against the extractive attitude in architecture, which she called "a global moratorium on new construction." In September 2022, Alexander Stumm also coordinated a moratorium on demolitions in Germany, with broad support from architectural professionals working in academia but also design and professional associations, by sending a letter to Federal Minister for Housing, Urban Development and Building, Klara Geywitz. And in Switzerland, building on a survey study of current demolition projects, a 2022 exhibition at SAM approached demolition as a topic

- through different representations and reflections, and launched a petition in the context of the exhibition. Malterre-Barthes, “A Global Moratorium on New Construction,” <https://www.charlottesalterrebarthes.com/practice/research-practice/a-global-moratorium-on-new-construction>; “Demolition Moratorium,” <https://abrisssmoratorium.de>; “Abriss-Moratorium,” *ARCH + News*, <https://archplus.net/de/abrisss-moratorium>; and Countdown 2030, curator, *Die Schweiz: Ein Abriss*, Swiss Architecture Museum (SAM), 3 September to 23 October 2022. See also Space Caviar, *Non-Extractive Architecture*, vol. 1.
- 162 Institute of Constructive Design, ZHAW School of Architecture, eds., *Reuse in Construction: A Compendium of Circular Architecture* (Zurich: Park Books, 2022).
- 163 The architectural history of clay and rammed earth indicates that the environmental and climatic advantages of the material were already known early on, towards the end of the eighteenth century. On the history of earthen building in Germany, see Gernot Minke, ed., *Bauen mit Lehm: Aktuelle Berichte aus Praxis und Forschung*, Vol 1 (Gebenstein: Ökobuch, 1984); on the history of earthen building in France and Switzerland, see Roger Boltshauser, Cyril Veillon, and Nadja Maillard, eds., *Pisé – Rammed Earth: Tradition and Potential* (Zurich: Triest Verlag, 2019); and on the material’s political problems, see Jesús Vassallo, “An Essay about Mud,” in *Pisé*, 152–155.
- 164 In 2019, the Oslo Architecture Triennale under the title “Enough” was dedicated to “The Architecture of Degrowth,” <https://www.oslotriennale.no/archive/2019>; and in collaboration with *e-flux Architecture*, a series of essays appeared under the theme “Overgrowth,” <https://www.e-flux.com/architecture/overgrowth>.

## MORE-THAN-HUMAN / ENTANGLEMENT HISTORIES

By recognizing and admitting the double crisis—the climate crisis as well as the biodiversity crisis—in view of the anthropogenic influence exerted on all parts of the Earth system, architectural history and the architectural humanities have begun addressing the societal relations with nature. In this endeavor, a nesting of levels of scale and a linking between disciplines serves the process of recognition. Since Rachel Carson, when environmentalist movements began levelling an ecological critique of human-caused environmental destruction—the extinction of species, whether plant or animal—and influencing ecological architecture and urban planning debates in the 1970s, the issue was defined by a dichotomy of city and countryside. <sup>(165)</sup> Seeing nature as what exists (in contrast to either untouched or ruined nature)—that is, the development of future environmental imaginaries starting from the ruderal vegetation regrowing from industrial wastelands or concrete jungles according to the typology of “third nature”—acknowledged the intervention into ecosystems, without reservations. <sup>(166)</sup> The debate over cultural landscapes, at the time resurgent, served to negotiate or even excuse human action and thought. Since then, the nature-versus-culture dichotomy was fundamental to the thesis of complete urbanization, which placed the actors and systems (materialized in buildings and infrastructures) in the foreground and was thus groundbreaking for environmental history in terms of content and methodology, although for a long time this remained national in its character. <sup>(167)</sup>

- 165 Raymond Williams defined a concept of nature in *Keywords: A Vocabulary of Culture and Society* (London: Croom Helm, 1976). In the later edition (Fontana, 1983), he added a concept of ecology but not of the environment.
- 166 Matthew Gandy, among others, discusses different definitions of first and second nature, citing Karl Marx, as well as third (designed urban nature) and even fourth nature (urban wilderness), here in reference to Ingo Kowarik. Matthew Gandy, *Natura Urbana: Ecological Constellations in Urban Space* (Cambridge, MA: MIT Press, 2022), 4 and 14. Susanne Hauser, *Metamorphosen des Abfalls: Konzepte für alte Industrieareale* (Frankfurt: Campus, 2001), 195–238.
- 167 Corboz, “The Land as Palimpsest.”

At the same time, colonialism, imperialism, and globalization had already produced corresponding structures and dynamics of conquest and exploitation of natural resources (rocks, minerals, trees, shrubs, and critters, indeed entire habitats), which was then only reinforced by neoliberalization, massive deregulation, and increasing inequalities. What the environmental perspective enables is the built environment to be seen in relation to other units of analysis: climate stress or climate anxiety in relation to endangered species, burning forests, overflowing rivers, persistent droughts, melting glaciers, thawing permafrost; or, on the largest scale, irreversible climate breakdown in all its complexity and long-term nature. <sup>(168)</sup>



While historians are questioning the separation of natural and human history (Dipesh Chakrabarty), a new approach is also needed in the architectural humanities. Building on the postulate of a nature-culture continuum, or “naturecultures,” the environmental humanities, based on the pioneering work of posthuman philosophy, anthropology, biology, and sociology (Donna Haraway and Bruno Latour, but also Isabelle Stengers, Anna Lowenhaupt Tsing, and others), are challenging the traditional approaches of the humanities to redefine the place of humans in the world, what it means to be human, and thereby to overcome anthropocentrism. <sup>(169)</sup>

- 168 The writing of late urban sociologist Mike Davis discussed this early on and addresses the relationship between forest fires and urbanization: Davis, *Ecology of Fear: Los Angeles and the Imagination of Disaster* (New York: Metropolitan Books, 1998); and Davis, “The Case for Letting Malibu Burn,” *Environmental History Review* 19, no. 2 (1995): 1–36.
- 169 From their own perspectives, Bruno Latour and Donna Haraway were the first to call renewed attention to the fact that we live in a nature-cultured world: Latour, *We Have Never Been Modern* (Cambridge, MA: Harvard University Press, 1993); and Haraway, *Modest\_Witness@Second\_Millennium. FemaleMan\_Meets\_OncoMouseTM. Feminism and Technoscience* (New York: Routledge, 1997).

In the face of the seemingly hopeless situation of the Anthropocene, a supposed dead end into which humanity has maneuvered itself in environmental and socioeconomic, but also affective and psychological terms, a posthumanist approach in architectural research now proposes to fundamentally question the humanistic view of humankind, and thereby concepts and ideals that are central to the Western world—which also means rethinking the architectural project as such. <sup>(170)</sup> If architectural modernism proceeded from the assumption of an enlightened, rational, sovereign, self-determined, and autonomous human being in relation to the human habitat, then posthumanism—which continues to include a technological school of thought in addition to the critical one (first cyborgs and mutants, today AI and augmented reality)—demands that humans step back and share the stage with other living beings, plants, and animals (for some even machines). <sup>(171)</sup> Instead of settling for purely technological or architectural solutions, for architecture and architectural research this means radically questioning the hierarchical system of species and species groups as well as human exceptionalism through multispecies studies and more-than-human approaches. <sup>(172)</sup> Among contemporary interrogations, as the critique of the standardized body has already shown, the design of a new image of the human being is of central importance. <sup>(173)</sup> This departs from the Vitruvian Man (1490), Leonardo da Vinci’s illustrated study that underlies humanism, as well as from ideas of symmetry and aesthetics that shaped an architecture revolving around measurements and dimensions, the perfect proportions of “man” (whether Ernst Neufert’s theory of building design or Le Corbusier’s Modulor). <sup>(174)</sup> Donna Haraway’s call for “staying with the trouble” and forging new connections refers to this, and finds itself reflected linguistically and narratively, counteracting the ossification of central dichotomies such as man/woman, nature/culture, subjectivity/objectivity. <sup>(175)</sup> Accordingly, posthumanism envisions a future in which the distinction between nature and culture is fluid and becomes a more gradual, sensitive matter.

- 170 Rosi Braidotti, *The Posthuman* (Cambridge, UK: Polity, 2013); and Ihab Hassan, “Prometheus as Performer: Toward a Posthumanist Culture?” *Georgia Review* 31, no. 4 (1977): 830–850.
- 171 Rosi Braidotti, “Posthumanist Critical Theory,” in *Posthuman Glossary*, eds. Rosi Braidotti and Maria Hlavajova (London: Bloomsbury, 2018), 339–342.
- 172 While the dividing line between human and non-human is difficult to draw, for Cary Wolfe there are certain conditions, “cultural and anthropological inheritances,” which enable us to become human: “tool use and technologies, archives and prosthetic devices, or semiotic systems of all kinds.” Wolfe, “Posthumanism,” in *Posthuman Glossary*, 356–359; and Wolfe, *What Is Posthumanism?* (Minneapolis: University of Minnesota Press, 2010).
- 173 Horn and Berghthaller, *The Anthropocene*.
- 174 Léopold Lambert, “Architectural Theories: A Subversive Approach to the Ideal Normalized Body,” *Funambulist Blog*, 29 April 2012, <https://thefunambulistdotnet.wordpress.com/2012/04/29/architectural-theories-a-subversive-approach-to-the-ideal-normalized-body>.

Architectural humanities, therefore, oriented toward biodiversity (the basis of all life, including human life), in dialogue with the natural sciences, social sciences, and the humanities at large, draw a distinction from the universalism of modernity by recognizing not only the limitations of its ideals, concepts, and tools (i.e., writing, language, and code, to say nothing of drawing, imaging, planning, or mapping), but ultimately of all semiotic systems through which we cognitively access the world. Furthermore, it also accepts the limitedness of the architectural project, which amounts to the fact that we as humans are always bound to other living beings. Within architecture and architectural research, this is compatible with a new materialism that promoted an interest in non-human entities, which, according to an expanded understanding, includes technological artifacts in addition to living beings.<sup>(176)</sup> Posthumanism now promises an epochal paradigm shift with regard to the reciprocal entanglements of relationships between all living and elemental things, drawing on the soft thinking of the environmental humanities, an integrated and empathic approach to environmental issues elaborated in conceptual work touching on philosophy, sociology, and anthropology, alongside science and technology studies.<sup>(177)</sup> For Haraway, “becoming with” stands in the foreground at the intersection of ontology, epistemology, and ethics, subject to a “situated knowledge”; for Tsing, taking an environmental anthropological perspective, at the centre stand relational “assemblages” whose maintenance and collaboration are now considered sustainable.<sup>(178)</sup> With regard to the co-creation of the world, “embodied” and “embedded” relationships can be differentiated. As for questions of meaning, values, politics, ethics, or the justice of knowledge production, architectural histories and the architectural humanities are also capable of developing ideas of the future that see not so much the building as an object, but rather building and living as a personal and at the same time collaborative, ultimately interlocking process—a kind of “building with” and “living with,” in contrast to the separation of nature and culture, inside and outside that persist.<sup>(179)</sup>

176 Bennett, *Vibrant Matter*.

177 Deborah Bird Rose et al., “Thinking through the Environment, Unsettling the Humanities,” *Environmental Humanities* 1, no. 1 (2012): 1–5.

178 In *The Mushroom at the End of the World*, Tsing outlines a theory of “alter-mondialization,” or countering the prevailing globalization, based on the assemblages around the *matsutake* mushroom in symbiosis with the forest in which it grows and along the product chains. See also Haraway, “Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective,” *Feminist Studies* 14, no. 3 (Fall 1988): 575–599; and Haraway, *When Species Meet* (Minneapolis: University of Minnesota Press, 2008).

179 For Maria Puig della Bellacasa, the permaculture movement represents a personal and collective empowerment that, due to the fusion of politics and ethics, is an “alter-biopolitical” intervention, and due to its non-extractive nature, one could also speak of an “alter-geopolitical” intervention. Puig de la Bellacasa, “Ethical Doings in Naturecultures,” *Ethics, Place and Environment* 13, no. 2 (2010): 151–169, esp. 152.

The formerly prevailing anthropocentric view, as well as the human consumption of natural resources and domination of plants and animals that is anchored in institutions and maintained through relationships, is closely linked to societal developments and global interactions since the early modern period. This has been illustrated most clearly in connection with European expansion and colonization of the world. The Columbian Exchange, that is, the exchange of two previously separate biota as a result of the arrival of European conquistadors in the Caribbean, is a subject of recent historiography. Critiquing the common Anthropocene narrative in order to expand it beyond its Eurocentric framing centring on the Industrial Revolution or Great Acceleration, efforts have been made to problematize settler colonialism in North America from 1610 onward as the tip of the spear of petrocapi-talism, demonstrating the power structures and pro-

found lasting influence of white populations on the environment (in the form of genocides and ultimately ecocides of Indigenous peoples, plants and animals, ecosystems, and landscapes). <sup>(180)</sup> Not only were Indigenous cultures (whether in the Americas or Oceania) defenseless against the diseases and microorganisms introduced by settlers; the westward settlement, the damming of rivers, the cutting down of forests, and the importation of plants and animals completely reshaped the North American continent, amounting to an enormous intervention in nature and the landscape, terraforming on a grand scale. <sup>(181)</sup> Thus, what North American environmental history had previously demonstrated in the case of the transition from an agrarian to an industrial economy and society, using the example of Chicago and its hinterland, can be brought forward and complicated: that nature is *not* a backdrop. <sup>(182)</sup> In the nineteenth century, with urbanization and metropolization, railroad expansion, and a new energy regime (for Mumford, a continuation of the mine and mining environment), whole swaths of land were converted to monoculture—including the Great Plains and the northern forests—through wheat cultivation and logging. The twentieth century, that so-called American Century, is thus a perpetuation of this process, an expansion of the settler-colonial logic on a global scale.

180 Heather Davis and Zoe Todd, “On the Importance of a Date, or Decolonizing the Anthropocene,” *ACME: An International Journal for Critical Geographies* 16, no. 4 (2017): 761–780.

181 Alfred W. Crosby, *The Columbian Exchange: Biological and Cultural Consequences of 1492* (Westport: Preager, 2003); and Simon L. Lewis and Mark A. Maslin, “Defining the Anthropocene,” *Nature* 519 (2015): 171–180.

182 Cronon, *Nature’s Metropolis*.

From a global perspective, within environmental histories and the environmental humanities, the close interconnection of ecology and economy is discussed today—also in dissociation from, indeed criticism of, the Anthropocene discourse—under the concept of the Plantationocene, alongside the Capitalocene. <sup>(183)</sup> The Plantationocene, which focuses on the colonial introduction of plantation agriculture, first by the Spanish and Portuguese in the Americas, and then especially in Africa and Southeast Asia with the emergence of the European colonial empires beginning in 1860 and the spread of forestry and the agricultural plantation system, provides a better understanding of human activities in relation to land use, ecosystems, biodiversity, and species extinction. <sup>(184)</sup> Unlike, for example, the scientific exploratory voyages of a figure such as Alexander von Humboldt at the beginning of the nineteenth century—whose collections, experiments, publications, and teachings were retrieved back to consciousness in popular and academic discourse—these early colonial and settler-colonial forms of globalization represented a serious watershed and drastic change for the modern human–animal–plant relationship within the intersectional historiography of capitalism, racism, and the environment. <sup>(185)</sup> Commercial shipping, on the other hand, the backbone of world trade, promoted the mobility of plants and animals, transporting not only raw materials and goods, livestock (including pests), and plant species for cultivation in the Old and New Worlds, but also all manner of seeds and seedlings in the soil used as ballast in the hulls of the ships. <sup>(186)</sup> A migration and transfer history of alien plants and animals, or an interwoven history of the establishment and spread of new invasive species—from colonies to mother countries, mixing biological and political narratives—is highly relevant for architecture and urban planning of the new climate regime. <sup>(187)</sup>

183 Donna Haraway, “Anthropocene, Capitalocene, Plantationocene, Chthulucene: Making Kin,” *Environmental Humanities* 6 (2015): 159–165; Jason W. Moore, *Capitalism in the Web of Life: Ecology and the Accumulation of Capital* (New York: Verso, 2015); Jason W. Moore, “The Capitalocene, Part I: On the Nature and Origins of Our Ecological Crisis,” *Journal of Peasant Studies* 44, no. 3 (2017): 594–630; and Moore, “The Capitalocene and Planetary Justice,” *Maize* 6 (2019): 49–54.

184 The reciprocity of cheap nature and cheap labour contained therein shows that with the advent of Manchester capitalism and

global densification, as well as cotton plantations, industrial production was based on slave labour. Beckert, *Empire of Cotton*; Anna Lowenhaupt Tsing and Rosetta S. Elkin, “The Politics of the Rhizosphere,” *Harvard Design Magazine*, no. 45 (2018): 50–55; and Donna Haraway and Tsing, “Reflections on the Plantationocene: A Conversation with Donna Haraway & Anna Tsing,” interview by Gregg Mitman, *Edge Effects Magazine*, 18 June 2019), [http://edgeeffects.net/wp-content/uploads/2019/06/PlantationoceneReflections\\_Haraway\\_Tsing.pdf](http://edgeeffects.net/wp-content/uploads/2019/06/PlantationoceneReflections_Haraway_Tsing.pdf).

- 185 Andrea Wulf, *The Invention of Nature: Alexander von Humboldt’s New World* (New York: Vintage Books, 2016); Bruno Latour, “Is Geology the New Umbrella for All the Sciences? Hints for a Neo-Humboldtian University,” 25 October 2016, Cornell University, <http://www.bruno-latour.fr/sites/default/files/150-CORNELL-2016-.pdf>; and Latour, “Seven Objections against Landing on Earth,” in *Critical Zones*, 8.
- 186 On the botany of colonization, see Maria Tereza Alves’s artistic work, *Seeds of Change*, 1999–ongoing, <http://www.mariatherezaalves.org/works/seeds-of-change>. See also Kenneth Morgan, “Shipping Patterns and the Atlantic Slave Trade of Bristol, 1749–1770,” *William and Mary Quarterly* 46, no. 3 (1989): 506–538.
- 187 Entangled history, as a form of transcultural relational history, goes back to Sidney Mintz’s history of sugar. Mintz, *Sweetness and Power: The Place of Sugar in Modern History* (New York: Penguin Books, 1986).

In terms of plant and animal relationships, a radical break is at hand, such that environmental histories of architecture are working through and reimagining what was previously assumed to be a foundation. The global interconnections that underlie today’s neophyte and neozoan plant worlds were also evident early on at architectural scales, most obviously in the botanical gardens of European metropolises. The colonial legacy of the British Empire, for example, manifested itself in Victorian England through the Kew Gardens in London, the seat of the Royal Botanical Society, whose palm houses (1844–1848, by Decimus Burton and Richard Turner) were realized in an architecture of modern iron and glass, becoming the site of a world-class science collection and the centre of an intensive trade in exotic species from all over the world. <sup>(188)</sup> At a larger scale, however, from a postcolonial environmental perspective, the forest, which once belonged to the commons but since modern times has been industrially managed, is now the object and figure of anthropological, artistic, and architectural research. The tropical rainforest is a central site of the Anthropocene, because here Indigenous forms of managing and caring for a living and nourishing space meet transnational corporate activities centred on maximum extraction and profitable sale as firewood or timber. In view of the accelerating climate and biodiversity crisis, deforestation gains additional significance. <sup>(189)</sup>

- 188 Luebken, “Undiszipliniert,” 6; Henrik Schoenefeldt, “The Use of Scientific Experimentation in Developing the Glazing for the Palm House at Kew,” *Construction History*, no. 26 (2011): 19–39, esp. 21; and Maren Koehler, “The Nature of Controlled Environments,” *Architectural Theory Review* 22, no. 2 (2018): 262–264. Koehler refers to the invention of the “Wardian case” in 1833, a micro-architecture that facilitated the expansion of a global market for plants.
- 189 Anna Lowenhaupt Tsing, *Friction: An Ethnography of Global Connection* (Princeton: Princeton University Press, 2005); and Tsing, *The Mushroom at the End of the World*.

Within forensic architectural research, postcolonial ecologies and economies are increasingly being problematized, especially through notions and practices of the forest. <sup>(190)</sup> Exemplary for postcolonial, decolonial, or even anticolonial analyses and a situated knowledge of the forest is the work of Paulo Tavares, who in “In the Forest Ruins” points to the myth of the founding of Rome in a wooded clearing, from which it follows that, historically, every settlement is to be seen as a civilizing act in humankind’s relationship to the forest. If Tavares succeeded in establishing a link to architectural history through his excursion into Western urban history—the forest as threshold to the *conditio humana*, a primal state of humanity and its antithesis—it was by highlighting deforestation in Brazil’s Amazon region and through field research and various modes of visual evidence (historical photography, satellite images, maps, etc.) to elaborate the cultural practices of Indigenous peoples and the social construction of the forest as an architectural artifact of a unique culture. <sup>(191)</sup> The incorporation of Indigenous as well as archaeological, botanical, and ethnographic knowledge makes it possible to claim a novel relationship to living



landscapes beyond nature and culture and beyond a Eurocentric cosmology of naturalism, and moreover to provide tangible arguments in favour of claiming landmark status for the endangered rainforest.<sup>(192)</sup> In collaboration with the cultural anthropologist and ethnobiologist William Balée, Tavares has not only worked through his collection of slides—an inventory of the plant wealth of the Amazon rainforest from the 1980s—but by making visible this archived knowledge of the anthropogenic forest, which for him contains inspirations, stories, and memories precisely in the plants, he adds to architectural history an example of a well-functioning ecosystem maintained by Indigenous peoples.<sup>(193)</sup> On the basis of this reciprocity, it is hoped that a better understanding of the forest will contribute to its care and custodianship (Tavares refers to gardening).<sup>(194)</sup> In the recent past, Brazil's Amazon rainforest was threatened with environmental crime since the military dictatorship of the 1970s and 1980s—threats that only intensified under the Bolsonaro regime. Such crimes include deforestation caused by the illegal extraction of marketable tropical timber species for Western markets, and the expansion of neo-extractive agribusiness, beef, and soy production through large-scale slash-and-burn agriculture.<sup>(195)</sup>

- 190 Tavares's larger project is that of a history of the modern colonization of the Amazon in the twentieth century, in which he gives voice to local Indigenous communities and the forest itself. Tavares, "In the Forest Ruins," *e-flux Architecture*, December 2016, <https://www.e-flux.com/architecture/superhumanity/68688/in-the-forest-ruins/>; and Tavares, "Over the Ruins of Amazonia: Colonial Violence and Decolonial Resistance at the Frontiers of Climate Change" (PhD diss., Goldsmiths, University of London, 2016).
- 191 Paulo Tavares, "Trees, Vines, Palms and Other Architectural Monuments," *Harvard Design Magazine*, no. 45 (2018): 189–195.
- 192 Philippe Descola, *Beyond Nature and Culture*, trans. Janet Lloyd (Chicago: University of Chicago Press, 2014), first published in French under the title *Par-delà nature et culture* (Paris: Gallimard, 2005); and Paulo Tavares, "The Political Nature of the Forest: A Botanical Archaeology of Genocide," in *Intercalations 4: The Word for World Is Still Forest*, eds. Sophie-Anna Springer and Etienne Turpin (Berlin: K Verlag and Haus der Kulturen der Welt, 2017), 125–157.
- 193 Paulo Tavares, "Architectural Botany: A Conversation with William Balée on Constructed Forests," in *Environmental Histories of Architecture*.
- 194 In landscape architecture, the garden is a central object and motif. For Gilles Clément, for instance, it is ultimately a matter of planetary gardening. Gilles Clément, *The Planetary Garden and Other Writings* (Philadelphia: University of Pennsylvania Press, 2015), the main essay of which was first published in French under the title *Le Jardin planétaire: Réconcilier l'homme et la nature* (Éditions albin Michel, 1999).
- 195 Hutton, *Reciprocal Landscapes*, esp. "Arresting Decay: Tropical Hardwood from Para, Brazil, to the High Line, 2009," 188–217.

The relevance and complexity of the topic of forests in Western architecture and architectural research can be seen, among other examples, in the fact that the *Harvard Design Magazine* dedicated an issue to it under the heading *Into the Woods*, which, using the example of the Torre Bosco Verticale (2014, Stefano Boeri) in Milan, issued an architectural critique of the trend of bush- and tree-covered high-rises as speculative urban objects—and a critique of the understanding of sustainability (and forests) associated with this.<sup>(196)</sup> In contrast, current architectural and urban research builds on a historicization of the planning of green spaces, especially using Martin Wagner's example in Berlin, by turning to air corridors (air reservoirs and air improvers) and, not least, wildlife corridors. It thus problematizes the creation of compensatory space for urban development to be accomplished by the real-estate industry through the acquisition or planting of woodland.<sup>(197)</sup> If the study of architecture and trees, technology and biology, is experiencing a renaissance, the architectural humanities from an environmental point of view should at the same time advocate large-scale, both atmospherically and biospherically relevant, reforestation as a counterweight to urbanization.<sup>(198)</sup>

- 196 Daniel Barber and Erin Putalik, "Forest, Tower, City: Rethinking the Green Machine Aesthetic," *Harvard Design Magazine*, no. 45 (2018): 234–243.
- 197 Daniel Spruth, "Das Sanitäre Grün der Städte," in *Licht Luft Scheiße: Archaeologies of Sustainability—Perspectives on Ecology and Modernity*, eds. Sandra Bartoli, Silvan Linden, and Florian Wüst (Hamburg: adocs, 2020), 353–355; and Roesler, *City, Climate, and Architecture*, esp. "Democratizing Urban Nature," 75–112.

- 198 Baubotanik, originally in the tradition of bio-design or bio-tecture, now likewise argues for the creation of urban microclimates. Ferdinand Ludwig, “Baubotanik: Designing with Living Material,” in *Materiality in Architecture*, ed. Sandra Karina Löschke (London: Routledge, 2016), 182–193; and Ferdinand Ludwig and Daniel Schönle, *Growing Architecture: Designing and Building with Trees* (Basel: Birkhäuser, 2022).

From a different perspective, in addition to the object, there is also the figure of the forest, whose ecological coloniality, but also its utopian potential, was highlighted with *The Word for World Is Still Forest*, a publication as an exhibition developed in conjunction with the Anthropocene Project of the Haus der Kulturen der Welt in Berlin, where the forest’s larger cultural significance was demonstrated through various formats. <sup>(199)</sup> In architectural history today, people are considering what it would mean to elevate dendrochronology (tree-ring dating) or radiocarbon dating (the detection of the decay of the carbon isotope C14 in organic relics), used for determining age and climatic and environmental influences, to the status of an object or method for demonstrating human impact on the environment. <sup>(200)</sup> The basic condition of all life being closely linked to the forest, although this relationship history is quite complex, was demonstrated by two research works focused on trees and wood: *Cambio* (Serpentine Gallery, London, 2020) by the Milan-based design duo Formafantasma, which explored materials, raw material origins, production conditions, and the lifespan of wood as a natural building material; and *Offsetted* (Arthur Ross Architecture Gallery, Columbia University, 2019) by the London-based architecture duo Cooking Sections, which lamented the financialization of trees in the streets of New York as a mitigation scheme for carbon emissions in the context of an out-of-control real-estate and insurance industry, and called for subject status and the concept of rights to be extended to trees. <sup>(201)</sup> It is this conflict between the use of trees as timber and the demand for stewardship or even legal status of forests that must be reckoned with in architecture and architectural research. <sup>(202)</sup> Moreover, in the course of architectural education’s decolonization, students today stand to learn much from those cultures whose perspectives and knowledge have long been embedded in the forest. <sup>(203)</sup>

- 199 The exhibition *Disappearing Legacies: The World as Forest*, which confronted prevailing ideas of nature with those of extinction, deforestation, and the climate crisis, targeted the Natural History Museum in Hamburg, Berlin, and Halle as a venue for discussion and was part of the research project Reassembling the Natural, <https://reassemblingnature.org>.
- 200 Albert Narath, “Talkative Timber. A. E. Douglas, the Beam Expeditions, and the Construction of Architectural Evidence,” in *Writing Architectural History*, 63–74.
- 201 Cooking Sections, *Offsetted* (Ostfildern: Hatje Cantz, 2022).
- 202 The Graz architecture magazine (GAM) issue “Wood: Rethinking Material,” addresses this basic conflict with individual essays: Laila Seewang, “Timber Territory,” *GAM* 17 (2021): 170–189; and Francesca Zanotto, “Non-exploitative Architecture. Beyond a Utilitarian Perspective on Wood,” *GAM* 17 (2021): 190–201.
- 203 Beginning in 2022, Forest School Talks is a public program of Central Saint Martin’s curated by Catalina Mejia Moreno, in collaboration with White Arkitekter and Forestry England.

To overcome the species-based and anthropocentric approach, in the environmental humanities the idea of interplay, indeed the intertwining of nature and culture, goes far beyond what we understand today by domestication and staging, or by green architecture or the green city (and thus the disappearance of insects, wildlife, bacteria, etc.). Ideas of urban nature of the nineteenth and twentieth centuries, as well as the era’s political-ecological urban geography, concentrated on plant worlds, whether through the creation and maintenance of public parks, botanical gardens, and tree-lined boulevards, or through the creation and implementation of garden city or spacious city concepts. But an integrated, ecological urban planning left the animal world out. <sup>(204)</sup> Recent research in urban history has shown that, under conditions of capitalist urbanization, not only plant but also animal relations were subordinated to value production. This is because farm and breeding animals, which previously had been part of everyday

life not only in the countryside but also in the city, for both labour and supply purposes, were banished from people's immediate living environments with the advent of mechanization and the emergence of the food-processing industry alongside the mass slaughter of animals, only to be commercialized in the form of house pets, the affective labour they perform, and the industries that emerged around them. <sup>(205)</sup> Architectural history in this multispecies perspective has long limited itself to the design and display enclosures of zoos, a practice of domination. With the "animal turn," however, urban history has begun investigating to what extent animals shaped the modern urbanization process, and how the human-animal relationship has transformed in historical terms. <sup>(206)</sup> The emergence of human-animal studies that critically examine the web of relations also means seeing animals as historical actors within architectural history. <sup>(207)</sup> When it comes to the question of what it means to be a human being or to pay attention to animals, architectural history can learn from the environmental humanities, especially multispecies studies. <sup>(208)</sup>

- 204 Matthew Gandy, "Urban Nature and the Ecological Imaginary," in *In the Nature of Cities: Urban Political Ecology and the Politics of Urban Metabolism*, eds. Nick Heynen, Marika Kaika, and Erik Swyngedouw (London: Taylor & Francis, 2006), 62–72, esp. 65. Gandy refers here only to dystopian notions of a future zoopolis.
- 205 Matthew Gandy, "Urban Political Ecology: A Critical Reconfiguration," *Progress in Human Geography* 46, no. 1 (2022): 21–43, esp. 27. See also Haraway, *When Species Meet*.
- 206 Harriet Ritvo, "On the Animal Turn," *Daedalus* no. 4 (2007): 118–122; and Dorothee Brantz, "Die 'animalische Stadt': Die Mensch-Tier-Beziehung in der Urbanisierungsforschung," *Informationen zur modernen Stadtgeschichte*, no. 1 (2008): 86–100.
- 207 André Krebber and Mieke Roscher, eds., "Tiere und Geschichtsschreibung," *Werkstatt Geschichte*, no. 56 (2011): 3–6. On the other hand, since the 1960s, animal architecture has been understood to mean the constructions created by animals as builders themselves as architecture. Sascha Roesler, "Bauten ohne Konstruktion. Tierarchitektur im Diskurs der Postmoderne," *Kunst + Architektur*, no. 4 (2008): 20–27.
- 208 Instead of simply celebrating biodiversity, the question is, who benefits when different species collide, see Eben Kirksey, "Multispecies," in *Posthuman Glossary*, 265–266. For multispecies studies, see Haraway, *When Species Meet*, esp. "Part 1: We Have Never Been Human," 1–42; Vinciane Despret, *What Would Animals Say If We Asked the Right Questions?* (Minneapolis: University of Minnesota Press, 2016); and Thom van Dooren, Eben Kirksey, and Ursula Münster, "Multispecies Studies: Cultivating Arts of Attentiveness," *Environmental Humanities* 8, no. 1 (2016): 1–23.

Exemplary as an entangled history within architectural research that problematizes how we can better inhabit the world and constitute it together, at the intersection of contingency and uncertainty, dependence and exploitation, but also responsibility and aliveness, is the research of Isabelle Doucet. Using the example of the Ducklands (1989–1991, Cedric Price), an ecological redevelopment project for Hamburg's docklands in Germany, Doucet argues with regard to environmental imaginaries that it is precisely when the primacy of economic growth is removed that the creation of a marshland can create new habitats for the coexistence of animals, humans, river, and city. In this case, the habitats were large nature preserves for waterfowl and migratory birds. <sup>(209)</sup> Even if this does not necessarily prevent new development, new cooperation and new alliances can nevertheless emerge, with humans in the role of observers, excursionists, and ultimately citizens. Informed by her commitment to feminist storytelling and her interest in radical positions in architecture, Doucet also proceeds cautiously, critiquing the prospects of success even for projects performed in the service of research and science, such as, for example, breeding and hatching endangered species, or meeting and communicating with other intelligent beings who take Indigenous practices of care and representation seriously. <sup>(210)</sup> This new posthumanist solidarity, questioning and expanding the human habitat through solidarity with all kinds of creatures and critters—non-human, or else more-than-human, actors—is addressed in contemporary architectural research through the concept of "cohabitation." <sup>(211)</sup> Historically speaking, settlement was never an action that belonged to humanity alone, and buildings always represented a node in the network of various

living beings. Environmental histories of architecture can lead the way by conceiving the house as *oikos* of multispecies encounters anew, as argued by Emanuele Coccia. <sup>(212)</sup> Or they can recognize animals and plants as collaborators of architectural practitioners and historians, for example when bat colonies are used to kill insects or as an argument against the demolition of old buildings. <sup>(213)</sup> It is important, however, to avoid valuing nature as an object, resource, or capital—that is, economically rather than ecologically—and to focus instead on community. The aim is to forge new connections between plants, animals, and people, for instance in the handling and design of classic green spaces (parks, gardens, and cemeteries) and *Brachen* (the German term only recently popularized in English literature by Matthew Gandy for urban wastelands and interstitial landscapes), but also of building ruins. <sup>(214)</sup> Overcoming the human–animal dichotomy in architecture, urbanism, and territorial planning would mean first recognizing all creatures as conscious agents, networked actors, intentional communicators, and ethical as well as political subjects—ultimately, as “companion species,” as formulated by Haraway. <sup>(215)</sup>

- 209 Isabelle Doucet, “Anticipating Fabulous Futures,” *e-flux Architecture*, September 2019, <https://www.e-flux.com/architecture/overgrowth/284918/anticipating-fabulous-futures>. On Doucet’s take on storytelling as a critical design tool and her critique of the central role of architects in relation to residents, birds, rivers, and ornithologists, see Doucet, “Architectural Storytelling: A Space Between Critical Practice and Fragile Environments,” in *Infrastructural Love: Caring for Our Architectural Support Systems*, eds. Hélène Frichot et al. (Basel: Birkhäuser, 2022), 36–51.
- 210 Isabelle Doucet, “Interspecies Encounters: Design (Hi)stories, Practices of Care, and Challenges,” in *Environmental Histories of Architecture*.
- 211 Building on research on human–animal relations in the city, conceived of by late cultural studies scholar, artist, and curator Marion von Osten, see “Cohabitation,” ed. Christian Hiller, special issue, *ARCH+*, no. 247 (2022).
- 212 Emanuele Coccia, “The Architecture of Species,” in *Toward a Non-Extractive Architecture*, eds. Space Caviar (Moscow; Berlin: V-A-C Press and Sternberg Press, 2021), 267–278.
- 213 Joyce Hwang, “Environment as Collaborator,” *Log*, no. 54 (2022): 151–154. Here, Hwang describes the efficacy of bats as a natural pesticide.
- 214 For Matthew Gandy, Berlin’s *Brachen* became the central object of investigation for an urban nature respectively its political ecology. His 2017 film *Natura Urbana: The Brachen of Berlin* was followed by the scholarly monograph *Natura Urbana* (Cambridge, MA: MIT Press, 2022). See also Dieter Genske and Susanne Hauser, *Die Brache als Chance: Ein transdisziplinärer Dialog über verbrauchte Flächen* (Berlin and Heidelberg: Springer, 2002); and Cornelia Escher and Kim Förster, “Revisiting Görlitzer Park: Material Practices and the Postmodern Landscape,” *Landscript* no. 5 (2017): 154–173. Here, Escher and I research Görlitzer Park, a prominent postwar *Brache* on a former railroad station in West Berlin.
- 215 Haraway, *When Species Meet*.

The more-than-human approach, on the other hand, which revives the discussion of ethics and politics of care, deals in addition with micro-level beings—fungi, mosses, lichens—but also microorganisms, algae, bacteria, and even viruses, which are incorporated into architectural research. In *The Mushroom at the End of the World*, Tsing describes the influence of capitalism and the new relationships it has created at the outset of the twenty-first century, focusing on the complex relations between humans and mushrooms. Her narration outlines what it means to think like other beings; how gatherers, along with tree and mushroom rhizomes, can be understood as collective beings, as non-totalized forms of assemblages, which, for Tsing, is the basis of conviviality, defining the environment from the perspective of multispecies studies as inherently political, unlike von Uexküll at the beginning of the twentieth century. <sup>(216)</sup> Architectural research already practices what Tsing highlights as a fundamental method—the art of noticing, the passionate immersion in the lives of others. In a world where the climate crisis has been joined by the COVID-19 pandemic, which intertwines the two and reinforces, once again, the efficacy and actions of the “anthropos,” the transdisciplinary collaborative research and digital publication project *Feral Atlas* has focused on analyzing and understanding the interconnectedness of globalized human infrastructure projects and untamed ecologies, putting a



focus on infrastructural impacts of imperial and industrial ruins. <sup>(217)</sup> A contrasting strain of architectural research focuses on understanding the experience of nature along the political conflict line of architecture, the city, and the environment as itself toxic to humans, as a queer ecology. Recall Nerea Calvillo's aforementioned work that traces the spread of hay fever, and conceives of urban nature itself as toxic, by focusing on the moment ragweed invaded the human urban milieu in non-built up areas (or rather vice versa), and subsequently became medicalized—a history of urban planning paired with a history of environmental racism. <sup>(218)</sup> If, from the perspective of urban political ecology the city is a central reference point, then architecture—more a method than an object—offers a starting point from which to plumb the ongoing preservation of the dualism contaminated/uncontaminated, healthy/unhealthy. <sup>(219)</sup>

- 216 Tsing, *Mushroom at the End of the World*; on mycelia, see Merlin Sheldrake, *Entangled Life: How Fungi Make Our Worlds, Change Our Minds & Shape Our Futures* (London: Random House, 2020); on Jakob Johann von Uexküll's concept of the environment, see Uexküll, *Umwelt und Innenwelt der Tiere*; and Uexküll, *Foray into the Worlds of Animals and Humans: With A Theory of Meaning* (Minneapolis: University of Minnesota Press, 2010) republished in German under the title *Streifzüge durch die Umwelten von Tieren und Menschen* (Berlin: Matthes & Seitz, 2022/1934).
- 217 The atlas has found its way into architectural teaching not least because of the visual form of its analysis and presentation. Anna Lowenhaupt Tsing et al., eds. *Feral Atlas: The More-Than-Human Anthropocene* (Stanford: Stanford University Press, 2021).
- 218 Nerea Calvillo, "Toxic Nature: Toward a Queer Theory of Pollution," in *Environmental Histories of Architecture*; Gregg Mitman, *Breathing Space: How Allergies Shape Our Lives and Landscapes* (New Haven: Yale University Press, 2007); and Pritchard, "Toward an Environmental History of Technology," 240.
- 219 Gandy, "Urban Political Ecology," 34.

An important contribution of the environmental humanities, but also interesting for architectural sciences as well, is the preservation of the soil as a central *topos*, which is of utmost importance alongside the stabilization of the climate. Science and technology scholar María Puig della Bellacasa has studied permaculture practices that focus not only on the interconnectedness of all life, of "people and their technologies"—plants and animals, microorganisms, and substances such as water and air—but above all on "the soil on which we feed" in all its ecological implications. <sup>(220)</sup> Similarly fundamental, though more radical, is architectural theorist Héléne Frichot, whose feminist approach to a new materialism explicitly follows Haraway and others in discussing artistic and architectural works that deal with mud and other materials (rather than, say, the sky). <sup>(221)</sup> Once again, Haraway rhetorically encapsulates the decentring of the human when she refers to herself as "compost-ist" rather than a "posthuman-ist," and highlights the terraforming work of bacteria. <sup>(222)</sup> A new mindfulness that recognizes the diversity of living things encompasses not only the effects of the sun and the wind, and our relationship to them, but also an awareness of material cycles, from mining to waste disposal and landfill. For environmental histories of architecture, this involves becoming concretely aware of the historical relationships of buildings and settlements, from their greening to their soil, to all that lives within it—especially the earthworm, as perhaps the most important terraforming creature <sup>(223)</sup>—and at the same time writing against excavation and depletion, against compaction (by heavy equipment) and sealing (by asphalt and concrete). <sup>(224)</sup> It means narrativizing toward a non-extractive approach, or if extractive then at least just, and toward a future that emphasizes building and living together on shared territory. <sup>(225)</sup>

- 220 See María Puig de la Bellacasa's writings: "Ethical Doings in Naturecultures"; "Encountering Bioinfrastructure: Ecological Struggles and the Sciences of Soil," *Social Epistemology* 28, no. 1 (2014): 26–40; "Making Time for Soil: Technoscientific Futurity and the Pace of Care," *Social Studies of Science* 45, no. 5 (2015): 691–716; and *Matters of Care: Speculative Ethics in More than Human Worlds* (Minneapolis: Minnesota University Press, 2017).
- 221 Frichot discusses, among others, *Moving Stuff* (2013), the site-specific work of New Zealand academic and practicing architect Julieanna Preston, and a performance on charcoal that took place during AHRA's eleventh annual conference in Newcastle, convened by Katie Lloyd Thomas. Frichot, *Creative Ecologies: Theorizing the Practice of Architecture* (London: Bloomsbury, 2019), esp. 126–133.

- 222 The human body, often used as an analogy for the city, is home to thirty million bacteria, equal in number to “our” cells, so it is understandable when Haraway points out that we are all becoming compost anyway, not posthumans. The process of turning compost into humus is anthropogenic, conceived and planned by humans. Haraway, “Anthropocene, Capitalocene, Plantationocene, Chthulucene,” 159–165, esp. 161; and for a more comprehensive interpretation, see Haraway, “Tentacular Thinking: Anthropocene, Capitalocene, Chthulucene,” *e-flux Journal*, no. 75, September 2016, <https://www.e-flux.com/journal/75/67125/tentacular-thinking-anthropocene-capitalocene-chthulucene>.
- 223 This is because the earthworm, which plays a prominent role in humus formation through the turnover of large amounts of organic matter, makes a decisive contribution to the fertility of the soil, the basis of all life on Earth. Baptiste Morizot, *Philosophie der Wildnis, oder, die Kunst vom Weg abzukommen* (Ditzingen: Reclam, 2022), 151–164, esp. 154. Several earthworm books and earthworm films give credit to the earthworm, be it as soil manager, storyteller, policeman, or simply labourer: Puig de la Bellacasa, “Encountering Bioinfrastructure,” 33; Tsing, *Mushroom at the End of the World*, 161; Haraway, “Tentacular Thinking,” 122; and Clément, *Planetary Garden*, 44 (I thank Mariya Hamada for these references).
- 224 On excavation, see Seth Denizen, “Three Holes: In the Geological Present,” in *Architecture and the Anthropocene: Encounters among Design, Deep Time, Science and Philosophy*, ed. Etienne Turpin (London: Open Humanities, 2014), 29–46; and on sealing, see Cristián Simonetti, “The Petrified Anthropocene,” *Theory, Culture & Society* 36, no. 7–8 (2019): 45–66.
- 225 On a non-extractive attitude toward architecture practice and education, see Charlotte Malterre-Barthes with Zosia Dzierżawska, “An Architecture without Extraction,” *Architectural Review*, November 2021, <https://www.architectural-review.com/essays/graphic-novel-a-global-moratorium-on-new-construction>; and Malterre-Barthes with Dzierżawska, “New Rules,” *Cartha*, no. 6, June 2022, <https://www.carthamagazine.com/wp-content/uploads/2022/05/Charlotte-Malterre-Barthes-Dziersawk.pdf>.

To reworld the world, to negotiate new *modi videndi*—even “in catastrophic times,” it is about “collective survival” in the ruins of capitalism<sup>(226)</sup>—environmental histories of architecture contribute (differently to sci-fi fantasies of escapism for the chosen ones in private space vessels, or the earthly survivalism of preppers)<sup>(227)</sup> by orienting the focus of philosophical and architectural debate toward the Earth. This worlding might take different forms. Latour and Stengers, for example, promote new ecological practices and cosmopolitan considerations following the Gaia hypothesis.<sup>(228)</sup> And Haraway promulgates an intersectional and interactional approach, as a logical consequence of her feminist approach of situated knowledges for living (and I would add building) on Earth, in her words a “Terrapolis,” which is for her a place for multispecies “becoming with.”<sup>(229)</sup> When it comes to a new grounding and Earth connection in the face of our planetary crisis, Latour’s late work in particular becomes increasingly important: beginning with reinterpreting and readjusting the relations, interests, and balances of modernization and ecologization, and proceeding to determine what should be kept and what should be cared for—which also has import for architecture—while continuing to strip away the outdated as well as to develop a fundamentally new understanding of nature, which is the object of politics.<sup>(230)</sup>

- 226 Tsing, *Mushroom at the End of the World*, 4.
- 227 Stephanie Wakefield, “Anthropocene Hubris,” *e-flux Architecture*, September 2021, <https://www.e-flux.com/architecture/accumulation/337991/anthropocene-hubris>; and Stephanie Wakefield, *Anthropocene Back Loop: Experimentation in Unsafe Operating Space* (London: Open Humanities Press, 2020).
- 228 Bruno Latour dealt with the Gaia concept of James Lovelock and Lynn Margulis in “Facing Gaia: A New Inquiry into Natural Religion,” The Gifford Lectures, February 2013, University of Edinburgh, <https://www.giffordlectures.org/lectures/facing-gaia-new-enquiry-natural-religion>; and Latour, *Facing Gaia: Eight Lectures on the New Climatic Regime* (Cambridge, UK: Polity, 2017.) Isabelle Stengers addresses the concept in “The Intrusion of Gaia,” in *In Catastrophic Times: Resisting the Coming Barbarism* (London: Open Humanities Press, 2015), 43–50, first published in French under the title *Au temps des catastrophes: Résister à la barbarie qui vient* (Paris: Éditions La Découverte, 2009). For a connection to the ground, which would make sense from an ecological point of view in architecture, see Christoph Küffer, “Cities as Ecosystems and Buildings as Living Organisms,” in *The Materials Book*, 206–210.
- 229 Haraway, *Staying with the Trouble*, 12; and Haraway, “SF: Speculative Fabulation und String-Figuren,” *100 Notizen – 100 Gedanken*, no. 33 (Ostfildern: Hatje Cantz, 2011). Haraway lists terms with the prefix “bio-” and asks readers to replace it with the prefix “terra-” —for instance, changing biodesign to terradesign.
- 230 For a first overview and summary of Bruno Latour’s ANT and STS approaches, concepts, and methods, which are relevant for architecture, see Albena Yaneva, *Latour for Architects* (London: Routledge, 2022). For his approaches to ecologizing, see Latour, “To Modernize or to Ecologize?”; and Latour, “A Cautious Prometheus: A Few Steps Toward a Philosophy of Design (with special attention to Peter Sloterdijk),” in *In Media Res: Peter Sloterdijk’s Spherological Poetics of Being*, eds. Willem Schinkel et al. (Amsterdam: Amsterdam University Press, 2012), 151–164. For more on how Latour turned to themes of society and the environment, of turning away from nature in favour of a political ecology, see Latour, *Politics of Nature*.

Latour's approach to finally understanding modernity as history and to shaping a new ecological thinking and acting by applying methods of science and technology studies, as well as concepts of actor-network theory, to ideas of nature and politics gave new impulses just at the moment when the anthropogenic greenhouse effect was becoming more and more scientifically proven, especially through the reports of the IPCC. (The perception of global heating by world society, one might conclude, resembles how people only notice their own body when they become seriously ill.) <sup>(231)</sup> Through exhibitions, scientific articles, performances, and philosophical works, Latour, building on a pronounced critique of deregulation under a neoliberal agenda since the 1990s, advanced to the forefront of an Anthropocene debate that looks to the future and is concerned with ensuring that the Earth remains habitable. <sup>(232)</sup> His lecture series *Facing Gaia* outlines the conflict between the earthbound and modernity, critiquing markets and states against the backdrop of a new climate regime using the concept developed by James Lovelock and Lynn Margulis, which encompasses mythical, political, and scientific aspects. And his book *Down to Earth*, based on the realization of the end of modernity, even globalization, promulgates not only a new understanding of the world, but also a new understanding of the planet, which, while recognizing that there is no outside, only an inside, can no longer accommodate modern ideas about innovation, progress, and growth. <sup>(233)</sup>

231 Bruno Latour, ed., *Reset Modernity!* (Cambridge, MA: MIT Press and ZKM | Center for Art and Media, Karlsruhe, 2016); Latour and Weibel, eds., *Critical Zones*.

232 Latour has always been in dialogue with other like-minded people, and in collaboration with artists, curators, natural scientists, especially biologists, geochemists, geologists, and geophysicists, with architects and landscape architects, while also engaging with research institutions, measuring instruments and ecological cycles, rain, soil, and so forth.

233 Latour, *Down to Earth: Politics in the New Climatic Regime* (London: Polity Press, 2018), first published in French under the title *Où atterrir – comment s'orienter en politique* (Paris: Éditions La Découverte, 2017).

For human beings—in Latour's words, the Earth-dwellers, the Earth-bound, or rather terrestrials—this would mean leaving behind the domination of the modern world and opening up to something new; to other living beings, even within the metropolis. In the interests of localizing all human thought and action (and thus architecture and urban planning) with regard to a new politics, or rather of reorienting in epistemological terms, this means that humanity today can no longer be conceived as starting from the primordial hut (a Vitruvian concept, reinterpreted by Marc-Antoine Laugier during the Enlightenment), under which conception architecture offers protection against threat, but also always entails the exploitation of natural resources, energy, material, and labour, and thus a complex relationship of human to the environment, or to the metropolis in the form of urbanization processes. <sup>(234)</sup> Whereas Latour originally took nothing for granted—not science, not society, not even the environment—in the last decade, the Earth, or rather the new cosmology of Gaia (or the critical zone, which basically described exactly the same idea) became for him a vital actor and intractable precondition. <sup>(235)</sup> The geosphere, as the foundation of the environment, is thus more comprehensive than any human-made shell, be it an architectural dwelling or a technological system of life support.

234 Ayala Levin, "Man, Nature, and the Question of Resources," in "Architecture and the Environment," 9.

235 Latour and Weibel, eds., *Critical Zones*; and Alexandra Arènes, "Inside the Critical Zone," *GeoHumanities* 7, no. 1 (2021): 131–147.

## RETROSPECT

Given solastalgia—the distress some might feel with all the environmental change—the capacity of humans to grieve and mourn ecological loss and actively engage with a new phase in the creation and destruction of the Anthropocene is understood as an ethical, ultimately political task. <sup>(236)</sup> Achieving coexistence, achieving future cohabitation on Earth,

is dependent on humans actually valuing more-than-human beings, thereby validating and activating their grief, and with any luck reducing its many causes. After a long period of debate over the scientific foundations of global heating—whether apocalyptic or post-apocalyptic narratives are more appropriate—we now seem to have moved one step further, despite all the climate-related fears and concerns. <sup>(237)</sup> Within scientific research, political debate, or civil-society protests, different practices of active mourning are undertaken in various forms of witnessing and recording. If climate mourning is first and foremost a rhetorical act that endows meaning to things, gives them value, triggers affect, generates knowledge, and arouses feelings, then artistic performances and architectural projects are also, ideally, practices of knowledge and world generation.

236 Glenn A. Albrecht, *Earth Emotions: New Words for a New World* (Ithaca: Cornell University Press, 2019); and Joshua Trey Barnett, *Mourning in the Anthropocene: Ecological Grief and Earthly Coexistence* (Chicago: Michigan State University Press, 2022).

237 David Wallace-Wells, “The Uninhabitable Earth,” *New York Magazine*, 10 July 2017, <https://nymag.com/intelligencer/2017/07/climate-change-earth-too-hot-for-humans.html>; and Wallace-Wells, “Beyond Catastrophe: A New Climate Reality Is Coming into View,” *New York Times Magazine*, 26 October 2022, <https://www.nytimes.com/interactive/2022/10/26/magazine/climate-change-warming-world.html>.

This essay, and indeed this series, neither of which are exhaustive but demonstrate different fields of inquiry and future perspectives by conducting historical research and presenting analysis on the present situation, can contribute to the reinvention and repositioning of architectural history, and the architectural humanities in general, from the perspective of the environment beyond the divide of critical versus operative. Understood as counterfactual history, the series is about reinterpreting certain events and episodes and thinking along alternative scenarios, especially now that our twenty-first-century global society finds itself in a moment of transition, from a state of “critical care,” which is based on devices to monitor important life functions and aims at healing, to a state of “palliative care,” which would ultimately encompass only care, relief, and support. <sup>(238)</sup> Contemporary approaches to writing environmental histories of architecture with objects of material culture as their subject matter are explicitly or implicitly based on the Anthropocene debate within the humanities regarding social unevenness, power, and domination. They are bound to both transdisciplinarity and transscalarity, and engage in a dialogue with environmental history and the environmental humanities, as well as related disciplines such as literary and cultural studies, philosophy, sociology, and anthropology, but also biology, geology, ecology, and so forth, and aim at levelling an economic, postcolonial, and feminist critique. Their relevance is demonstrated by their deliberate focus on design, practice, research, and teaching; on scientific and technological approaches; on academic, pedagogical, practical, and cultural dimensions; on path dependencies and market dependencies; ultimately on historiography itself, on concepts and conceptualizations, with the goal of fostering other narratives, images, imaginaries, and enabling “undisciplined knowing.”

238 Angelika Fitz and Elke Krasny, eds., *Critical Care: Architecture and Urbanism for a Broken Planet* (Cambridge, MA: MIT Press and Architekturzentrum Wien, 2021). Relatedly, in 1980, in Germany, an eco-solar house competition organized by the city of Landstuhl, in which Oswald Mathias Ungers among others participated, still involved a reference to the principles of the Hippocratic oath, not doing harm. For details, see Kim Förster, “Energy – Architecture – Transition. Oswald Mathias Ungers, IBUS and the Search for Good Architecture,” in *Negotiating Ungers: The Aesthetics of Sustainability*, eds. common room and Cornelia Escher (Brussels: common books, 2020).

## PROSPECT

Looking back from the future, this moment in climate and human history may one day prove to be decisive. <sup>(239)</sup> Beyond tropes of doomsday—given the impending climate catastrophe, the increasing greed



for raw materials, the progressing desertification and mass species extinction, the trashing of land and sea, and the unsolvable handling of nuclear waste <sup>(240)</sup>—there are two possibilities for architecture and architectural history to become complicit in “undisciplined knowing” from an environmental perspective, which both carry the hope of transforming cultural and political aspects of the tension between repair and reparation. Architecture can actively tackle the building, energy, and material transition, through continual improvements in techniques of efficiency or sufficiency in the realms of extraction and construction, production and consumption, building and rebuilding. Or, and this is the more radical solution, it can fundamentally reconsider our view of nature as a resource and commodity, which also means undoing, for example through rewilding, or even withdrawing, and thereby meeting other more-than-human critters on an equal footing by applying the idea of assemblage to plants and animals, but also to ecosystems and landscapes. <sup>(241)</sup>

- 239 Naomi Oreskes and Erik M. Conway, *The Collapse of Western Civilization: A View from the Future* (New York: Columbia University Press, 2014).
- 240 Rosemary A. Joyce, “Failure? An Archaeology of the Architecture of Nuclear Waste Containment,” in *Elements of Architecture: Assembling Archaeology, Atmosphere and the Performance of Building Spaces*, eds. Mikkel Bille and Tim Flohr Sorensen (London: Routledge, 2016), 424–438; and Rosemary A. Joyce, *The Future of Nuclear Waste* (New York: Oxford University Press, 2020). On the waste rock in uranium mining, see Gabrielle Hecht, *Being Nuclear: Africans and the Global Uranium Trade* (Cambridge, MA: MIT Press, 2012).
- 241 Facing the threat of extinction, however, the spiral of urbanization is contrasted with rewilding, the abandonment of parts of the Earth, in extreme cases half of it. Maja and Reuben Fowkes, “Rewilding,” in *Posthuman Glossary*, eds. Braidotti and Hlavajova, 388–390.

This “undisciplined knowing” would oblige humans, once they recognize themselves as a force of nature, and perceive the Earth as a significant actor, to reconceive nature as a legal subject rather than an object of conservation. <sup>(242)</sup> After nature was first granted constitutional status in Ecuador in 2008, other countries followed suit. Whereas, previously, the objective protection of species and landscapes was enshrined in basic law, now subjective rights of rivers, mountains, or even entire ecosystems and landscapes can also be taken into account. The legal status of nature has consequences of a political and cultural nature for buildings—which includes architecture as a discipline and profession, and thus architectural history and the architectural humanities as well—since it makes their normal operations, ruinous construction, and urban sprawl, no longer conceivable and sustainable. Beyond the legal and political facts, ethics and care come into play, as discussed in the environmental humanities. This environmental perspective, which denies the separation of nature and culture (and thus the market) in the service of new human-animal-plant relationships and a reorientation toward the Earth, demonstrates the entire problem and the limits of considering architecture itself simply as a form of environmental protection, even when conducted with a balanced measure of mindfulness and concern, with the promise of bringing about the urgently needed building transition. <sup>(243)</sup> Even if the existing paradigm of sustainability that runs through the profession, discipline, institution, culture, authorities, and industries of architecture, and encompasses new circular and digitized approaches to energy and material cycles, needs to be critiqued and interrogated, can a new concept of sustainability be shaped in relation to the building transition—in relation, ultimately, to a new, shared, and collaborative practice of renewability and regenerativity?

- 242 Tabios Hillebrecht, Anna Leah, and María Valeria Berros, eds., “Can Nature Have Rights? Legal and Political Insights,” *Rachel Carson Center Perspectives*, no. 6 (2017).
- 243 Michael Hampe, *Tunguska, or the End of Nature* (Chicago: University of Chicago Press, 2015), first published in German under the title *Tunguska, oder das Ende der Natur* (Munich: Hanser, 2011); and Gion A. Caminada and Michael Hampe, “Für und wider die Natur,” interview by Viviane Ehrensberger and Yvonne Michel, *Trans*, no. 21 (2012): 38–41.

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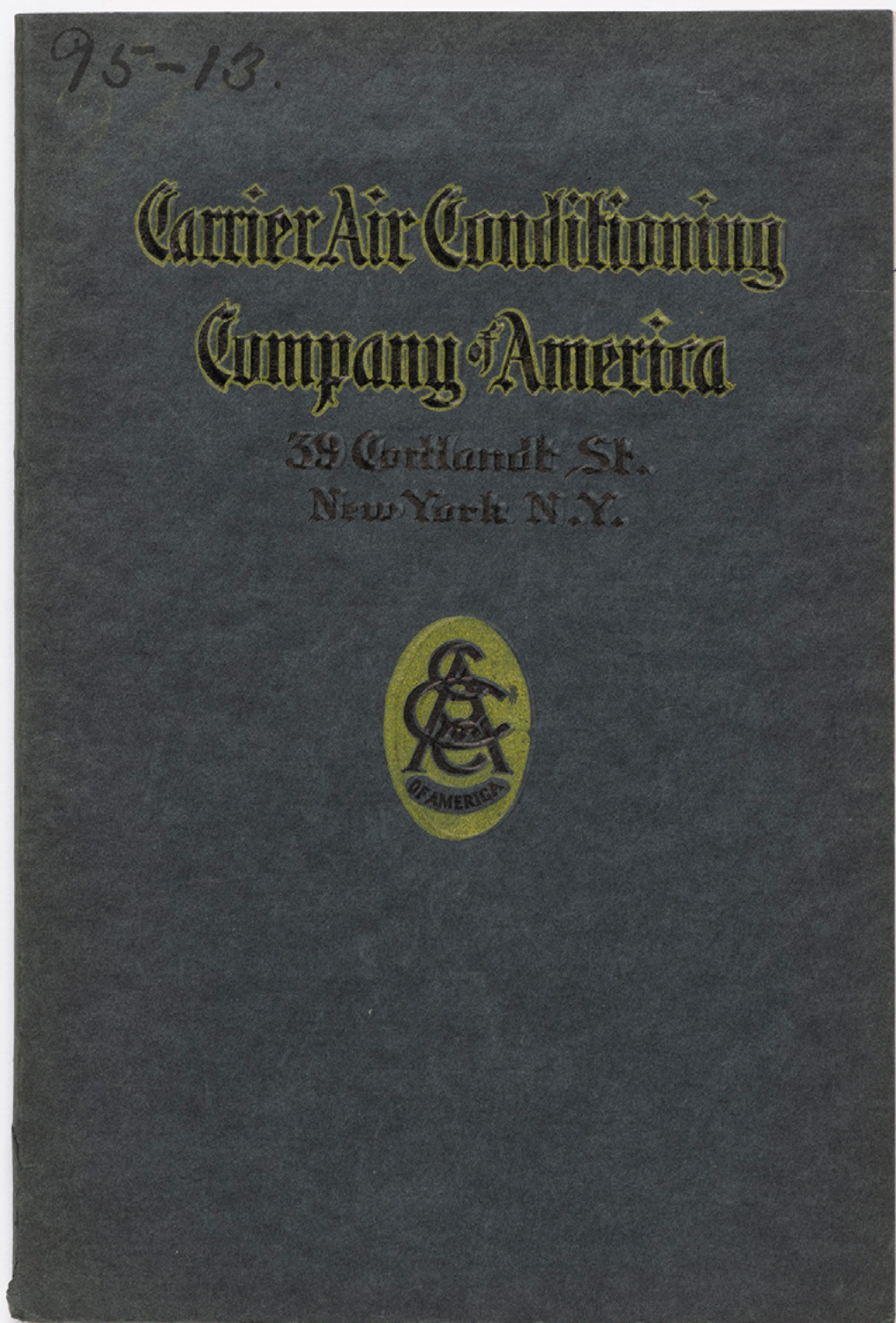


fig. 1a



## The Carrier Differential Thermostat

A device for automatically regulating the percentage of humidity regardless of the temperature.

It is positive and reliable.

It is the most accurate instrument invented.

It is constructed on correct scientific principles.

It is extremely simple in construction and operation.

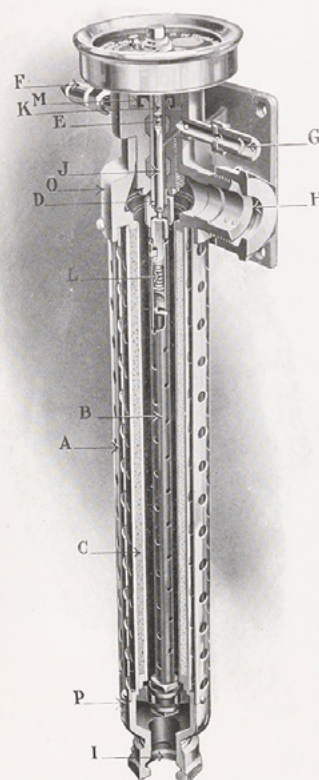
It is guaranteed to regulate the percentage of humidity within two per cent.

It is adapted for use either in connection with the Carrier System of Humidifying or with any other system.

It can be applied to old installations of any make as well as new systems.

*Section No. 4 of Catalog describes it; if interested, write for a copy.*

40



Differential Thermostat

41



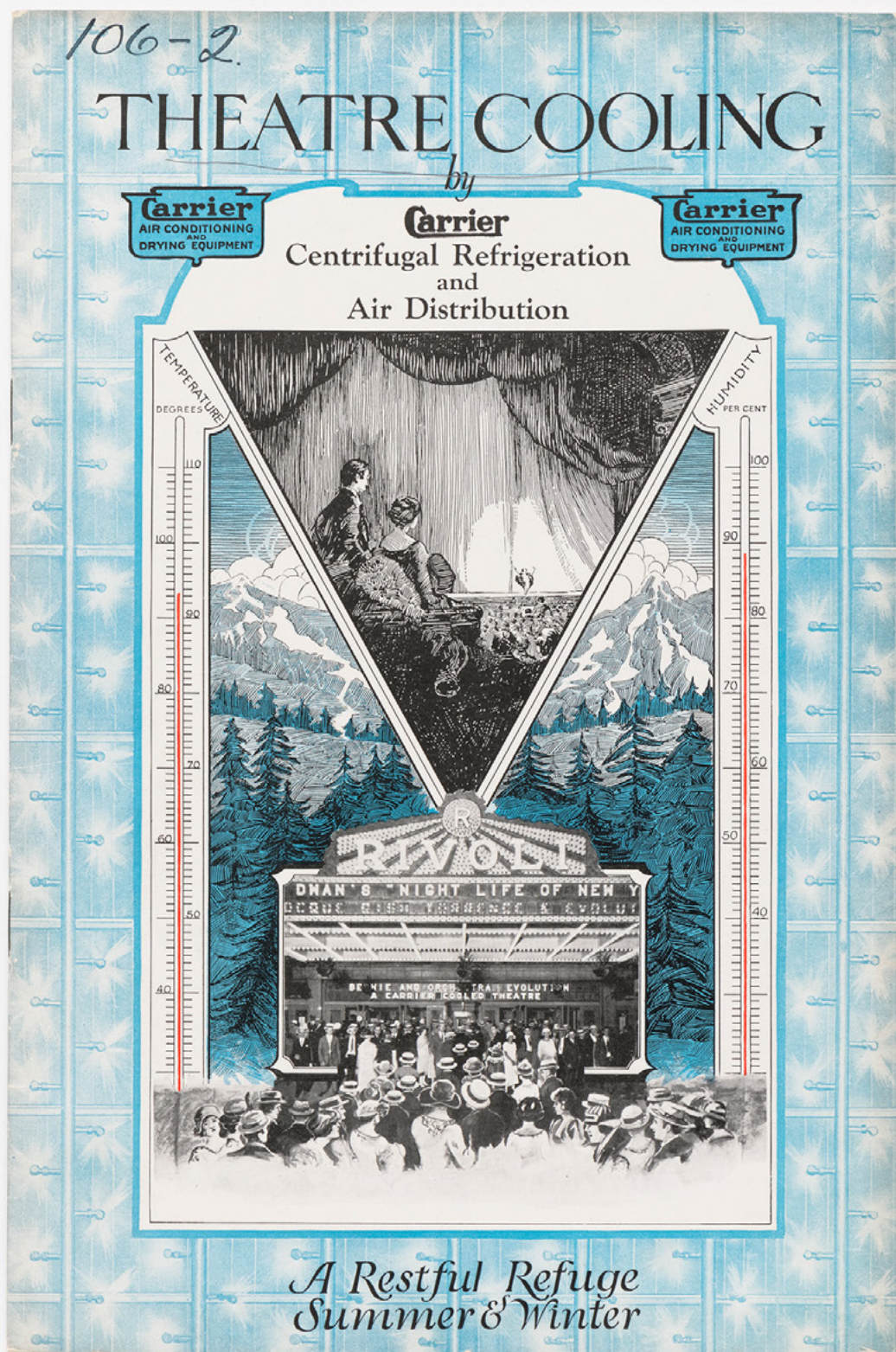
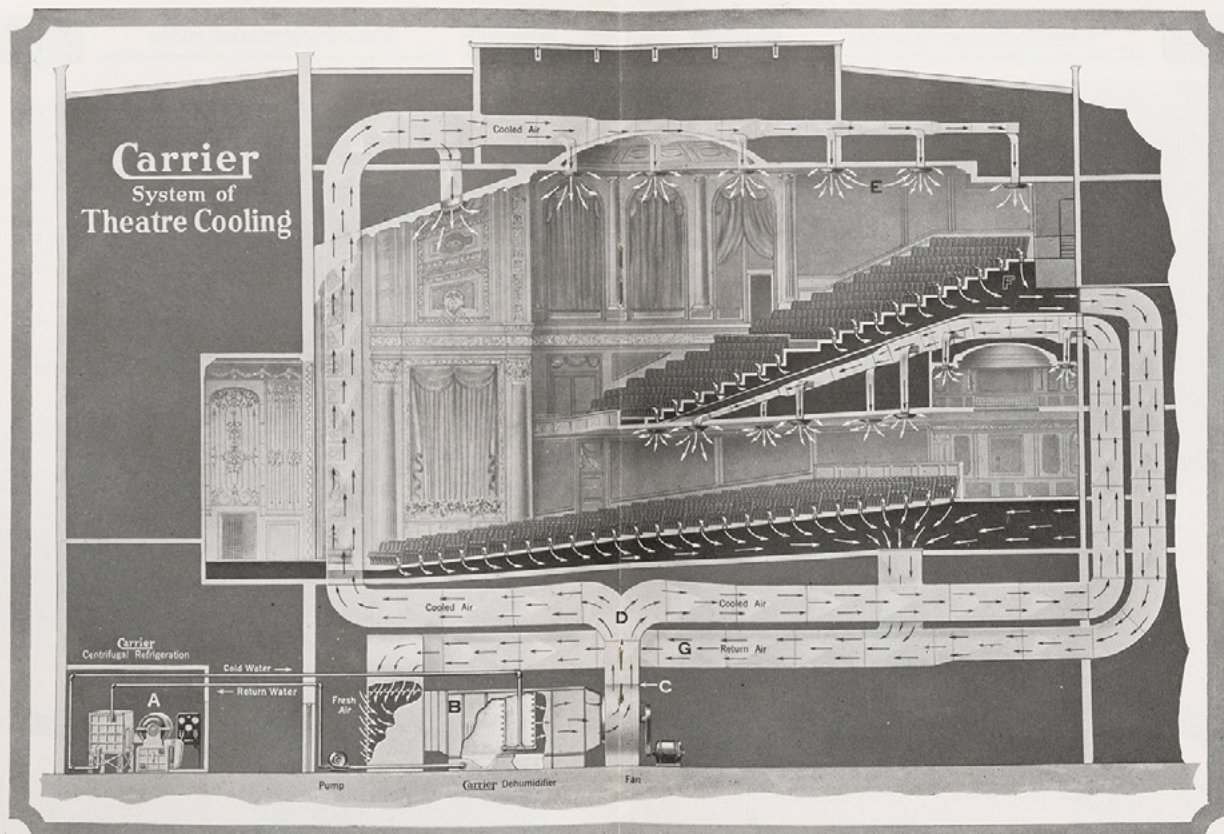


fig. 2a





*Cross Section of a Typical Theatre Equipped with a Carrier System for Cooling, Conditioning and Distributing Air.*

A. The Carrier Centrifugal Refrigeration unit which cools the water for the spray chamber.  
 B. The spray chamber or dehumidifier where the air is dehumidified, cooled and cleansed.  
 C. The centrifugal fan which draws the air through the spray chamber and passes it through metal ducts to the theatre.  
 D. The large metal ducts through which conditioned air is passed to the ceilings of the theatre.

E. The downward diffusion outlets through which the air is diffused over the audience, reaching the Breathing Zone first with complete absence of draughts.  
 F. The chambers beneath the balcony and orchestra seats into which the air is drawn from the theatre.  
 G. The large metal ducts through which the used air passes back to the spray chamber to be rewashied, cooled, dehumidified and mixed with fresh air.

fourteen

fifteen

9-9 Cross Section of a Typical Theatre Equipped with a Carrier System for Cooling, Conditioning, and Distributing Air, in *Theatre Cooling by Carrier Centrifugal Refrigeration and Air Distribution: A Restful Refuge Summer & Winter*, 14-15. CCA, Franklin Institute Trade Catalogue Collection, ID:89-B8935. © Carrier. All rights reserved.

fig. 2b



*The Uses of Granite Rock Wool and Its Products in Filtration, Architecture, Refrigeration, Car Building, Fireproofing, Insulation, Steam Engineering* (St. Louis: American Insulating Material Mfg. Co., 1898), cover. CCA, Franklin Institute Trade Catalogue Collection, ID:89-B8071.

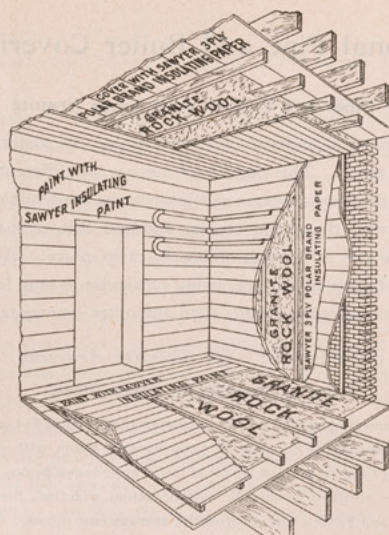


fig. 3a



## Cold Storage Insulation.

Insulating Materials that are (and that always will be) Insulating Materials.



WE advocate the painting of the inside walls and ceiling of any place where products are stored with our Preservative and Insulating Paint, as all walls and ceilings can be washed off and kept clean and wholesome, and the life of the wood is prolonged.

We would always advocate the use of 2 to 6 layers of 3-ply Insulating Paper and 4 to 6 inches of Granite Rock Wool in walls, floors and sides of cooling chambers, cellars, refrigerators, ice boxes, etc.

### Sawyer's Polar Brand Insulating Papers.

This line of papers is made from first-class stock and saturated with a special compound, which is in itself an *insulator* and *preservative* not affected by changes of temperature. These papers are thus rendered *water, gas, acid and alkali proof*. They are *air-tight, odorless* and contain *no coal tar*. They unroll freely, will *always remain pliable*, will *not crack*, and *will not deteriorate* with age. These papers are extensively used *under slate and metal roofs*, as they are water and gas proof and prevent corrosion. For *sheathing purposes* and any place where protection against dampness is required they cannot be equaled. They are also *vermin-proof*.

### Sawyer's Polar Brand Insulating and Building Paper.

Especially valuable for use in lining refrigerators, ice and cold storage houses—for the sides, to protect them against dampness, and between floors, to render them waterproof. It is absolutely necessary to use paper of this description in refrigerators, ice and cold storage houses, on account of the *collision* in the *insulation* of *hot and cold* air, which causes *dampness*, and where ordinary paper is used this dampness will cause the paper to rot. By using the Polar Brand Paper you overcome all this trouble, as it *improves* with age, and moisture cannot penetrate it.

Put up in rolls, 500 square feet, 36 inches wide.

Price, per roll, - - - 1-ply, \$2.00; 2-ply, \$3.00; 3-ply, \$4.00.

fig. 3b



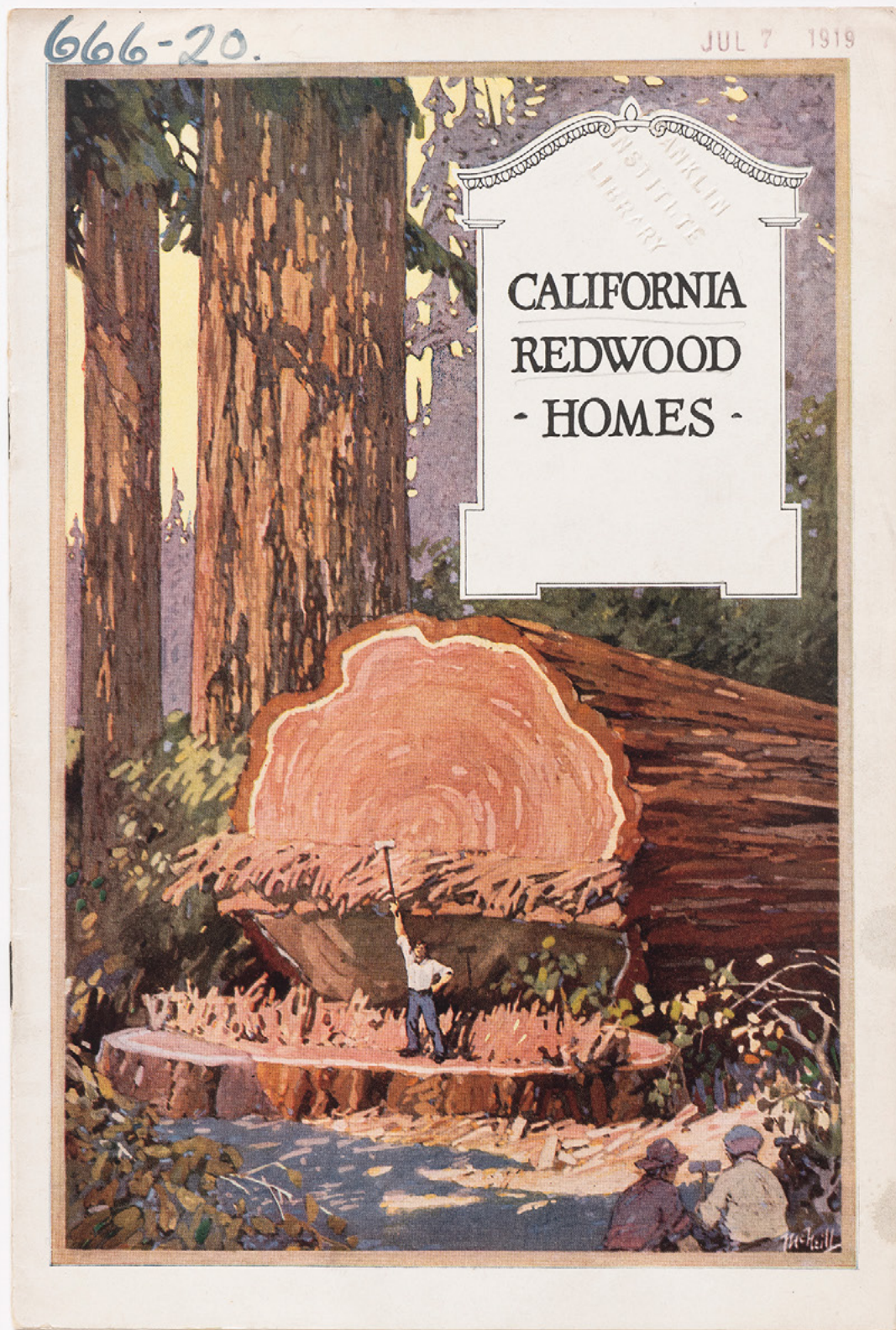
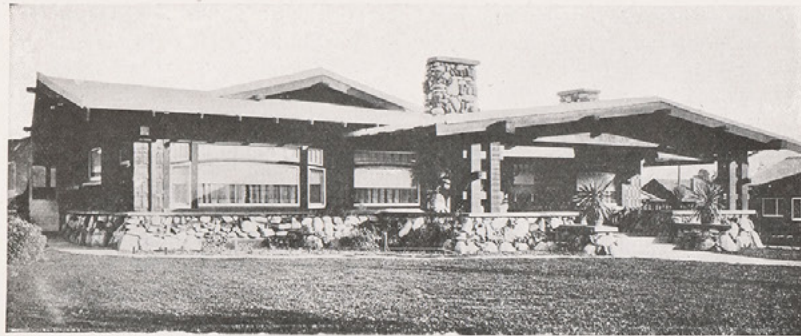


fig. 4a



## C A L I F O R N I A R E D W O O D



*A roomy, light, airy and most charming type of the Redwood bungalow, and especially suited to the large lot*

### The California Bungalow

THE bungalow is distinctly a California ideal. It is the architect's refinement of the original settler's cabin. To be a real California bungalow it must be built, from mudsill to the shingle roof, of California Redwood. The California bungalow is the most charming, cozy, and comfortable form of home. As a type it is the cheapest to construct and affords the most convenient arrangement for the family.

The bungalow is the type of home within reach of the ordinary purse, and it has been successfully transplanted to all parts of the country. If built of California Redwood it combines durability with fire resistance and makes possible unlimited combinations of artistic effects in the color scheme of its interior finish.

#### The House Builder's Wood

For home building Redwood is the most durable and serviceable material you can use. If Nature, when she created Redwood, had deliberately set out to most generously take account of our present-day needs in house construction, as well as our artistic appetites, she could hardly have improved her work. She achieved a miracle in making an "all-purpose" wood so richly adaptable to not only the rough, but also to the more refined uses of lumber. She put

into every Redwood tree a variety of grain, grade and texture probably not paralleled in any other species of wood.

In California, where Redwood is so well known, architects and builders recommend and use it where long life, artistic finish and "no-worry service" is wanted. Redwood is an asset in building.

From mudsill to shingled roof Redwood is ideally adaptable for every purpose, except uncovered interior floors.

WILL NOT SHRINK, SWELL OR WARP



F. H. Kindl, ed., *Pocket Companion Containing Useful Information and Tables Appertaining to the Use of Steel, as Manufactured by The Carnegie Steel Company, Limited, Pittsburg [sic], PA., For Engineers, Architects and Builders* (Pittsburgh: The Carnegie Steel Company, Limited, 1893), title page. CCA, ID:89-B16980.

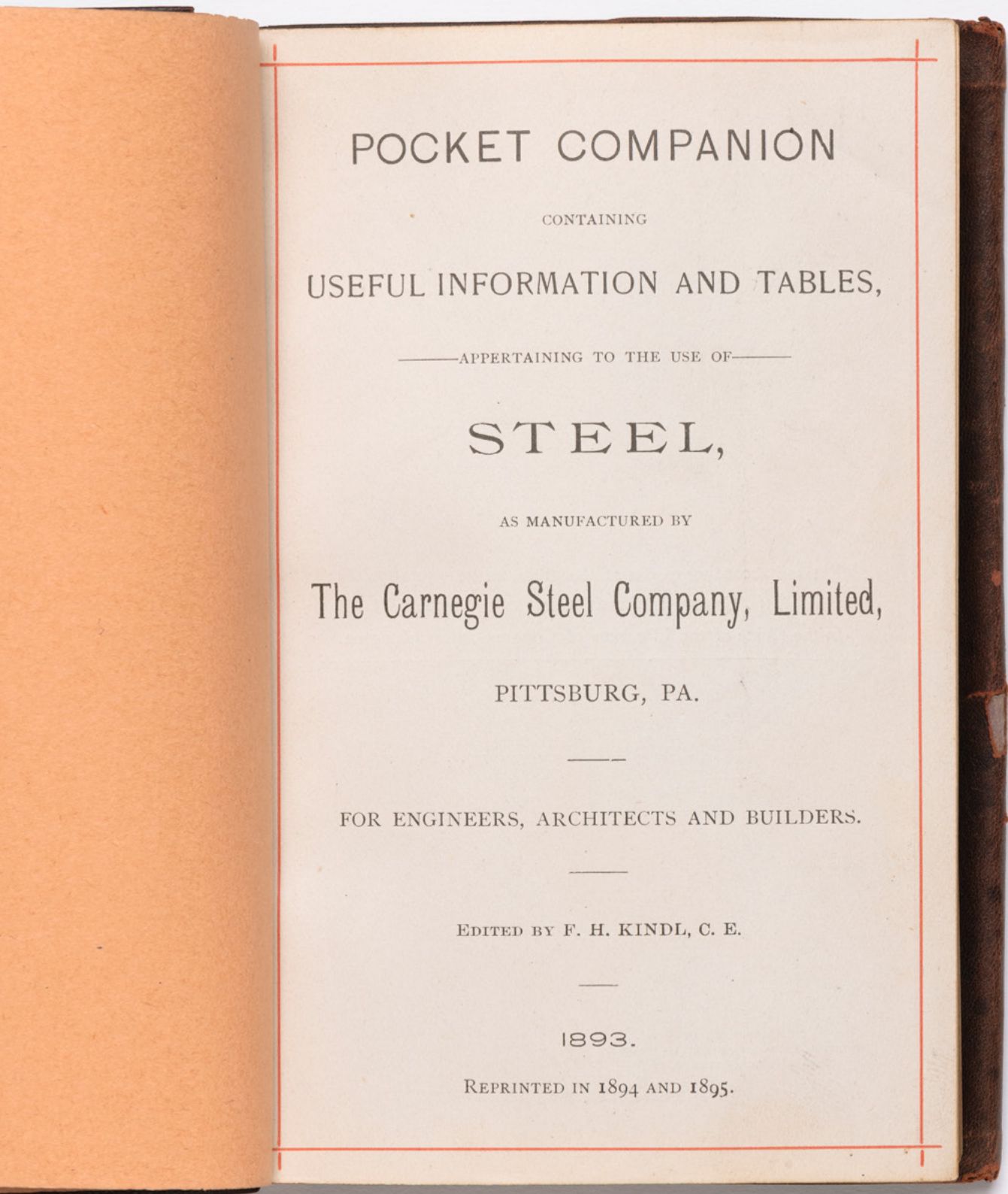
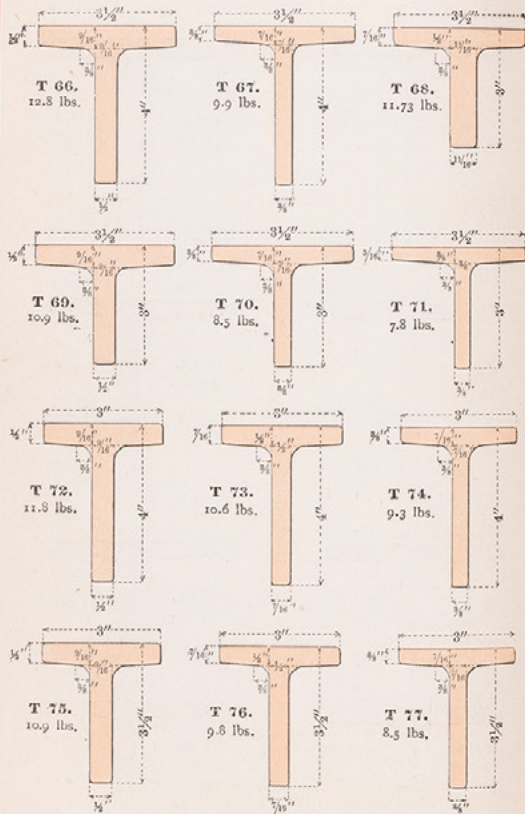


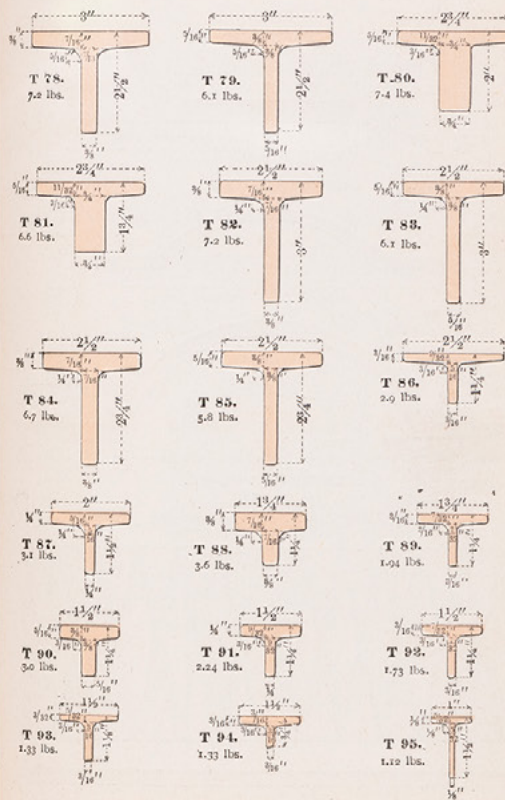
fig. 5a

## TEES WITH UNEQUAL LEGS.



29

## TEES WITH UNEQUAL LEGS.



30

Sections of steel tees with unequal legs, in *Pocket Companion Containing Useful Information and Tables Appertaining to the Use of Steel, as Manufactured by The Carnegie Steel Company, Limited, Pittsburg [sic], PA., For Engineers, Architects and Builders*, 29-30. CCA, ID:89-B16980.

fig. 5b



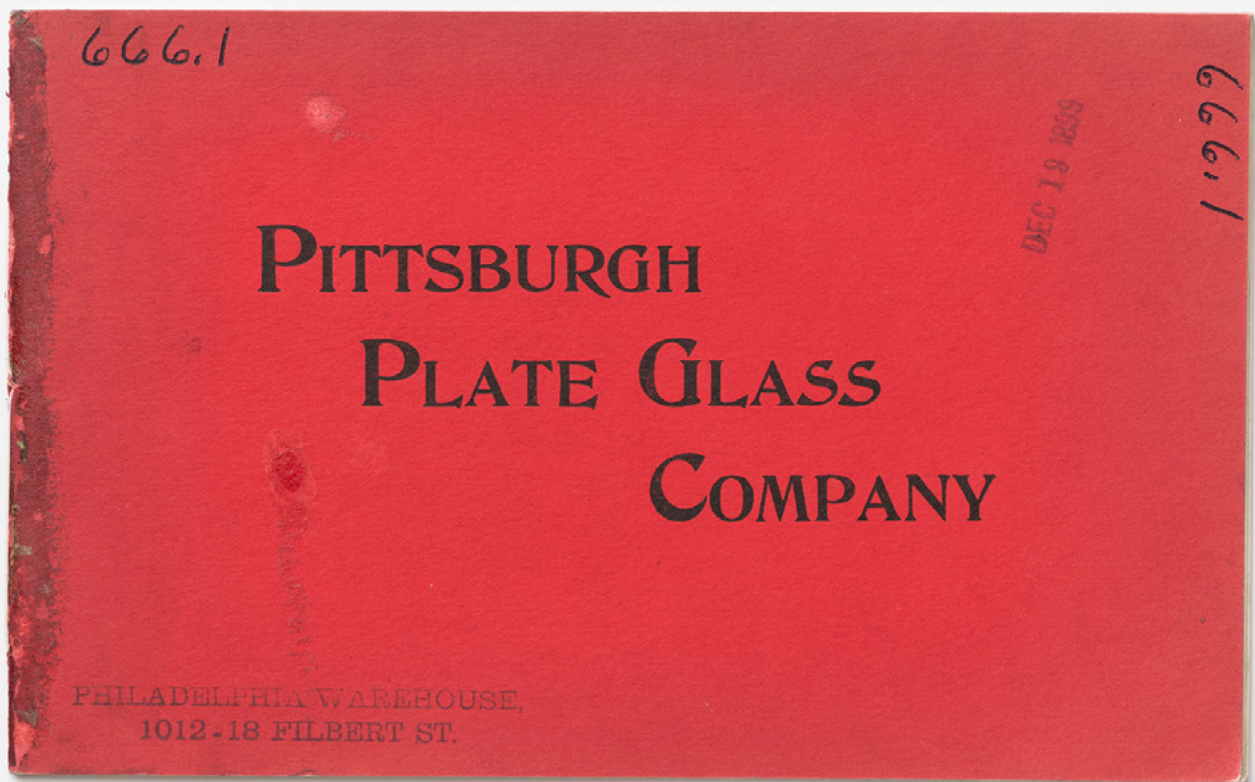
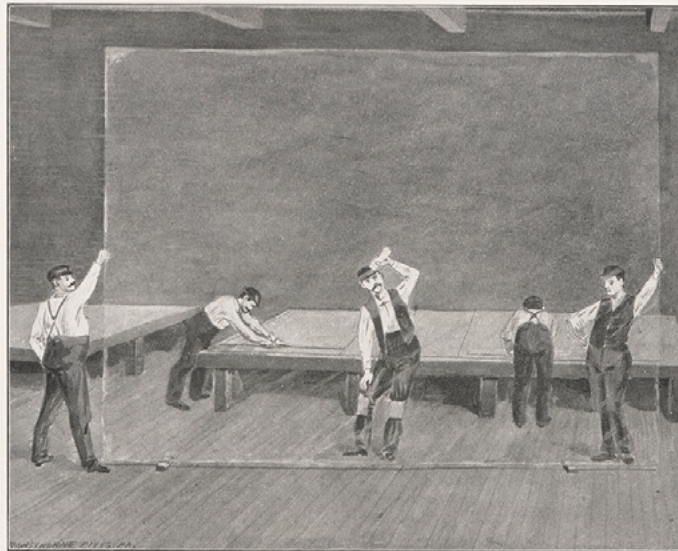


fig. 6a



EXAMINING THE FINISHED PLATE FOR DEFECTS AND CUTTING PLATE GLASS.

fig. 6b



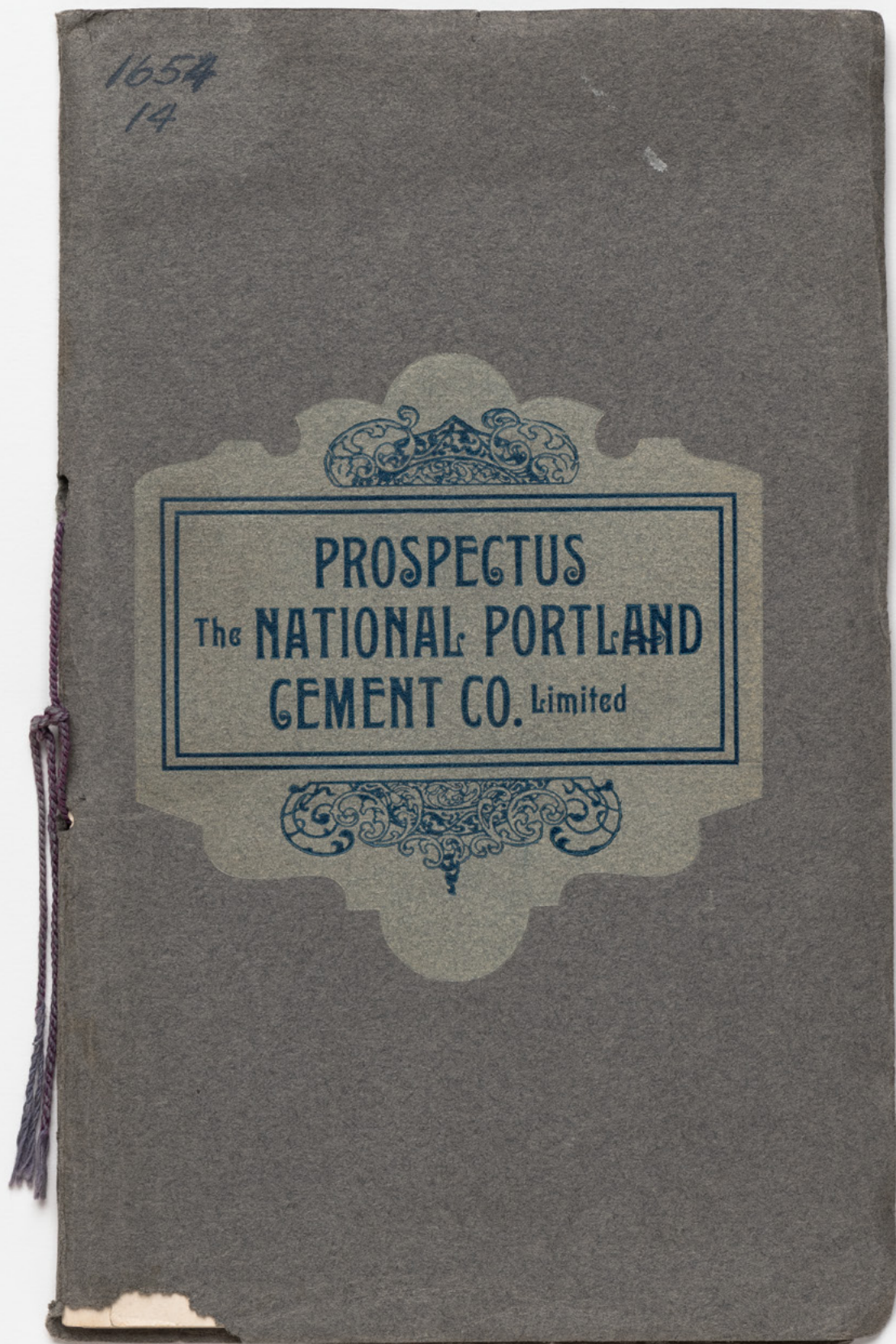


fig. 7a



"To the people of Ontario and those who may become interested in The National Portland Cement Company Limited," 27 March 1901, in *Prospectus: The National Portland Cement Co. Limited*, 12. CCA, Franklin Institute Trade Catalogue Collection, ID:88-B7252. © Australian Portland Cement Ltd

Durham, March 27th, 1901.

To the people of Ontario and those who may become interested in  
The National Portland Cement Company Limited.

Gentlemen:-

For some time it has been well known by citizens of our town that there is located, almost at our door, a large deposit of marl and clay suitable for the manufacture of a high grade Portland Cement. Our leading citizens have from time to time discussed the advisability and the feasibility of organizing a company for the purpose of utilizing this rich material. With this object in view hundreds of samples have been taken from different locations and depths over the entire deposit, and submitted for analysis to some of the most eminent chemists of the Province and elsewhere including the Provincial Assayer, Mr. J. Walter Wells, the results of which prove beyond a doubt that our material is of exceptional purity and value. The report of eminent engineers and chemists who have made a personal investigation of the property, show not only the value of the material, but that it covers an area of several hundred acres, and is of great depth, running from twenty to sixty feet deep, and is of sufficient quantities to operate a thousand barrel per day mill for centuries.

With reference to the mill site, the raw material is also exceptionally advantageously located, it being about two hundred feet above the level of the factory site, which will render it practicable to convey the raw material from its resting place to the factory cheaply and conveniently.

To be doubly sure, our citizens recently invited a noted staff of cement engineers to visit our property and make a thorough examination of our raw materials, water powers, mill site, etc. After receiving their reports steps were immediately taken which resulted in the organization of the Company now known as The National Portland Cement Company, Limited. The leading men of our town assisted in the organization of the Company, and as an evidence of our faith in the enterprise have guaranteed a free mill site, and exemption from taxation (except school tax) for a period of ten years, and the citizens of Durham have subscribed for upwards of \$100,000 of its capital stock. We invite the people of Ontario and especially the prospective investors in this large and growing industry, to visit our town and a committee of our citizens will be pleased to show them the property, and assist them in any way possible to thoroughly investigate our materials, and the truth of our claim.

Yours very truly,

D. Jamieson, M.P.P.      *Chas. Ramage*  
*Wm. McKeen, Ex. M.P.P.*      *Pub. Review*  
*W. B. Alder, Mayor*      *W. Campbell, I.P.S.*  
*W. Laidlaw, Ex. Mayor*      *Jake Striss*  
*Thos. Allan, Pres. N.S. School*      *William Caldwell*  
*H. B. Barker*      *Timothy Moran*  
*W. Irwin, Publisher Chronicle*  
*Con. Newspaper*  
*Wm. H. Anderson*  
*Dr. R. F. Sluey*      *J. W. Crawford*  
*John W. Agnew*      *Arthur H. Jackson*  
*Neil McKeen*



One of the V

fig. 7b





fig. 8a



CLASSIFICATION 9  
HANDRAILS AND BALUSTERS

SECTION NUMBER	SECTION FACTOR	ALCAN ALLOY	WEIGHT LB/FT	SECTION NUMBER	SECTION FACTOR	ALCAN ALLOY	WEIGHT LB/FT	SECTION NUMBER	SECTION FACTOR	ALCAN ALLOY	WEIGHT LB/FT
51010	7	505 655	0.582	51001	6	505 655	0.606	51006	11	505 655	0.582
51011	10	505 655	0.715	51003	10	505 655	0.778	51007	11	505 655	0.866
51004	7	505 655	0.759	51002	6	505 655	0.846	51012	12	505 655	1.39
51000	5	505 655	4.73	51009	6	505 655	0.871				
51014	14	505	0.920	51013	14	505 655	1.23	51008	7	505 655	2.73
51005	1	505 655	6.89	94011	—	505	2.20	94012	—	505	0.700

34.

CLASSIFICATION 9  
HANDRAILS AND BALUSTERS

SECTION NUMBER	SECTION FACTOR	ALCAN ALLOY	WEIGHT LB/FT	SECTION NUMBER	SECTION FACTOR	ALCAN ALLOY	WEIGHT LB/FT	SECTION NUMBER	SECTION FACTOR	ALCAN ALLOY	WEIGHT LB/FT
94014	—	505	2.00	94013	—	505	1.58	51018	4	505 655	0.810
51015	7	505 655	0.814	51017	7	505 655	0.439	51016	6	505 655	1.07

35.

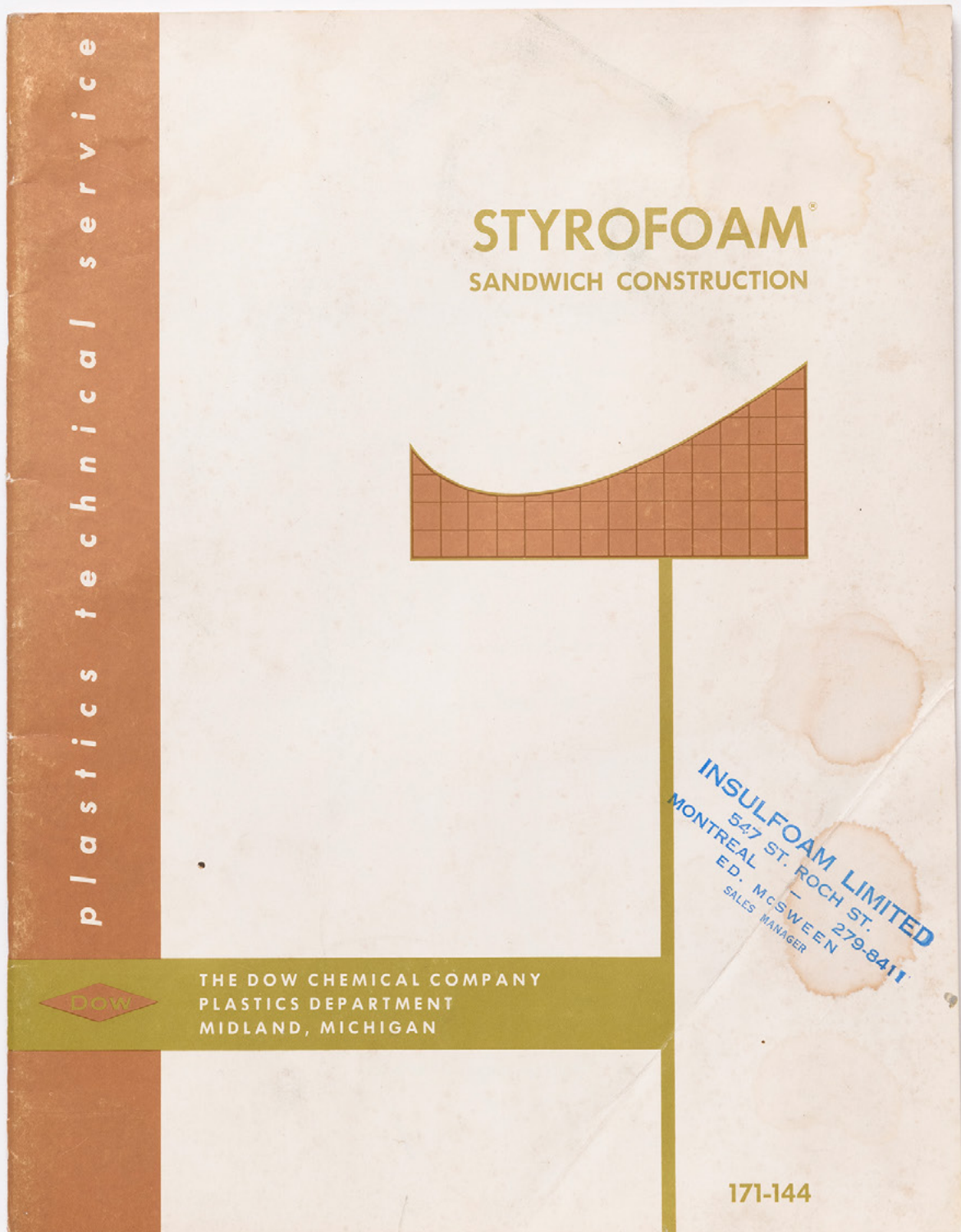


fig. 9a





**ARDEN FARMS PANELIZED  
REFRIGERATED ROOM**  
PANEL DESIGN AND FABRICATION:  
BESTEEL COMPANY  
LA PUENTE, CALIFORNIA  
LOCATION: SAN FRANCISCO,  
CALIFORNIA



This refrigerated room by Arden Farms Co. is an excellent example of good engineering and refrigeration design.

The 22' x 48' x 9' room operates at  $-20^{\circ}\text{F}$ . To efficiently maintain this temperature 8" of Styrofoam was used as core in both structural roof and wall panels. No wood sleepers, splines or metal connections between facings are utilized.

Panels fabricated by Besteel for this type of installation come in widths of 16", 24" and 32". Standard roof panels utilizing 4" to 8" of Styrofoam as core are designed for clear spans of 16' to 27'. Epoxy adhesives are used to bond available facings of galvanized steel, aluminum or stainless

steel to the Styrofoam core. Baked enamel finishes can also be obtained. Designs vary with temperature requirements—sub-zero, zero or above zero.

This type of panelized structure is suitable for either indoor or outdoor service. Rooms in service are easily enlarged or dismantled for moving. On site labor costs for either erection or dismantling are low. The use of one or more roof supports in conjunction with panels over clear spans up to 27' allows erection of larger buildings in essentially any width required,—50', 75', 100', etc. The length of the building has no limit and is determined by the number of panels utilized.



B. Marcuse, *Asbestos* — “*Pierre à Coton*” (Montréal: Canadian Asbestos Company, 1931), cover. First published in *Canadian Geographical Journal*, no. 10 (October 1930). CCA, Franklin Institute Trade Catalogue Collection, ID:89-B8309. © Mazarin / Asbestos. All rights reserved.

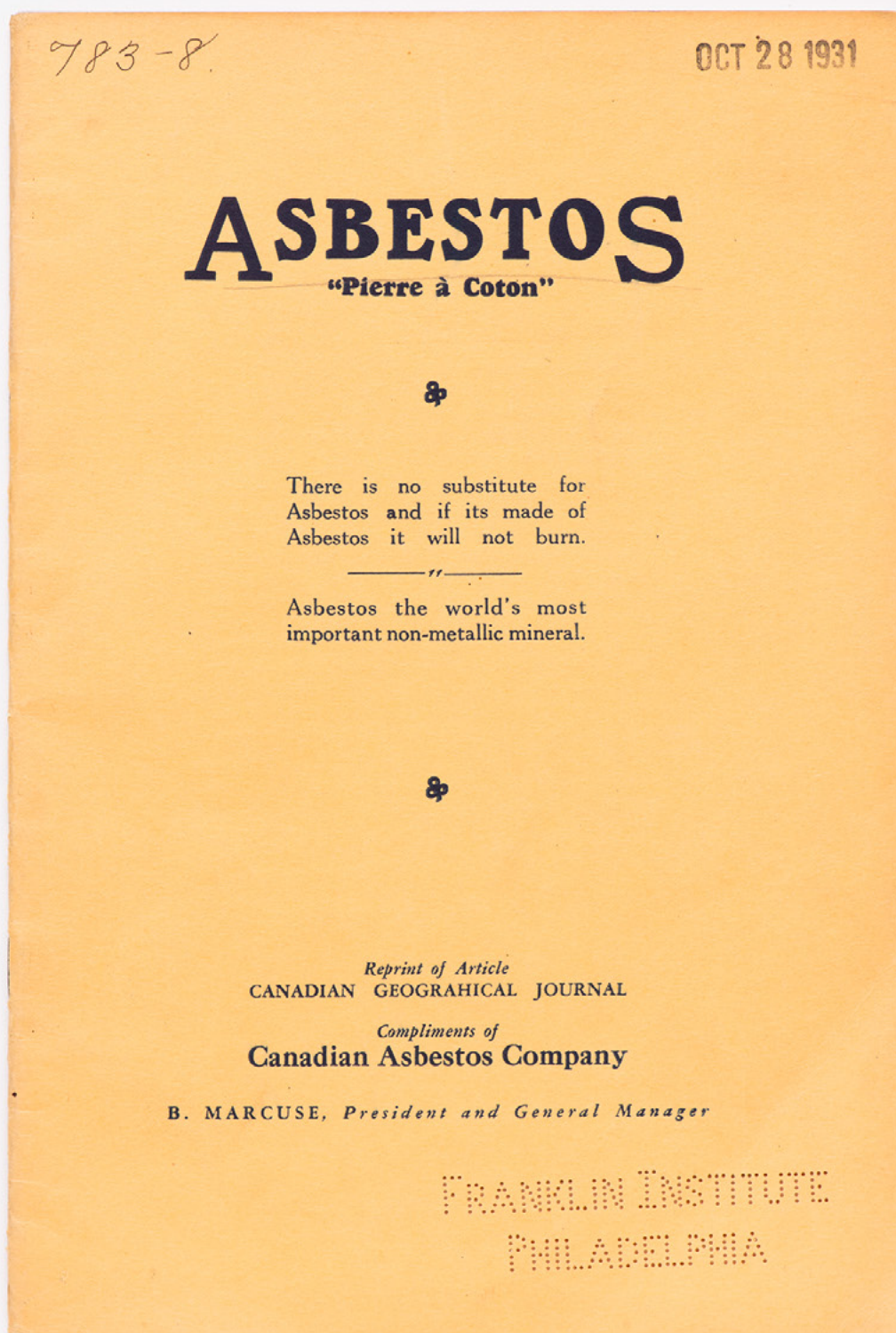


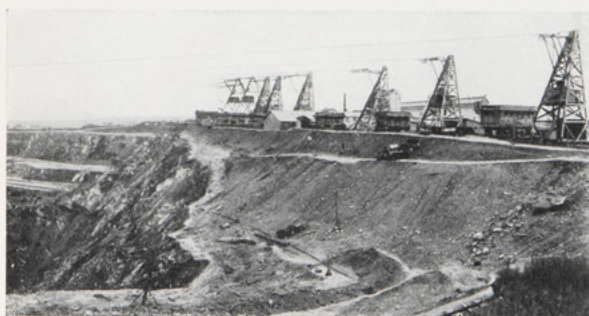
fig. 10a



A panoramic view of the vast amphitheatre of the Canadian Johns-Manville mine at Asbestos, which covers an area of 50 acres. It is a shallow mine, and constantly extends as the terraces are cut further back into the rock. Portable railway tracks are laid along the terraces, and dump trains move the broken rock from terrace to mill. When a new terrace is blasted the tracks are moved into the "face". A machine called a "track mover" is gripped to a length of track and in a few minutes it moves the track to the new position, lifting it about two feet at a time, ties and all. In the dim distance, near the centre, is seen a church steeple, a land-mark of the village of Asbestos, which is on the edge of the mine and is gradually being pushed



further away by the growth of the mine in its direction. Below is the Asbestos Corporation pit at Thetford Mines. It is a deep mine, being 450 feet from the surface, with the sides rising steeply. The method of moving rock from the working "face" here is by "scoops" which are first hoisted vertically to cable-ways, and then drawn horizontally along the cables to the cable stations, from which dump trucks take it to the mills. This is the greatest cable-way system in the world having a length of 1,400 feet between derricks, and being capable of lifting over 7,000 tons of rock every working day. The Bell pit is seen in the distance.



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