Non-Extractive

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On Designing without Depletion

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> *"Like archeology, which is time read backwards, gravel mines are metaphorically cities turned upside down, though urban culture is unaware of its origins and rural birthplaces." –Lucy Lippard* [1]

The raw materials from which our cities are built are extracted from discrete places.

Every city has its pit, and every material its extraction landscape. The city is a complex amalgamation of millions of supply chains, each one moving materials from their sites of extraction, through production lines and factories, along shipping channels and railroads and highways, to construction sites, and to their intended destinations in the assembly of the built environment — each small part eventually making its way into a skyscraper, a rowhouse, a bridge, a public school, a hospital.

When we consider elemental building materials such as stone or brick, the extraction is clearly evident: each brick is made with clay from a specific pit, each stone comes from a specific quarry, the geology and provenance of the material clearly legible and occasionally even named.[2] With wood, too, each tree is cut from a specific forest or woodlot, although the supply chains for wood have grown longer and more opaque as material travels from the forest to the sawmill to the construction site — mixed and blended with other adjacent material streams from within the same "wood basket." Most wood products sold today are impossible to trace back to any specific location — making efforts to buy exclusively sustainably-managed, carbon-smart, or even simply legally harvested lumber nearly impossible.

But contemporary buildings — not to mention cities — are vastly more complex material assemblages. They contain concrete, steel, aluminum, glass, plastics, biobased composites, foams, all kinds of petroleum byproducts, along with myriad electronics and mechanical systems — each product a tangle of materials originating from many sites of extraction, a trail across many landscapes and communities — material transformed and transmuted into its prescribed form and function. Any one of these products contains a mix of raw materials, industrial processes, specialized facilities, and discrete inputs of energy, heat, pressure, and chemistry. A single window unit contains dozens of components, composed of multiple layers of glass and laminate coatings, filled with gas, sealed with silicone and rubber gasketing, held together with stainless steel clips and fasteners, framed in anodized or coated

[1] Lucy R. Lippard, Undermining: A Wild Ride Through Land Art, Politics, and Art in the Changing West (New York & London: The New Press, 2014), 11.

[2] Jane Hutton. "Reciprocal landscapes: material portraits in New York City and elsewhere." Journal of Landscape Architecture 8, no. 1 (2013): 40-47.

aluminum, steel, or wood. These kinds of architectural products may have a clear origin at a specific factory, but to go deeper often means to lose the trail — commodities by definition obfuscate their origins, each unit anonymized and indistinguishable from any other. Yet we know that even commodities and raw materials originate in specific landscapes, and that many of their extraction processes — the mines in particular — irrevocably chew up and alter the earth.[3]

What would it mean to aim for a non-extractive architecture? Is construction anything other than a process of physically moving a substance from one place to another, the transformation of materials into space? Or is the goal simply to extract materials less forcefully and with less trauma — applying an anesthetic of distraction or an ointment of monetary compensation before pulling copper from the pit, the tree from the forest, the coal from the mountaintop?

Perhaps, we can meet our insatiable need for economic development and material consumption through reuse and recovery, forming new cities from the carcasses of the old. Design for disassembly and an emphasis on circular economy practices might eventually close the loop on some material extraction and manufacturing, assuming the logistics of getting the right parts back to the right factories, to be refashioned into other components for other buildings of the future, can be solved and incentivized.

But the economics of waste and labor consistently privilege demolition and disposal over material recovery. Cheap construction, poor design and detailing, and an emphasis on first cost makes thoughtful life cycle thinking difficult. The few materials for which global recycling and recovery are effective and ubiquitous are materials for which the market drives this process — there is money to be made in secondary aluminum, recycled steel, rare earth metals. With plastics, there is far more money to be made by dumping disposable products that cannot be recycled or reused on the market and letting the microscopic particles fall where they may. Moreover, the environmental and social impacts of all materials are not the same. When we think about a non-extractive architecture, what is it that we really care about?

TRACKING THE CARBON

Confronted with the urgency of the climate crisis, perhaps we need to set our targets lower — to shut off the gushing faucet of carbon emissions in building materials, rather than focus on the pure consumption of materials themselves. Perhaps it is more important for us to keep fossil fuels in the ground than to reduce our consumption of bricks or gravel. It may be the case that rather than fixating on recyclability, we ought to be increasing our use of bio-based materials and agricultural waste products, sequestering their carbon in long-lived building materials rather than having them decom-

[3] Stephanie Carlisle and Nicholas Pevzner. "Mangiare la crosta. Paesaggi minerari. [Eating the Crust. Landscapes of Extraction]," Domus 1033 (March 2019): 276-285.

pose out in the fields. Perhaps we need to think of landscapes of ecological production and extraction as potentially working in concert with one another. Radically decarbonizing building materials will be a monumental task, and will require the transformation of nearly every aspect of the design and construction trades. Yet in order to meet global carbon targets and do our part to avoid catastrophic climate change, we know that architecture must decarbonize: it must become net-zero carbon, and must do so quickly.

From sites of extraction, through the myriad supply chains and factories, to all the materials that make up our cities and buildings, architects and engineers will need to track the thin thread of carbon, accounting for it at every step, and systematically eliminating emissions. This will fundamentally change the way we think about materials. Concrete alone accounts for eight percent of global CO2 emissions. Concrete is the most widely used material on earth after water, and a necessary component of nearly all buildings and infrastructure projects. Decarbonizing concrete is difficult, because not only is the bulk of emissions tied to cement, the primary binder in concrete that assures its structural performance, but some of the emissions are also directly tied to the chemical processes of curing concrete itself. To decarbonize cement completely is to completely rethink concrete. For concrete, designers will need to think beyond structural performance or final appearance to also consider the materials and chemistry of concrete mixes: where the component parts come from — the cement, aggregate, sand, water, admixtures, additional binders — how much cement can be substituted with fly ash or other lower-carbon substitutes, and finally, how much captured CO2 can be injected into the mix to reduce the carbon content and sequester those emissions permanently. A negative-carbon concrete is theoretically possible, but only if the chemistry of cement is redesigned, if the supply chains for these novel products exist, if carbon sequestration becomes widespread, if building code and standards are overhauled, if carbon capture, utilization, and storage (CCUS) markets spring up, and if non-extractive architects of the future choose this material over its high-carbon lookalike.

For steel, there are many variables that would influence the carbon footprint. A designer might ask where the iron ore comes from, how it was mined, what fuel powered the furnaces, how much recycled content was used, how it was forged or extruded or cast, how many miles it traveled on what kind of trucks. More importantly perhaps than tracking every step and process along the way, designers should know which of these processes and decisions actually matter. They should know that the largest determining factor in the carbon footprint of steel is likely whether or not it was made using an electric arc furnace, as opposed to a coal-fired basic oxygen furnace, though this information is not generally captured in specification language or made transparent when selecting steel products.[4] It might be more useful for a designer to know that the shape of the steel members and their country of origin will likely determine which production method was used. For example, hot rolled shapes like wide-flange members, angles, channels and rebar tend to come from electric arc furnaces.

[4] American Institute of Steel Construction. “More than Recycled Content: The Sustainable Characteristics of Structural Steel,” (White Paper, AISC, May 2017). www.aisc.org/

Many designers and scientists have begun advocating for increased use of wood as an alternative to carbon-intensive steel and concrete, and recasting buildings as a massive carbon sink.[5] Wood products have the ability to store biogenic carbon, but harvesting wood also has its share of impacts — many of which can be reduced or avoided through responsible forest management. The extent to which an immediate increase in global wood consumption would mitigate or aggravate climate change hinges on the short- and long-term carbon dynamics of forests as ecosystems. Just as we must view other building material supply chains with nuance, not all wood should be treated equally.

Currently, in much of the world, there is little ability for a designer to have a sense of the most basic details about wood supply chains or the variability of carbon impacts across wood products. It should matter to a project whether the wood products installed were harvested legally, whether they resulted in land transformation and deforestation, or whether they came from a sustainability managed forest. It is not enough for designers to call for increased use of wood without strengthening forest stewardship, restoration, conservation and increased transparency in wood products. Designers should support "climate-smart forestry," a holistic approach to forest management that increases forest carbon storage while enhancing forest health and increasing ecosystem services.[6] If architects and engineers are to leverage the power of wood and healthy forests to mitigate climate change, they must encourage manufacturers of wood products to disclose such information and reward the measurable environmental and social benefits that climate-smart forestry achieves.

We don't care about a zero-carbon architecture in the abstract — we care about how architects make meaningful progress towards meeting international decarbonization goals and timelines. The window of opportunity to meet 1.5 or 2 degree targets is rapidly closing.[7] Buildings have long lives and persistent legacies, and the embodied carbon associated with building materials and construction — unlike operational carbon — comes all at once. Right now the world is experiencing a one-of-a-kind urbanization push as populations swell and rural residents relocate into cities. As global population reaches 10 billion, building stock across the world is expected to nearly double.[8] In the next 30 years, exactly the critical time in which we must draw down carbon emissions, building materials alone will account for more than half of the entire carbon footprint of new construction, consuming much of our global carbon budget and assuring a path towards climate catastrophe. So the need for non-extractive, zero-carbon architecture is now — not tomorrow.

CHASING GHOSTS

Material supply chains are abstract and hard to trace, which is rather convenient for those actors and industries that benefit from an exploitative system. We need robust carbon accounting and data to keep us from chasing ghosts, clinging to variables that are not significant from a carbon perspective.

[5] Churkina, Galina, Alan Organschi, Christopher P. O. Reyer, Andrew Ruff, Kira Vinke, Zhu Liu, Barbara K. Reck, T. E. Graedel, and Hans Joachim Schellnhuber. "Buildings as a Global Carbon Sink." Nature Sustainability, January 2020.

[6] Verkerk, P. J., R. Costanza, L. Hetemäki, I. Kubiszewski, P. Leskinen, G. J. Nabuurs, J. Potočnik, and M. Palahí. "Climate-Smart Forestry: The Missing Link." Forest Policy and Economics 115, no. January (2020).

[7] IPCC. "Special Report on the impacts of global warming of 1.5 C above pre-industrial levels and related global greenhouse gas emission pathways." Intergovernmental Panel on Climate Change (2018). This report is also commonly known as SR15.

[8] World Green Building Council (WGBC). "Bringing Embodied Carbon Upfront: Coordinated action for the building and construction sector to tackle embodied carbon." Toronto and London, 2019.

Luckily, it is already possible to track this thin thread of carbon, despite the complexity of building assemblies and the far-flung geographies of material supply chains. Life Cycle Assessment (LCA) is an internationally accepted methodology dedicated to the tracking of environmental impacts across a material or product's full life cycle from extraction to end of life or reuse.[9] LCA models form the basis of global carbon accounting across many sectors from building construction to energy production, transportation, agriculture, and land use. Increasingly, designers are using a wide array of LCA tools developed specifically for architects, engineers, and contractors to help improve the transparency of carbon accounting and support decision-making on projects.[10] As manufacturers are forced to become more transparent and specific about their carbon footprint and material supply chains, changes to policy and code have sprung up to regulate the embodied carbon of building materials and incentivize low-carbon alternatives.

Still, accounting for the carbon, as well as its local environmental impacts, is only the first step. Can we ever get past an extractive model of building materials? Can we achieve an architecture that is in fact truly net-zero carbon, or even regenerative and carbon negative? How can we fundamentally transform supply chains that are built on the exploitation of cheap work and cheap nature, to name just a few of capitalism's "seven cheap things"?[11]

What is the role of the designer in this new endeavor? One thing is certain: that our obligations don't end with construction documents or architectural graphics. Architects are the major consumers of building materials, governments are the major procurers, and they each have the power to reshape entire industries. Architects have never been content to accept materials as they are, off the shelf; now we are being asked to have some responsibility for our choices, to consider a new layer of building performance, and to direct our innovation towards the challenge of the climate crisis.

ELECTRIFY EVERYTHING, AND CLEAN UP THE GRID

At the same time that we strive to close the loop on the extractive practices of building materials themselves, we must expand the limit of our concern to also care about the larger system of energy that powers our buildings. Buildings run on fossil energy can never become carbon-neutral or regenerative, no matter how cleaned-up or greenwashed their material supply chains, because of the inherently extractive and exploitative nature of fossil fuels — and because operational carbon adds up over the building's lifetime, precisely when climate goals are calling for increasingly stringent decarbonization.

As a precondition for becoming non-extractive, carbon-neutral and just, buildings must eliminate fossil heat and power, transition to all-electric appliances and building systems, and clean up their energy supply. No more natural gas micro-turbines for on-site energy generation. No more diesel backup

[9] Carbon Leadership Forum. "Life Cycle Assessment of Buildings: A Practice Guide." Seattle, 2019. https://carbonleadershipforum.org/lca-practice-guide/

London Energy Transformation Initiative (LETI). "Embodied Carbon Primer: Supplementary Guidance to the Climate Emergency Design Guide." London, 2020. https://www.leti.london/.

[10] Herrero-Garcia, Victoria. "Whole-Building Life Cycle Assessment: Comparison of Available Tools." Technology | Architecture + Design. 4:2, 2020. p 248-252.

Tools such as Tally, Athena, OneClick, EC3 and many others support design teams in comparing the carbon intensity and environmental impacts of materials, assemblies and whole buildings during the design, procurement and construction processes.

[11] Raj Patel and Jason W. Moore. A History of the World in Seven Cheap Things: A Guide to Capitalism, Nature, and the Future of the Planet. London and New York: Verso, 2018.

generators or natural gas-powered CHP microgrids. No heavy fuel generators on construction sites, or oil-burning furnaces in basements. The Rewiring America project has laid out an economy-wide strategy of what the authors call a “maximum feasible transition,” which entails a rapid production ramp-up of decarbonized infrastructure and technology, followed by an intensive deployment phase. It calls for “close to 100% adoption of decarbonized technology when fossil machines reach retirement age.”[12] Every natural gas or coal plant that retires, must be replaced with a renewable or zero-emission power plant. Every natural gas furnace and boiler must be replaced with a more efficient electric option.

No money should be spent propping up or retrofitting fossil fuel infrastructure or adding systems and equipment into buildings that will lock in legacy emissions for decades to come. These are all technologies that work. The real question is how quickly we can ramp up their production, and whether or not society can wean itself off a cheaper and dirtier status quo.

For now, while we are still obligated to rely on a dirty grid, this will entail a continued reliance on some amount of fossil fueled energy to produce these technologies for decarbonization. Here too, a life cycle approach can help us better understand trade-offs and critical variables up and down supply chains, to quantify and characterize environmental impacts, and refocus attention on the physical transformations needed to produce those electrons, and to get them to their destination. LCA analyses of the solar industry, for example, have shown that it has already paid off the “carbon debt” of its 40 years of development, starting around 2011, and is now producing a net-carbon benefit for climate compared to its never having been born.[13]

Using rigorous carbon accounting, such as LCA, researchers can similarly demonstrate that the production of wind, solar, and nuclear power plants all produce carbon footprints that, while not zero, are insignificant compared to a continued dependence on fossil fuel energy.[14] Using a carbon budget approach, meanwhile, even a hyper-efficient new natural gas power plant still doesn’t pencil out when we map it against what remains of the carbon budget for a 2-degree planet, never mind a 1.5 degree one. As Oil Change International put it in its 2019 report, “gas breaks the carbon budget…there is no room for new fossil fuel development — gas included — within the Paris Agreement goals.”[15]

But Life Cycle Assessment, or any quantitative calculation method alone, is insufficient to tell the complete story of extraction landscapes. It doesn’t capture the social justice dynamics of supply chains, or their labor and political issues. The architecture that we urgently need must both zero out its carbon footprint, and also expand the scope of its concern out to the factory, and into the pit—designing in solidarity with the communities out on the edge of the extraction frontier.

[12] Saul Griffith and Sam Calisch. “Mobilizing for a zero carbon America: Jobs, jobs, jobs, and more jobs: A Jobs and Employment Study Report.” Rewiring America. (July 2020).

[13] Atse Louwen, Wilfried GJHM Van Sark, André PC Faaij, and Ruud EI Schropp. “Re-assessment of net energy production and greenhouse gas emissions avoidance after 40 years of photovoltaics development.” Nature Communications 7, no. 1 (2016): 1-9.

[14] Michaja Pehl, Anders Arvesen, Florian Humpenöder, Alexander Popp, Edgar G. Hertwich, and Gunnar Luderer. “Understanding future emissions from low-carbon power systems by integration of life-cycle assessment and integrated energy modelling.” Nature Energy 2, no. 12 (2017): 939-945.

[15] Lorne Stockman, Kelly Trout, and Barb Blumenthal, “Burning the Gas ‘Bridge Fuel’ Myth: Why Gas Is Not Clean, Cheap, or Necessary,” (Washington, D.C.: Oil Change International, May 2019), http://priceofoil.org/content/uploads/2019/05/gasBridgeMyth_web-FINAL.pdf.

A JUST TRANSITION

Materials for zero-carbon buildings will still have to come from somewhere, produced by someone. Extraction will not innately or easily come to a halt in the all-electric world, and the massive global expansion of renewable energy cannot be achieved purely through a circular economy logic. The move towards a renewable and all-electric grid will in fact open up new territories of extraction, and new extractive frontiers.

Some of the earliest flashpoints have been around lithium, a critical component in batteries. Nearly 30% of the world's lithium production takes place in the Atacama desert in Chile, lithium mines serve as one of the few sources of employment, yet the pumping and evaporation of brine for lithium has depleted potable water reserves, contaminated the landscape and created tensions over economic versus environmental health.[16] There are many such examples of the difficult conversations that lay ahead when we expand our concern upstream to include all of a material's supply chain — all of the landscapes, communities and economies that it touches.

The Climate Justice Alliance describes a "just transition" as the move from an extractive economy to a regenerative one — from a system that treats some communities as sacrifice zones for energy and industry, to an approach that redistributes resources and power to local communities, allows for community self-determination, creates meaningful work, respects culture, tradition, and sacred land, and pursues energy democracy.[17] Calls for a just transition highlight the need for equitable treatment for frontline communities most vulnerable to harm or displacement due to climate change, and fossil fuel workers and communities most vulnerable to the economic changes that stem from decarbonization.

As political theorist Damian White has written, "the concept of the just transition has been around for a number of decades but has re-emerged of late in labor and trade union, climate justice, and, more recently, indigenous environmental mobilizations as a powerful and salient frame through which to think about the multiple challenges that confront the project of deep decarbonization."[18] A just transitions framing moves us out of the binary of protecting the environment versus protecting workers and economies. It might also shift our conceptualization of material supply chains away from an unregulated model of extraction for maximum profit, towards one that foregrounds community consultation, worker empowerment, and internationalist models of solidarity between material producers and consumers.

To arrive at a truly non-extractive architecture, we must make sure that mining and industrial production are transformed to acknowledge and uplift the workers and communities affected by these processes, and to daylight exploitative practices that must be fixed. Even if architecture moves to radically

[16] Thea Riofrancos. "What Green Costs" Logic Magazine, Issue 9 (December 2019). https://logicmag.io/nature/what-green-costs/

[17] Climate Justice Alliance, "Just Transition," Accessed Oct. 30, 2020. https://climatejusticealliance.org/just-transition/

[18] Damian White. "Just transitions/design for transitions: preliminary notes on a design politics for a Green New Deal." Capitalism Nature Socialism 31, no. 2 (2020): 20-39.

decarbonize, but fails to address the extractive mindset of colonialism, capitalism, racism, and oppression — then we have failed. But it is the process of remaking architecture as a practice, as a profession, into one that is capable of tracking the thin thread of carbon through its myriad geographies, its entanglements with mine sites and mine workers, with factory floors and factory workers, with regional and global shipping routes and the people and machines that carry it, to the fantastic architectural assemblies at the end of the line, that gives us such extraordinary agency as designers. The climate crisis may add urgency, but does not take away the fundamental critical exercise of looking broadly at the physical world, its complex social and environmental systems, and its intertwined flows of matter that should underpin the drive towards a non-extractive architecture.