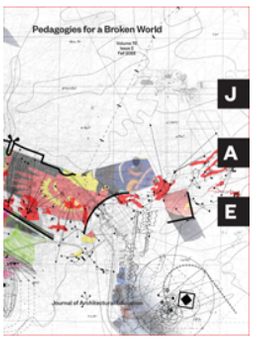

Routledge
Taylor & Francis Group

Journal of Architectural Education

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/rjae20

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A Broken Geological Paradigm

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To cite this article: Cristina Parreño Alonso (2022) The Builtsphere, Journal of Architectural Education, 76:2, 126-136, DOI: 10.1080/10464883.2022.2097530

To link to this article: https://doi.org/10.1080/10464883.2022.2097530

The Builtsphere
A Broken Geological Paradigm

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This essay discusses the role that architecture plays as a new geological paradigm. Similar to the way geologist Peter K. Haff conceived the technosphere as "the proliferation of technology across the globe," this essay defines the builtsphere as the proliferation of everything built across the planet and proposes both—the technosphere and the builtsphere—as subsystems of the anthroposphere. This essay illustrates this way of thinking architecture with a pedagogical experiment developed as a design studio that takes issue with the various ways in which the builtsphere has caused the breakdown of the Earth cycles.

Since the concept of the "black box" was first attributed to two port networks by mathematician Franz Breisig in 1921, the black box theory has been widely applied to philosophy and science.[1] In his 1963 essay, "A General Black Box Theory," philosopher and scientist Mario Bunge describes the black box as a "fiction representing a set of concrete systems into which stimuli *S* impinge and out of which reactions *R* emerge," explaining that "the constitution and structure of the box are altogether irrelevant to the approach under consideration."[2] A few years later, Bruno Latour elaborated on the concept of *blackboxing* as the "process that makes the joint production of actors and artifacts entirely opaque." The concept is illustrated with the example of a projector that, when working properly, is a "silent and mute intermediary, taken for granted," becoming visible only when it breaks down.[3] While the *phenomenon of malfunction* "reminds us of the projector's existence," *the acts of the repairmen* are what reveal that "the projector is made of several parts, each with its role and function." In other words, it is the act of reparation that releases the epistemic power of the breakdown, by displaying the object as a set of actors and actions.

But if the real potential of the breakdown is only released in the act of reassembly, what happens when repairability is seen as an increasingly outmoded virtue by a society that has become more inclined to throw something away than to repair it? In today's culture of planned obsolescence, we not only design technology to fail prematurely, but we also prioritize compactness and efficiency over repairability. While certain agents and actions were activated yesterday to repair what was broken, others are put in motion today to ensure that the malfunctioning object is swiftly replaced. These acts of replacement respond to a desire for smoothness—the same desire that keeps things hidden in order to avoid friction. Replacement wears the mask of the effortless, concealing all actions, actors, processes, and flows of material, energy, and labor. Replacement displaces the critical role these actors and actions serve in the correct functioning of the object itself. Replacement is a violent abstraction that externalizes everything that is uncomfortable, keeping it beyond our perception by locking it inside the black box. It perpetuates existing hegemonic forces and power structures by keeping them hidden and deliberately unknown.

Repair and reparation are born of other desires. They come from a willingness to struggle, to face friction and conflict: from the courage to confront and to overcome. To repair requires a profound desire to know and to translate knowledge into "subtle acts of care."[4] This "care" is, in the words of professor of women's studies and political science Joan Claire Tronto, "everything that we do to maintain, continue, and repair 'our world' so that we can live in it as well as possible. That world includes our bodies, ourselves, and

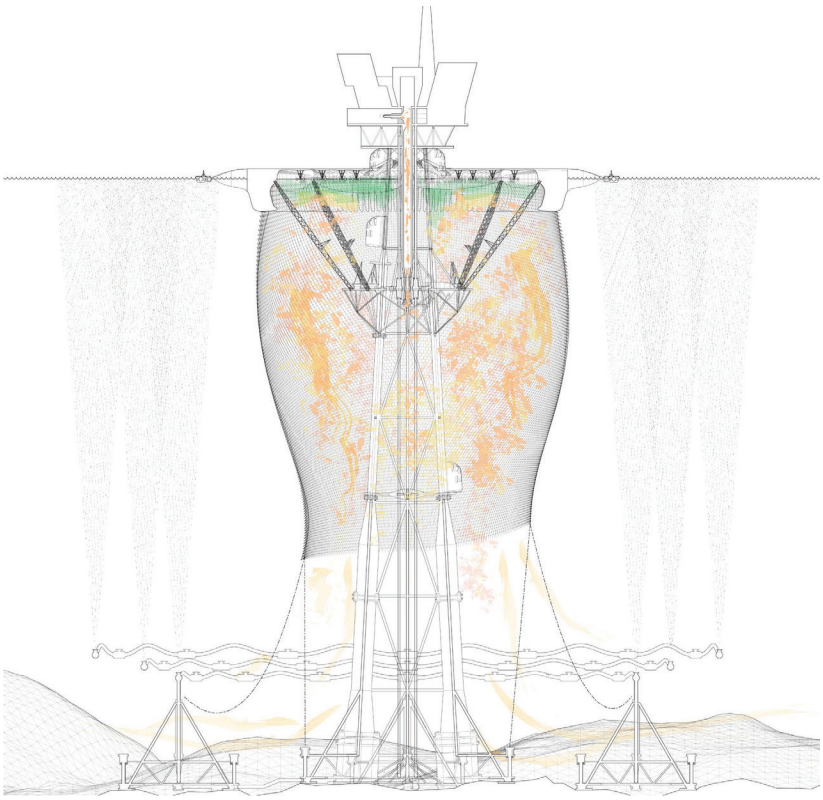

Figure 1. Daniel B. Griffin, Carbon Collective.

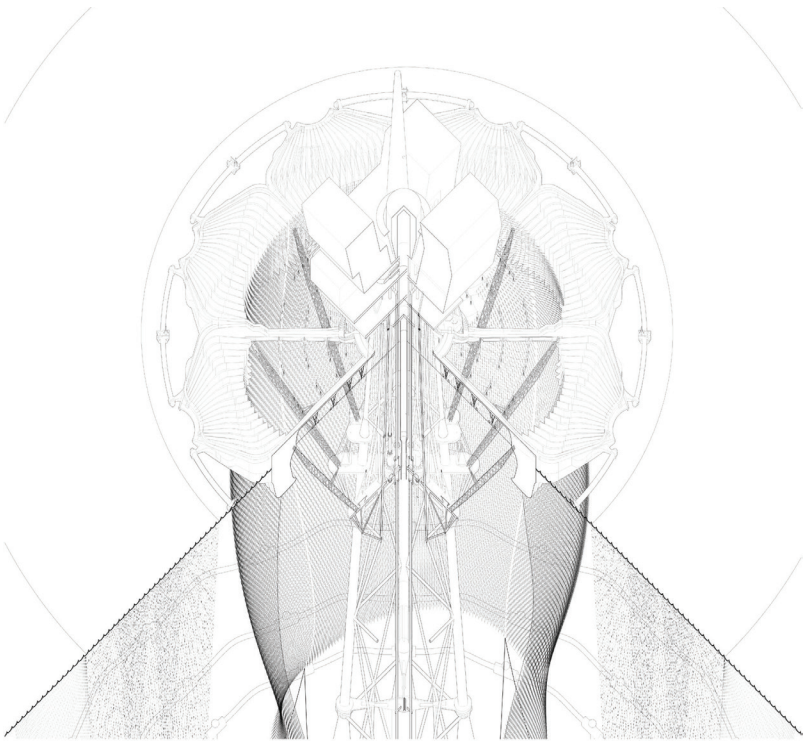

Figure 2. Daniel B. Griffin, Carbon Collective.

our environment, all of which we seek to interweave in a complex, life-sustaining web."[5] Whether it is for us to live "as well as possible" or for other philosophical-ethical reasons, the realization that we need to "care for our world" seems to be surfacing, at last, today in different forms and with a much-needed sense of urgency. And yet, paradoxically, it may be this very sense of urgency— to care for our world— that is preventing us from seeing all the ways in which our world takes care of us. We cannot see all the ways in which our planet "embodies the traditionally maternal value of 'care,'" or all the ways in which the Earth behaves as "a self-regulating complex system that works to perpetuate the conditions for life on the planet."[6] We cannot see all the ways in which we have *not* been taking care of our world, and much worse, we have been actively *preventing* our world from taking care of us. Indeed, we cannot see any of this because we have placed it all in a planetary big black box.

Our planet's marvelous infrastructure of care has been called the Earth System, and has traditionally been subdivided into four main geological paradigms: geosphere, atmosphere, hydrosphere, and biosphere.[7] Each of these systems is characterized by four common traits whose correct functioning is essential for world-care and self-repair: (1) far-reaching dynamics, (2) interconnection with other spheres, (3) autonomy of operations, and (4) appropriation of resources sustained by cyclical activity.[8] The complexity of the interconnections that makes the system work in balance is also its Achilles' heel. It takes only one sphere to break for the entire system to be compromised. None of these older geological paradigms, however, is compromising the planet's health. Instead, a giant baby sphere, born broken, has begun to shift the Earth out of its equilibrium. In the nineteenth century, Austrian geologist Eduard Suess introduced

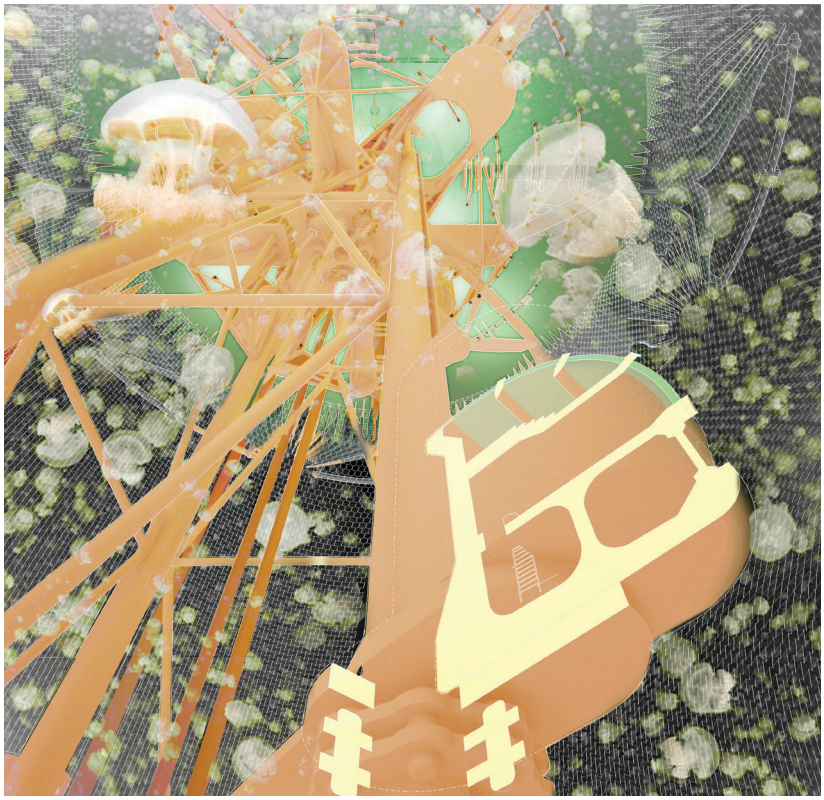

Figure 3. Daniel B. Griffin, Carbon Collective.

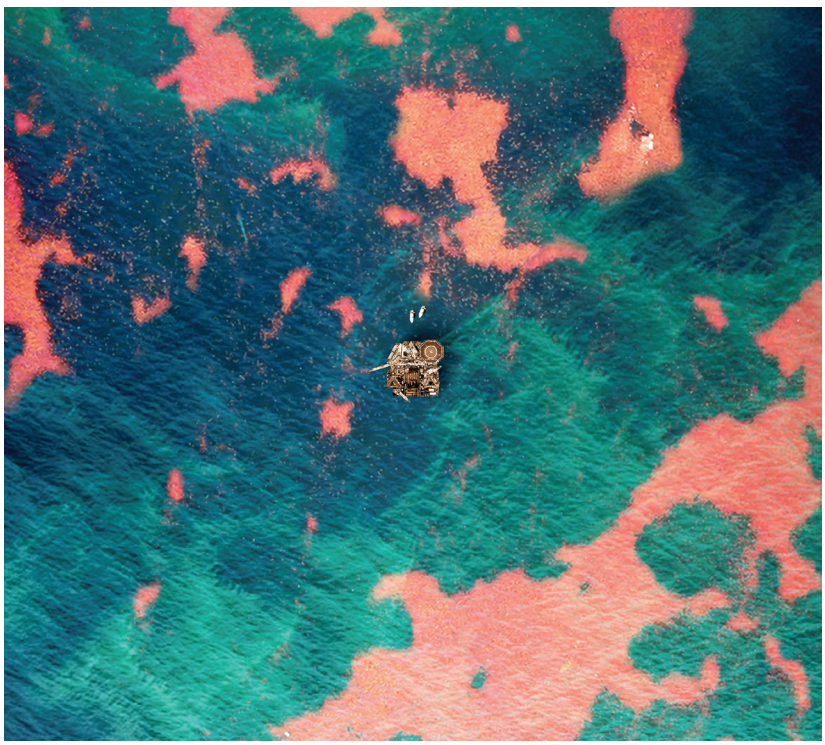

Figure 4. Daniel B. Griffin, Carbon Collective.

it as the *anthroposphere*, "the total mass of human-generated systems and materials, including the human population."

Like the older spheres, the anthroposphere operates through a series of subsystems.[9] Similar to the way geologist Peter K. Haff conceived the technosphere as "the proliferation of technology across the globe,"[10] we could define the builtsphere as the proliferation of everything built across the planet; and we could see both—the technosphere and the builtsphere—as subsystems of the anthroposphere. The emergence of the builtsphere as a new geological paradigm in its own right reveals architecture as an activity that affects and is affected by the Earth System and opens to new ways of looking at the entanglement between architecture and the development of life on Earth.

There are two characteristics that differentiate the builtsphere—and every other subsystem of the anthroposphere—from older geological paradigms. First, the builtsphere's cyclical activity does not function properly[11] and, as a result, any other sphere that the builtsphere interacts with—essentially all of them—emerges from this exchange with broken cycles. The second unique characteristic of this geological paradigm is a new, unprecedented level of complexity by which the builtsphere becomes "aware, through its human components, of the essential contribution to its own existence of the support provided by established paradigms."[12] This capacity of awareness brings us closer to what psychiatrist and philosopher Karl Jaspers coined "epochal consciousness," which emerges when "man not only exists but knows that he exists. In full awareness he studies his world and changes it to suit his purposes. He has learned how to interfere with 'natural causation.'"[13] Jaspers articulated the concept of *epochal consciousness* at a time of a

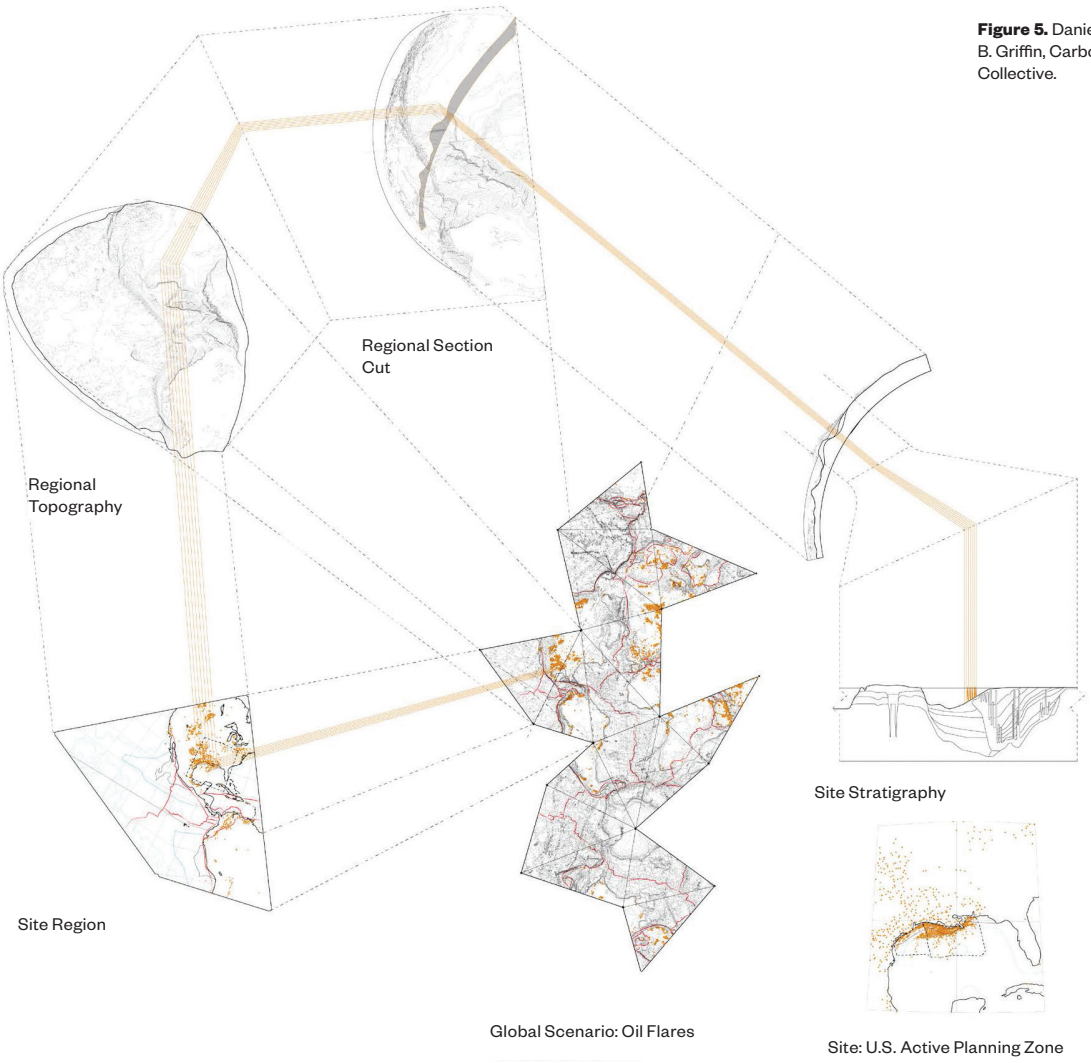

Figure 5. Daniel B. Griffin, Carbon Collective.

nuclear holocaust menace in the mid-twentieth century. At that time, he said: "An altogether novel situation has been created by the atom bomb. Either all mankind will physically perish or there will be a change in the moral-political condition of man."[14] As historian Dipesh Chakrabarty points out, we could "replace 'the atom bomb' with 'global warming,'"[15] but also, I would add, with any other adversity caused by the malfunctioning of the builtsphere. Chakrabarty considers Jasper's epochal consciousness to be fundamentally ethical: "It is about how we comport ourselves with regard to the world under contemplation in a moment of global—and now planetary—crisis."[16] In the culture of replacement, "how we comport ourselves," is a state of denial, insistently suffocating any desire to know by pushing the planet—and all its crises—into a smooth, frictionless black box, a smoothness that some still believe will be found on Mars, or some other replacement planet.

When grand moments of epochal consciousness emerge in a culture of care, they bring a new level of awareness that comes with a deep capacity for appreciation. Epochal consciousness in architecture translates into a recognition that *its practice will always affect and be affected by the Earth System*. In order to open the architectural black box, we need to embrace a process of expanding its timeframes of perception and to develop new vantage points to rethink architecture's agency in the current constellation of human and environmental crises within the larger context of the deeper history of this planet. To open the black box in architecture in a moment of epochal consciousness is to reveal the new planetary dimensions of the builtsphere by which the agent of architecture expands, becoming "a complex formation that involves humans and more-than-humans"[17]—from the technologies involved in the production of a building, for instance, to the geological substrate that supports it.

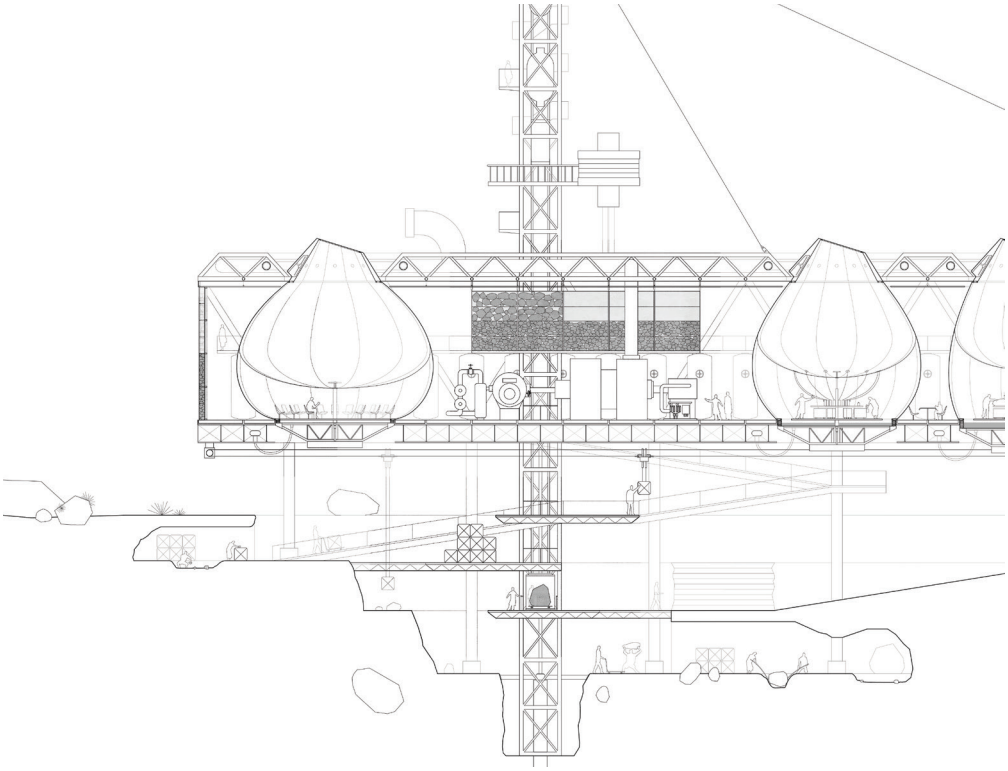

Figure 6. Carolyn Tam, Journey to the Center of the Earth.

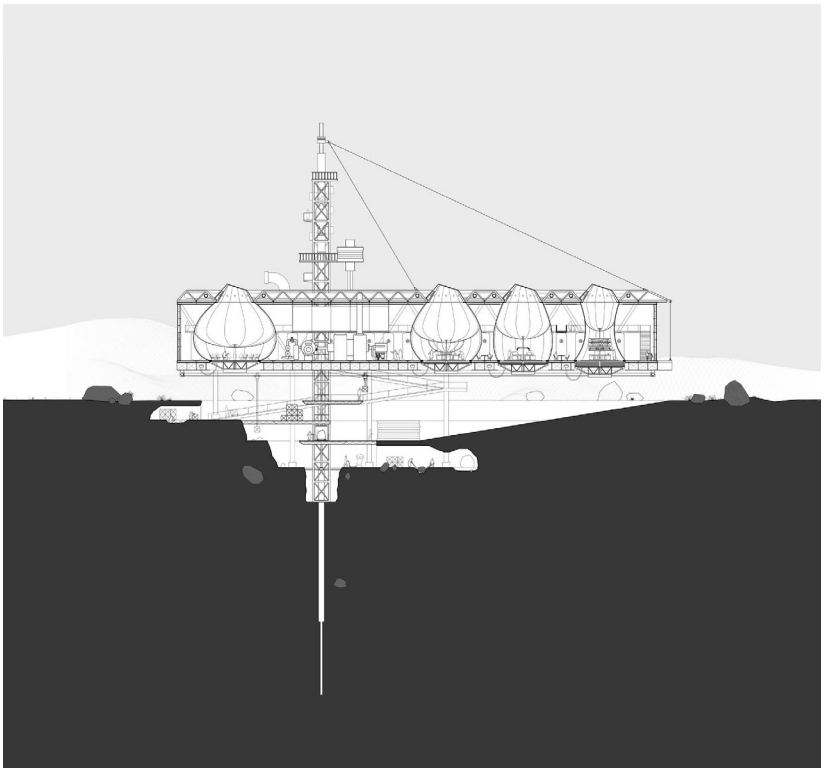

Figure 7. Carolyn Tam, Journey to the Center of the Earth.

Teaching architecture in the context of a new epochal consciousness requires novel pedagogical strategies and wider methodological frames. A design studio called Carbon to Rock[18] was an experiment with this pedagogical approach, which I developed and taught at MIT's Department of Architecture in the Spring of 2020. The studio emphasized the formulation of new conceptual vocabularies to make it possible to conceive architecture as a new geological paradigm. To this end, the studio was a collaborative effort with the Department of Earth, Atmospheric and Planetary Sciences at MIT which allowed students to situate architecture as entangled with the deep history of the planet. Students explored speculative scenarios where architecture would cease being the source of planetary malfunction, and become, rather, an enabler of Earth's self-reparation. To highlight several examples:

- *Carbon Collective* (Figures 1, 2, 3, 4, and 5), a project by Daniel B. Griffin, envisioned a future when the maritime industrial efforts of humans are instead redirected into productive, alternative ecologies. Here, instead of drilling for oil to burn and release carbon into the atmosphere, the 4,000 active offshore platforms in the Gulf of Mexico are decommissioned and converted into jellyfish habitats in order to help address the issue of ocean dead zones. The harmful ecological conditions characterized by low oxygen levels are isolated to preserve marine life in the ocean at large. The project harnesses the unique opportunities that dead zones provide for algae and jellyfish to thrive, which in turn enlarges the volume of biomass acting as vessels for sinking carbon into the ocean.
- *Journey to the Center of the Earth* (Figures 6 and 7), by Carolyn Tam, was situated at the intersection of the lithosphere and the atmosphere. The project investigated new, cutting-edge technologies that have radically shortened the timespans that turn CO2 into basalt. Carolyn envisioned a future where deep-drill technology would be implemented worldwide to access geothermal energy at hotter temperatures. The CO2 produced would be captured and dissolved into large volumes of water that would then be injected 400 meters deep into the basalt substrate. She explored these new artificial manipulations of the geological timescales of the carbon cycle, rethinking igneous rocks as a new resilient material for high-carbon-capture architectures.
- *Travel Fiction* (Figures 8, 9, 10, and 11), by Ana McIntosh, explored the way air travel is disrupting the carbon cycle and speculated on a moment in 2050 when commercial air travel is suspended worldwide. In design response, a new option for air travel emerges with a ground facility and travel experience that does not release additional greenhouse gases into the atmosphere. Balloons attached to hermetically sealed travel pods use hydrogen to propel themselves in the air at selected sites located underneath jet streams 9 to 16 kilometers up in the atmosphere. As masses of warm and cool air collide, pockets of fast-moving air can average 180 km/hr. Once the balloons reach these pockets, they are propelled to a new location without the use of fuel.
- And *On the Horizon* (Figures 12, 13, and 14), by Jitske Swagemakers, was a proposal for river deltas that aimed to protect marine life and purify water before it enters the ocean. The intervention would enhance carbon sequestration, deploying the natural flow and network of the rivers in a transition toward more ecologically-friendly industry. The project consisted of a series of floating seaweed farms folding or expanding mechanically depending on the eight-month growth cycle of seaweed, assisting in wastewater treatment and the reestablishment of ecological habitats. The seaweed farms would provide a vertical structure and habitat complexity to the water altering the physical environment by modifying wave strength, and therefore, influencing water flow and associated processes of sedimentation and production. The project was designed to create a linear dispersal corridor from the river to the sea providing shelter, food, and nursery grounds for many organisms. With a focus on wastewater treatment with seaweed, the architecture of the project was informed by the constraints of the plant cycles that drive the CO2 capture and the extraction of nutrients.

Builtsphere Pedagogies

The gaps at moments of planetary breakdown hold vital pedagogical potential. Those moments reveal important agents and actions involved in the Earth System, and also present opportunities for intervention in the builtsphere with strategic acts of reparation that might assist processes of planetary healing.

The potential of this gap—created in moments of breakdown and bridged during the process of healing—has been theorized in multiple fields. In 1978, the Soviet psychologist Lev Vygotsky used the notion of this gap to describe the distance between what a learner can do without assistance and what

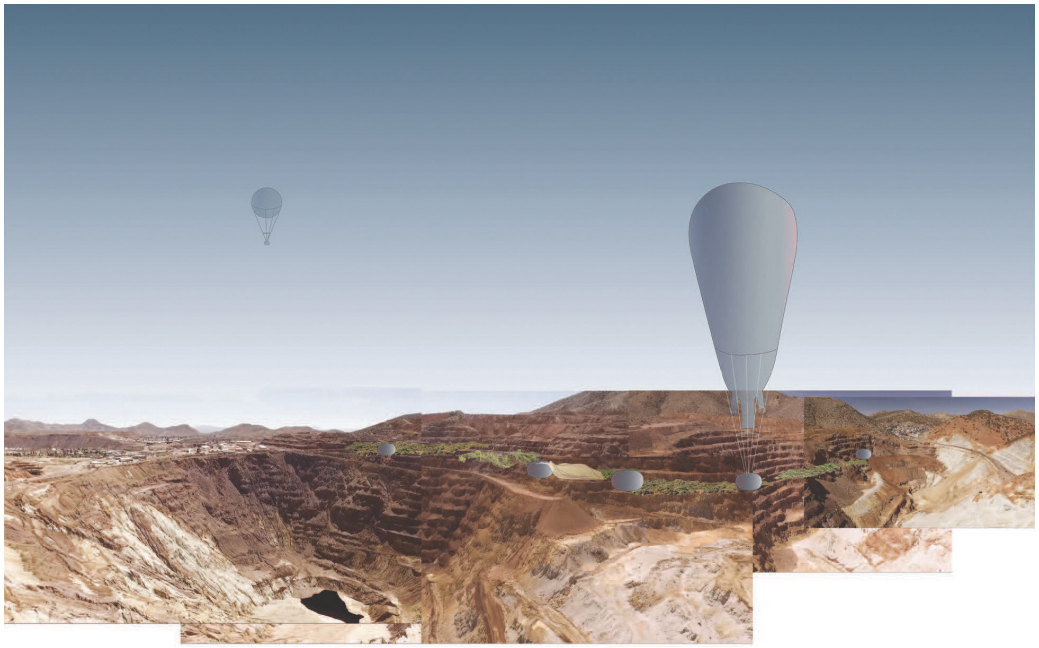

Figure 8. Ana McIntosh, Travel Fiction.

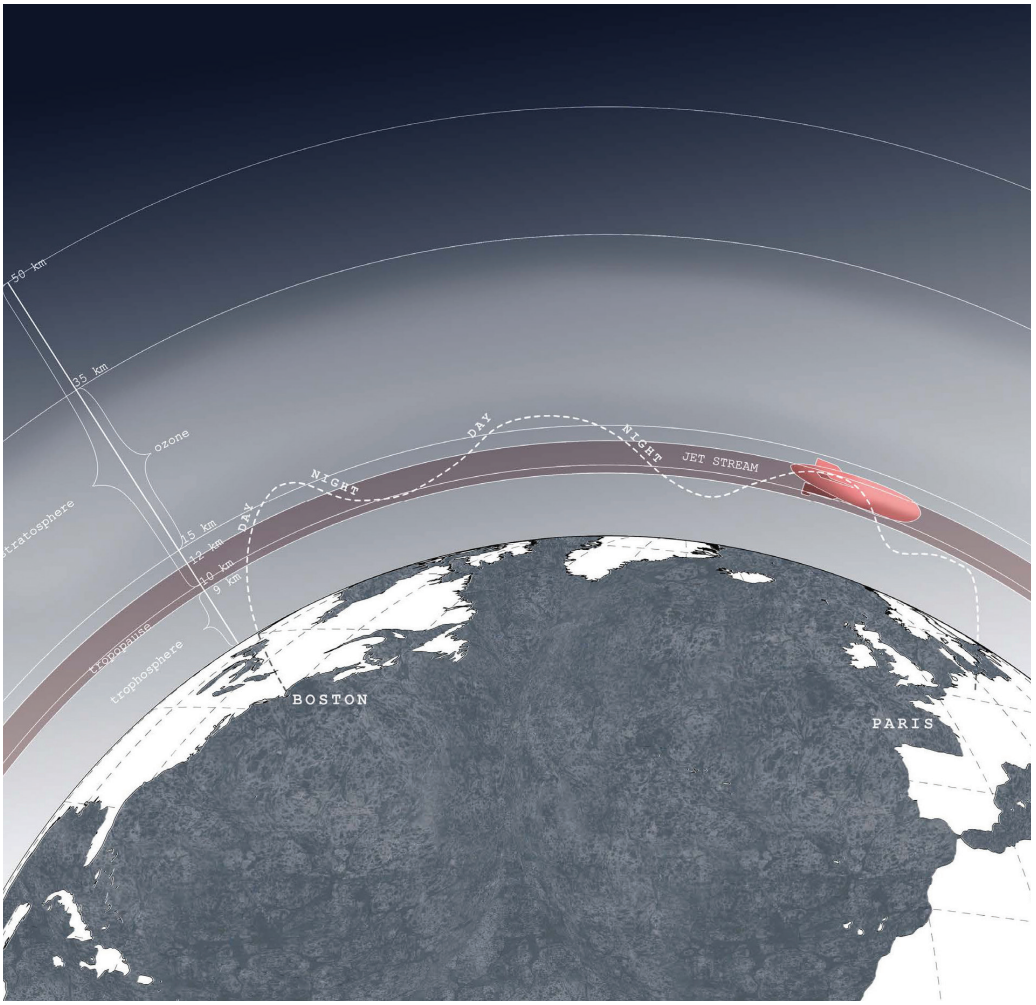

Figure 9. Ana McIntosh, Travel Fiction.

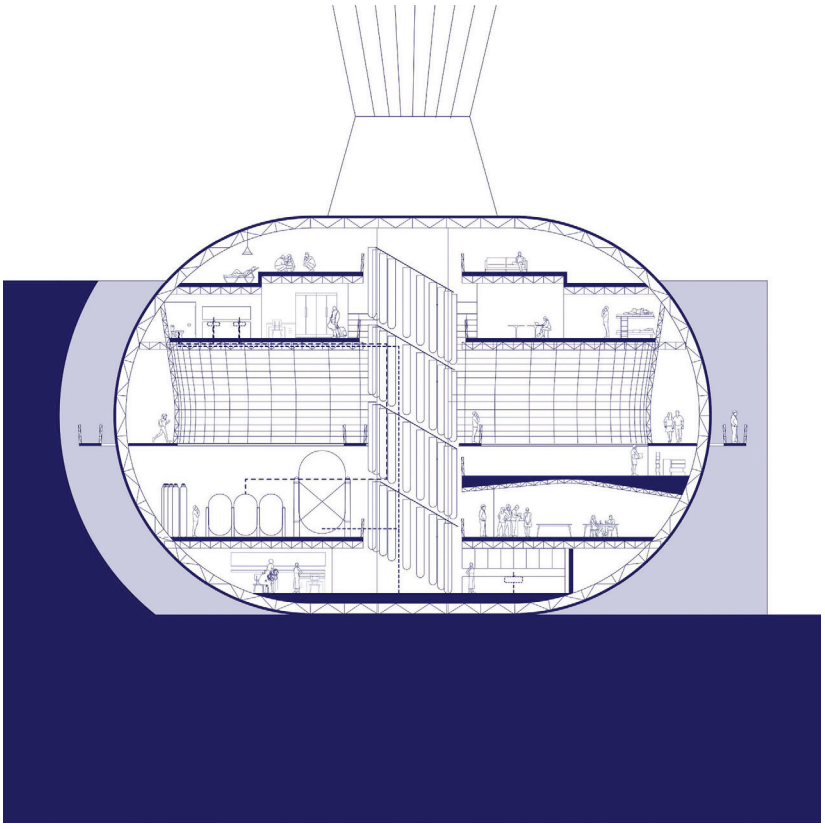

Figure 10. Ana McIntosh, Travel Fiction.

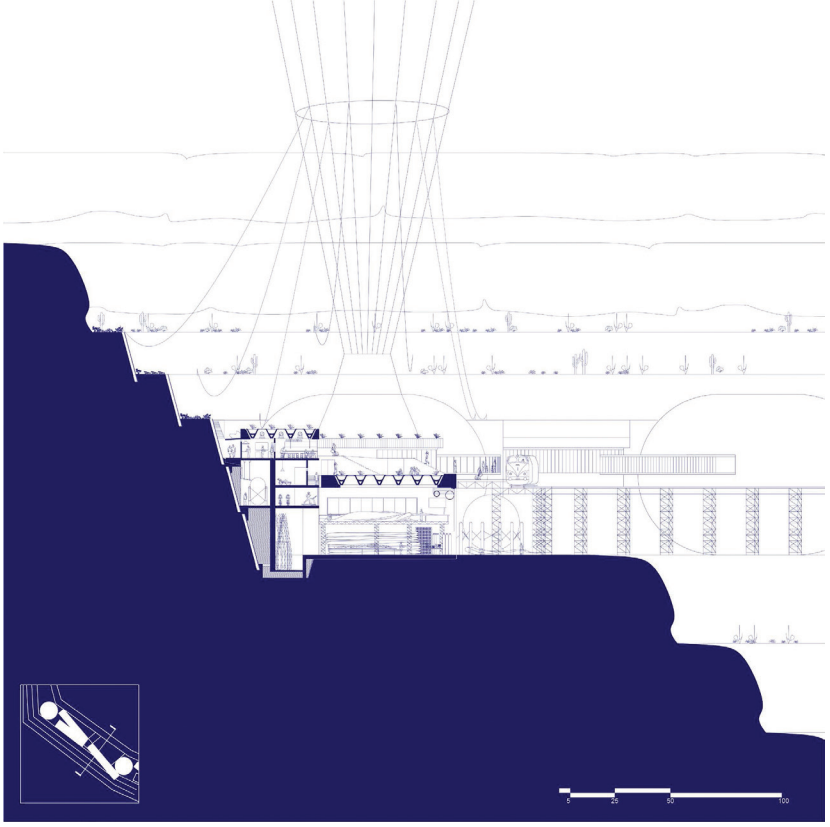

Figure 11. Ana McIntosh, Travel Fiction.

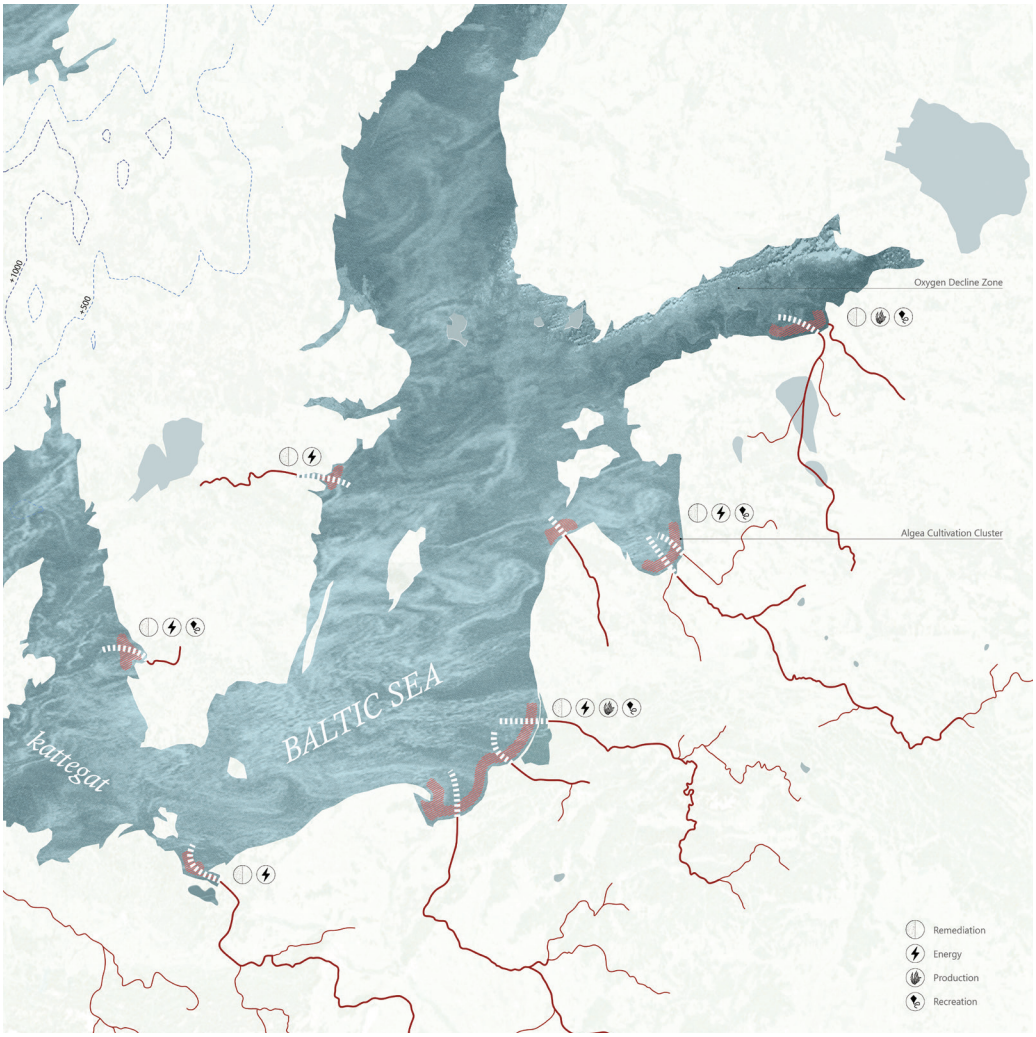

Figure 12. Jitske Swagemakers, On the Horizon.

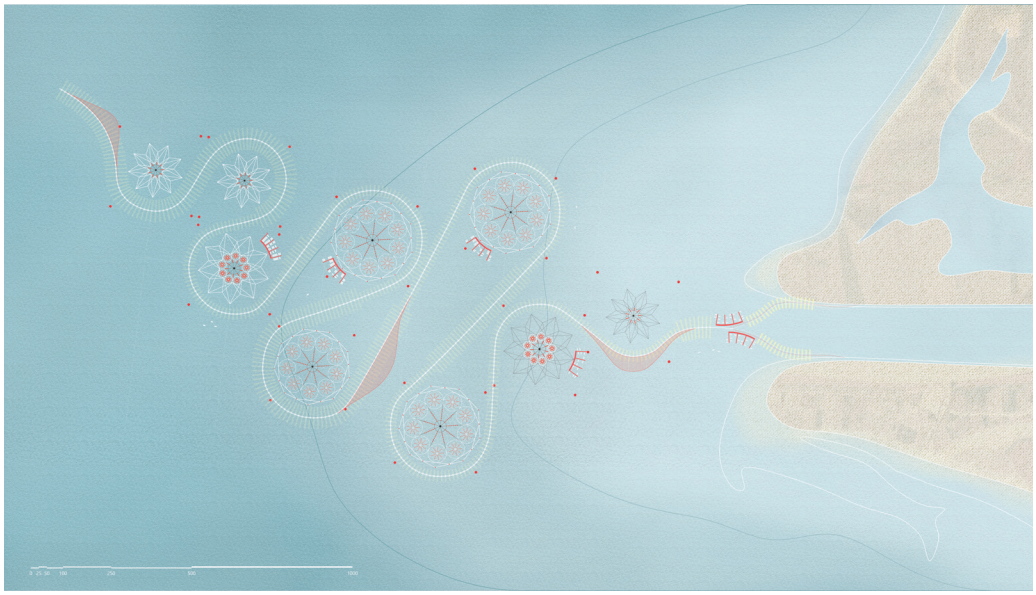

Figure 13. Jitske Swagemakers, On the Horizon.

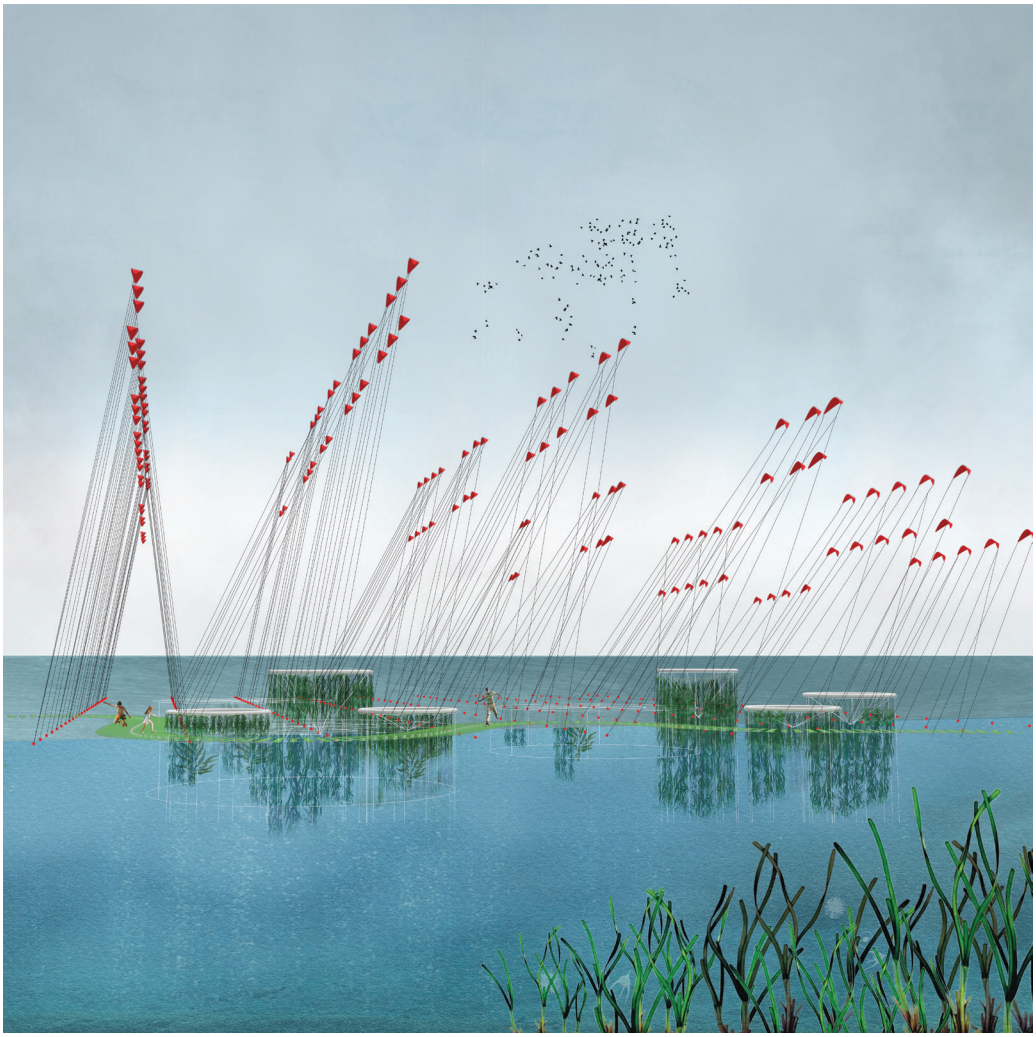

Figure 14. Jitske Swagemakers, On the Horizon.

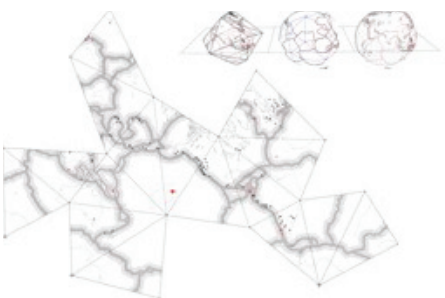

Figure 15. Igneous Dymaxion World Map Deltahedron (16 faces).

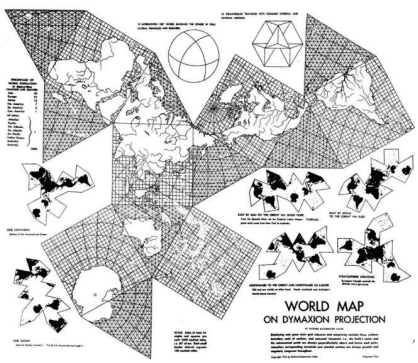

Figure 16. Dymaxion World Map Icosahedron (20 faces).

a learner can do with guidance, or in collaboration with more capable peers—a generative pedagogical space he called "the zone of proximal development."[19] This insight also informs theories developed by cognitive scientists like Heinz von Foerster, whose "Principle of Undifferentiated Encoding"[20] describes perception as the function of crossing the gap that exists between the environment and the subject—the epistemological gap—in a process of computing that is also an act of "worldmaking."

The design process is very much about finding new ways of crossing the epistemological gap from zones of proximal development. From this zone, the Carbon to Rock studio group engaged with ways of conceiving architecture's relation to the Earth. In doing so, we hoped to transcend the scale of the global, in order to bring the scale of the planetary, instead, forward.[21] The class, as a group, developed the Igneous Dymaxion (Figure 15), a new world map projection designed to keep the representation of political boundaries in the background. The Igneous Dymaxion foregrounded, instead, the geological fractures where the Earth's crust breaks into eight main tectonic plates. The map was inspired by Buckminster Fuller's icosahedron, (Figure 16) but developed instead by the unfolding of an irregular sixteen-face deltahedron where each of the faces was designed to project the intersections between tectonic faults.

The Igneous Dymaxion aimed to create a productive estrangement from the planet, to undo preestablished modes of representation in order to produce new ways of seeing. Here, the disclosing potential of the breakdown is closer to the context of the black box theater, where the breaking of the fourth wall produces a moment of defamiliarization. There is a rupturing of preconceived ideas in what Bertolt Brecht coined "the alienating effect," whose pedagogical potential emerges as the audience tries to put the pieces back together in their minds. The Carbon to Rock studio sought to develop the tools to think architecture in deep time. It aimed to harness the potential of the spaces left by fractures: in Earth Cycles, in the Earth's Crust, in our ways of perceiving the environment, in architecture's relation to the planet.

Author Biography

Cristina Parreño Alonso is an architect, designer, and educator at the School of Architecture and Planning at the Massachusetts Institute of Technology, where her research, Transtectonics, explores expanded timescales of architecture in the age of the Anthropocene. She is the director of her eponymous architectural firm. Her work has recently been on view at the Shchusev State Museum of Architecture in Moscow, and she was one of the architects selected to participate in the 2021 Venice Architecture Biennale.

Notes

1 V. Belevitch, "Summary of the History of Circuit Theory," *Proceedings of the IRE* 50:5 (May 1962): 848–55.

2 Mario Bunge, "A General Black Box Theory," *Philosophy of Science* 30:4 (Oct. 1963): 346–58.

3 Bruno Latour, *Pandora's Hope: Essays on the Reality of Science Studies* (Cambridge, MA: Harvard University Press, 1999).

4 In "Rethinking Repair" Steven Jackson defines repair as: the subtle acts of care by which order and meaning in complex sociotechnical systems are maintained and transformed, human value is preserved and extended, and the complicated work of fitting to the varied circumstances of organizations, systems, and lives is accomplished. Steven Jackson, "Rethinking repair" in *Media Technologies: Essays on Communication, Materiality, and Society*, ed. Tarleton Gillespie, Pablo J. Boczkowski, and Kirsten A. Foot (MIT Press Scholarship Online: September 2014.

5 Joan Claire Tronto, "An Ethic of Care," *Generations: Journal of the American Society on Aging* 22:3 (Fall 1998): 15–20.

6 James Lovelock, *The Vanishing Face of Gaia* (New York: Basic Books, 2009), 255.

7 For scientists Tim Lenton and Andrew Watson, Gaia and the Earth system are close to synonymous. Timothy M. Lenton and Andrew Watson, *Revolutions That Made the Earth* (New York: Oxford University Press, 2011).

8 Peter K. Haff, "Technology as a Geological Phenomenon: Implications for Human Well-Being," *Geological Society London Special Publications* 395:1: 301–9.

9 The atmosphere, for instance, is composed of the mesosphere, lithosphere, exosphere, and so on.

10 While I am presenting the technosphere as a subsystem of the anthroposphere, it is important to note that in Haff's view, the technosphere is not a part of the anthroposphere but a more accurate description of the same thing. "If the term 'anthroposphere' is meant to emphasize the role of human beings as causative agents responsible for Earth transformations that define the Anthropocene, the use of 'technosphere' suggests a more detached view of an emerging geological process that has entrained humans as essential components that support its dynamics." Haff, "Technology as a Geological Phenomenon," 301–9 [302].

11 Peter Haff talks about this same problem in relation to the technosphere when he mentions how "the recycling shortcomings of the technosphere with respect to carbon and other essential inputs may make it appear a poor candidate for a new paradigm, especially when compared to the ability of, say, the biosphere to recycle its own waste." Haff, "Technology as a Geological Phenomenon," 305.

12 Haff, "Technology as a Geological Phenomenon," 301–9.

13 Karl Jaspers, *Man in the Modern Age* (New York: Routledge Revivals, 2010).

14 Dipesh Chakrabarty, "The Human Condition in the Anthropocene" (lecture delivered as part of Tanner Lectures in Human Values series, Yale University, New Haven, CT, February 18–19, 2015).

15 Chakrabarty, "The Human Condition."

16 Chakrabarty, "The Human Condition."

17 Cristina Parreño Alonso, "Deep and Shallow Timescales of the Builtsphere," *Log 54: Coauthoring*. May 2022.

18 The studio Carbon to Rock was taught at MIT by Cristina Parreño Alonso in collaboration with Sergio Araya with lectures by geologist Matěj Peč. Teaching assistant: Yuxuan Lei. Students: Ana Alice MacIntosh, Carolyn Tam, Daniel B Griffin, Florence Luyao Ma, Jitske Swagemakers, Lynced Angelica Torres, Melika Konjicanin, and Taylor Lynn Boes. http://4.154.scripts.mit.edu/carbontorock/index.html.

19 L. S. Vygotsky, *Mind in Society: The Development of Higher Psychological Processes* (Cambridge, MA: Harvard University Press, 1978).

20 Heinz von Foerster, "On Constructing a Reality," *Environmental Design Research* 2 (April 1973): 35–46.

21 When discussing *historical time* and *deep time,* historian Dipesh Chakrabarty refers to the planet, which decenters humans and whose timescales relate to the Earth system, and the globe, which is a human-centric construct operating at the shallow timescale of globalization and capitalism. See Dipesh Chakrabarty, *The Climate of History in a Planetary Age* (Chicago, IL: University of Chicago Press, 2021).