CARBON SINK STUDIO


Amazon Basin, photo by Sabastiao Salgado


Construction of Brasilia, photo by Marcel Gautherot

OVERVIEW

Carbon is king of the elements. It is the fourth most abundant element in the universe and the second most abundant element in the human body. It forms ten million different compounds. It has been used by humans for over 5,000 years, and its cycle of transformation is essential to the functioning of all life and ecosystems on earth.
In a sense, carbon makes architecture possible—it is a critical element in the materials of the built environment. Yet carbon also makes architecture a threat—it is an invisible byproduct of making and operating buildings, and it plays a major role in climate change.

This studio explores the complex issues of designing with carbon, including the possibility of reimagining architecture as a carbon sink. Students in the studio will work at the scale of the molecule and the scale of global flows, as well as all of the scales in between. They will employ both systems of measurement and practices of aesthetics. They will invent new forms of drawing. They will model time. They will travel to Brazil, visiting Brasilia and the Amazon, and studying both the construction of cities and the management of forests—as well as the feedback between them. Ultimately, they will design new buildings and footprints as if their lives depended on it.

CARBON AND CLIMATE

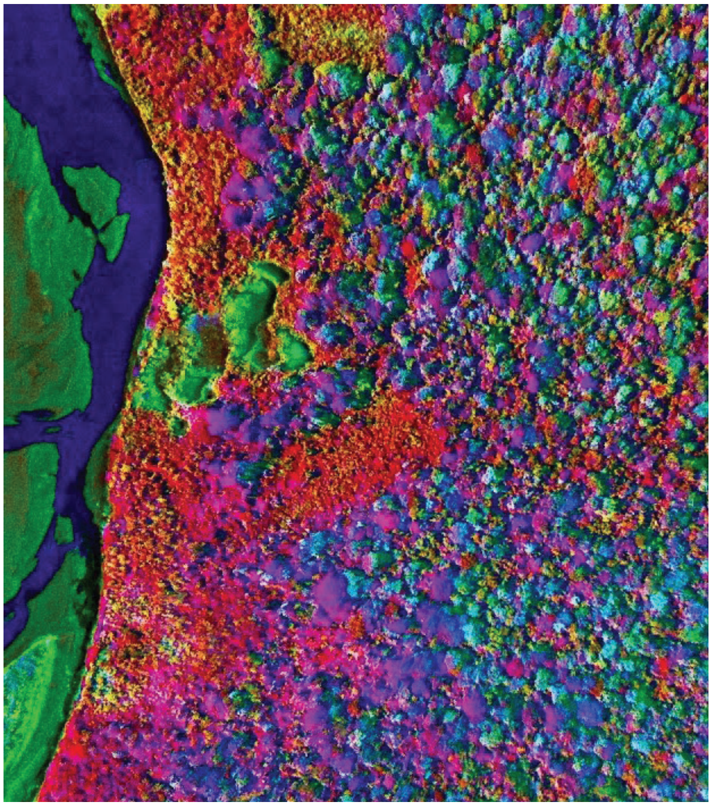
In the fall of 2018, the United Nations Intergovernmental Panel on Climate Change (IPCC) released a report that was both familiar and unfamiliar. It built on facts we already knew about climate change: carbon emissions cause warming, which causes sea level rise and extreme weather and loss of biodiversity, which causes disease and hunger and migration and death. But it also reached a new conclusion: the world has only 12 years to halt carbon emissions and avoid the most catastrophic global effects. The warming target of 1.5 degrees Celsius (rather than

Mud architecture of Great Mosque of Djenné

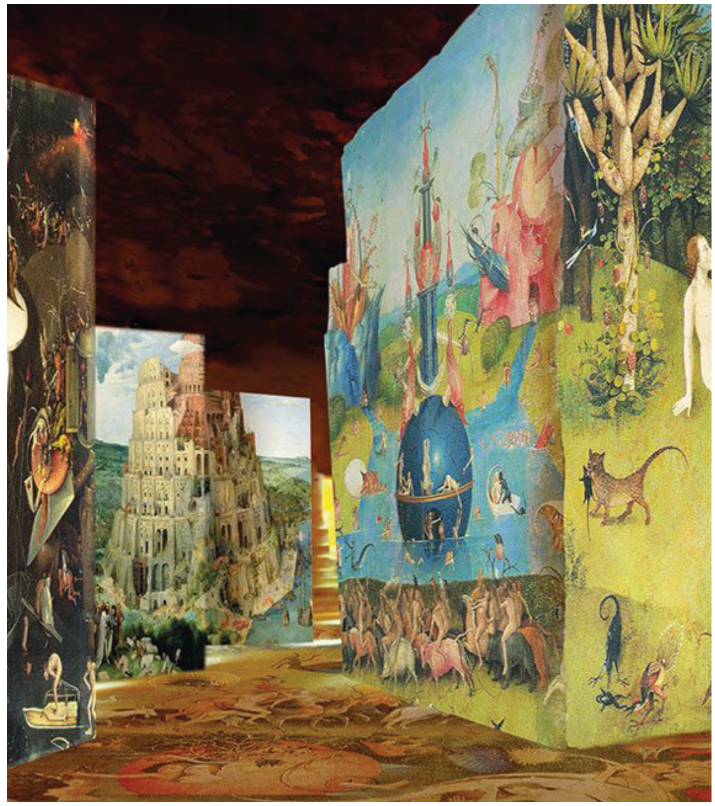
Mass timber architecture of Albina Yard by Lever Architectue

2.0 degrees) is required, not optional. The difference of half a degree dramatically improves our odds of preserving any coral reefs, avoiding the collapse of insect life, escaping the trigger of irreversible planetary transformation, and minimizing drought, floods, extreme heat, and poverty for hundreds of millions of people. Urgent and unprecedented action is required. Not eventually. Now.

Architecture makes up 30-40% of global carbon emissions. And 15 of the 20 largest cities in 2050 have yet to be built. Most of the contemporary focus in sustainability in architecture aims to reduce *operational energy and operational carbon*—the energy and carbon emissions involved in heating, cooling, and lighting. Yet over the past 50 years, there has been a dramatic increase in *embodied energy and embodied carbon*—the energy and carbon emissions involved in extracting, transporting, manufacturing, and assembling materials into buildings. There is growing awareness that embodied energy and carbon are crucial. We must not only reduce the amount of carbon emissions for operating a building; we must also reduce the amount of carbon emissions in the process of making a building in the first place. In fact, with only 12 years to achieve unprecedented change, embodied carbon becomes even more significant. The traditional calculation says it may be worth it to add carbon now (in embodied carbon during a year of construction) if you can save carbon later (in operational carbon over the 80-year lifespan of a building). But the new context of urgency means that it matters when the carbon is emitted. Adding carbon now may cause us to miss our only chance of avoiding catastrophe. According to architect and writer Bruce King, "Consideration of the carbon footprint ... of construction materials should be as fundamental as designing for fire, wind, and earthquake."



Amazon Biodiversity Mapping by Carnegie Science



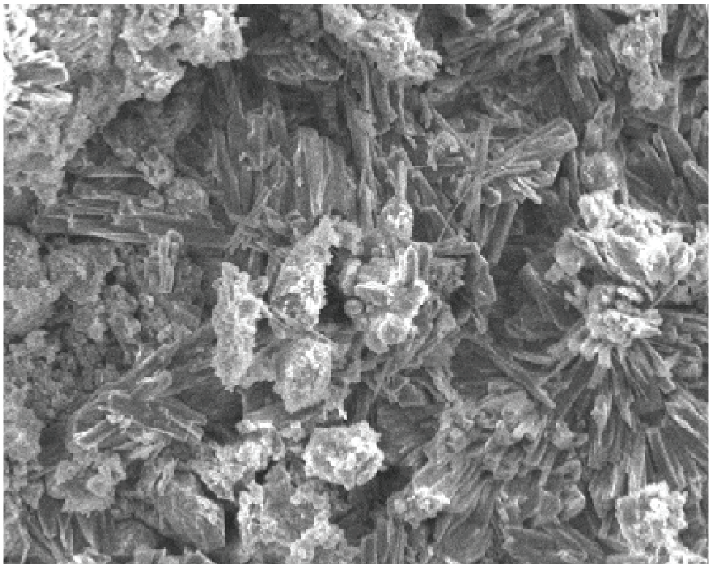
Carrieres de Lumiere

ARCHITECTURE AS CARBON SINK

In this context, one under-explored topic is the potential for buildings to capture carbon—architecture as carbon sink. The idea that buildings might actively remove carbon—rather than simply reducing the amount of carbon that they produce—offers a new perspective on the situation. Carbon sinks mean actively removing carbon from the air, not just reducing carbon emissions. Examples of carbon sinks in architecture include mass timber (glulam and cross-laminated timber), new kinds of concrete that absorb carbon, and trees and plants within buildings or sites that store carbon in their physical being. In the realm of materials, many architects have recently been extending the capabilities of mass timber. And new studies suggest that concrete absorbs carbon over its lifespan—all of the concrete in the world may currently absorb about one-fourth as much carbon as all of the forests in the world. More broadly, there have been experiments in accelerating carbon removal in the ocean through adding a specfic enzyme or bio-engineering microbes that fix carbon (non-photosynthetic carbon fixation). And the concept of carbon offsets involves paying money to sequester carbon (or avoid emitting carbon) in one location in order to cancel out adding carbon in another. As carbon taxes in France and Washington state (among other regions) have faltered, and as regulation of auto emissions and building codes is slow going, capturing carbon may become a critical component of a low carbon future.

HOW DO WE DRAW CARBON?

The materials and forms around us are inevitably linked to the greater web of events that makes up climate change. These forces are usually invisible to the eye because of their minute or immense scale of impact over time. Some forces inside buildings that contribute to climate change are just beginning to be measured, like the carbon-capturing quality of concrete. In exploring how atmospheric flows become tangible, architecture has the potential to be a more direct interface with the invisible. Renewable materials already play a role in reducing carbon, but what types of materials have yet to imagined? And how can we begin to measure their impact? Are there untapped everyday actions that people inside a building can perform that have the potential to actively take CO_2 out of the air? Through research and iterative design, students in this studio will seek to better understand what it means for a building to



SEM micrograph of geo polymer concrete

“Tree plantations are not forests,” by World Rainforest Movement

perform as a carbon sink, not only by working with new materials and construction systems, but also by designing new ways of life. To link the measurement and flow of carbon with the structure and experience of architecture, students will experiment with making new tools of representation, and designing the corresponding form, materiality and experience of this new approach.

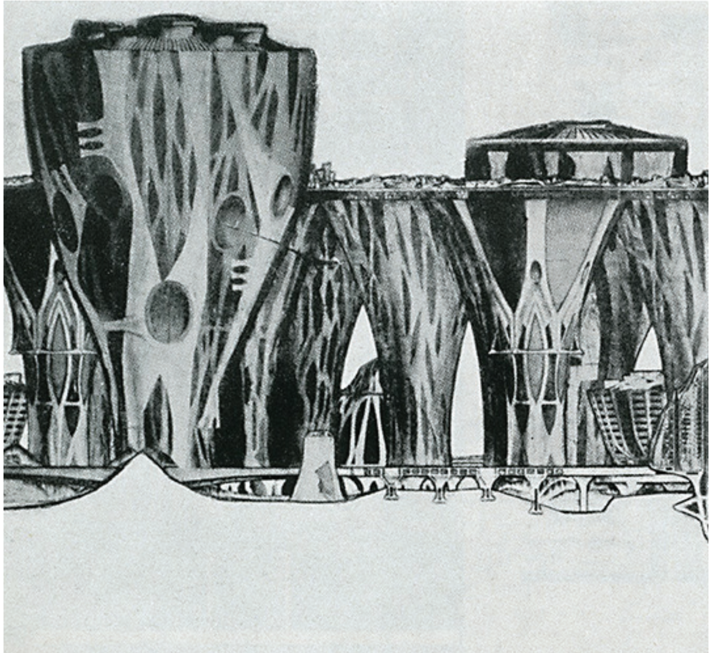
Originally, architecture was captured in written text. Plan and section drawings were tools designed to communicate information more visually and aid the process of construction. Perspective was a tool designed to accurately represent depth as perceived by the human eye. Isometry (axonometric drawing) was originally designed for engineers to accurately measure drawings without optical distortion. Our methods for abstracting information into a story ultimately shape the way we design. This is why inventing types of projection beyond plan, section, perspective, and axonometric may help us discover new forms and new design languages to work within. In an effort to break free of representational modes that cannot reveal carbon, we must reinvent the method itself. Are there representational technologies outside the field of architecture that are ready to be adapted? What types of projection make carbon more tangible?

NEW WAYS OF SEEING SPACE

In a series of iterative projections throughout the semester, proposals will be developed through the use of two distinct scales: the reach of impact and the space of personal experience. By designing with both a network of resources and a human point-of-view, architecture has the potential to expand beyond one or the other. Students will design buildings in a way that includes their ecosystems, including air, water, flora and fauna—as well as where materials come from and how long the building will last— and they will look simultaneously through these two lenses.

The studio will also partner with the Columbia Department of Computer Science in a two day workshop to explore these ideas. With a student team specializing in Augmented Reality and Virtual Reality, it may be possible to uncover new ways of storytelling that engage a larger audience or to become part of the design process itself, with the aim of building upon the content of the proposals taking shape over the course of the semester. Whether with the help of AR or VR or other ways of drawing or modeling, the studio will experiment with ways to design with the invisible in our natural and manmade environments and make proposals that treat carbon as a driving factor.


Meeting of the Waters, the Amazon, Brazil


Arcosanti by Paolo Soleri

SITE AND PROGRAM

The Rainforest Foundation US was one of the first non-profit NGOs working in South America to actively protect indigenous peoples as well as the natural biodiversity of their claimed landscape. Indigenous rights in South America are linked with the protection of the forest, and people advocating for these rights have acted as a guarding force against agriculture and development, along with environmental organizations and climate change experts. Rainforests absorb around 20% of the earth's CO2, but at the same time tropical deforestation contributes around 15% of the earth's greenhouse gas emissions—and the proportions are continuing to shift. Because of the strong farming economy in South America, rainforest protection has wavered through the years, but has seen a steady decline in the past decade.

As 2020 approaches,the forests of Brazil are predicted to be dramatically altered. And with the recent election of president Jair Bolsonaro, theyare even more under threat. "Environmental politics can't muddle with Brazil's development," he said in December of 2018. "Today, the economy is almost back on track thanks to agribusiness, and they are suffocated by environmental questions." Along with illegal deforestation and corruption, there have been proposals in the recent days to dissolve the environmental ministry into the agricultural ministry. The biggest carbon sink on the planet, besides our oceans, is facing a very uncertain future.

This studio will engage Brazil, indigenous people, and biodiversity. Students will conduct an initial study of key architectural precedents in the region, determine measurements of carbon emissions seen over the lifespan of the building, and establish their own carbon goals that include scale, site, program, and material systems. Distinct building typologies may perform differently, and projects may include housing, museum, factory, school, villages, or other. The studio will travel to architectural, urban, and landscape sites in Brazil, speaking to experts, and spending time in rainforests—a natural resource that, along with glaciers, will continue to be a key global marker of the Anthropocene. Situated within one of the world's largest carbon sinks, proposals not only have the potential to tap into this ecological resource and reimagine its future, but will engage the Brazilian social and political context surrounding environmental protection, deforestation, economics, and how these policies translate to carbon timelines. Each student will develop their own position and building in this context, designing massing, details, materials, program, site, and cultural impact as a unique hypothesis about the future of carbon architecture.