Presented By:

Architecting Change

DESIGN STRATEGIES FOR A HEALTHY, RESILIENT, CLIMATE SMART FUTURE

Photo credit: Lluc Miralles, courtesy Lacol Arquitectura Cooperativa

LEARNING OBJECTIVES

1. Understand and describe current and emerging social, economic and technological trends impacting the built environment, urbanism and the business of architecture.
2. Explain how community-centered participatory design and the strategic use of greenspaces in urban environments can benefit the health of individuals, communities and cities.
3. Understand the built environment's significant contribution to carbon emissions, and learn how designers are using lifecycle analysis to measure a building material's impact on the carbon footprint of a project.
4. Identify key factors contributing to the cost of mixed-use and multi-family developments, along with planning and design strategies that can help make these projects more affordable.

CONTINUING EDUCATION

This course is approved for AIA & GCBI Learning Unit Credits.

AIA Continuing Education Provider

THE DECADE AHEAD: DESIGN AND CITIES IN 2021 AND BEYOND

Designers Respond to the Demands of a Rapidly Changing World

Over the past decade, the architectural, construction and engineering (AEC) sector has grappled with unprecedented technological and socioeconomic changes along with an unprecedented confluence of challenges to the health of our communities, our cities and our planet. Climate change is accelerating—the 10 years leading up to 2020 was the warmest decade on record.[1] Buildings and their construction account for 39% of global carbon dioxide emissions.[2] At the same time, the built environment is growing at a record pace in the United States. It is estimated that 2.5 million new housing units are needed to make up for the nation's housing shortage,[3] a trend that has not abated in the face of a global pandemic.[4] Economically, the price of housing has eclipsed the income of many Americans—precipitating a critical housing crisis in some regions—and adding to inequality and a rising homeless population across the nation.[5] Amidst this, we spend as much as 90% of our time indoors, often cut off from nature.[6]

While these challenges are daunting, thought leaders in the AEC industry increasingly see it as an opportunity to be at the forefront of change, with examples of design leadership across the country and around the world. Technological gains within the built environment are making zero-carbon construction attainable[7], dramatic energy savings achievable[8] and taller mass timber construction possible.[9] Industry research, along with bold demonstration projects, is expanding the sector's understanding of carbon sequestration, life cycle assessment (LCA), Passive House principles, and biophilic and health-centered design.

Four design approaches are leading the industry's response to these challenges and opportunities:

1. **Incorporating Greenspace**
   Boosting health, resilience and well-being by including greenspaces in project designs
2. **A Focus on Community Building + Placemaking**

Lessons and learnings of community-centred, participatory design

3. **Lowering Building Carbon Footprints**
   Redesigning the built environment to mitigate climate change
4. **Designing for Density and Affordability**
   Boosting urban density and affordability through creative means

In this course you'll learn from design teams who are embracing these strategies and delivering solutions that begin to address some of the most pressing global challenges of our times.

GREENSPACE: A NATURAL PRESCRIPTION FOR HEALTHIER CITIES

Take a Walk in the Woods and Call Me in the Morning

A healthy city is a green city; a healthy urban dweller, a park-goer. There is ever-growing evidence[10] that local access to greenspace and green views positively impacts physical health, mental well-being and the overall resilience of a city[11]—defined as its capacity to survive, adapt and grow in the face of adversity.

Easy access to greenspace, urban parks and nature has been linked with improved human health—everything from better immune function, mental health and cognitive capacity to a reduction in type 2 diabetes and cardiovascular morbidity. Proximity to greenspace has been correlated with lower rates of psychiatric disorders.[12] Beyond this, a city of well-connected, attractive greenspaces may be better equipped to bounce back from crisis, natural disasters and extreme weather events. These benefits extend to all population groups, particularly marginalized and low-income segments.

The science is still emerging[13] and more research is needed, but initial findings and anecdotal reports show promising results. A walk in the woods may be just what the doctor ordered.

Density Isn't the Problem, Equitable Access to Greenspace Is

Increasing equitable access to greenspace may be the biggest hurdle to countering such crowding and creating more resilient cities. In the U.S. alone, 100 million people (28 million children included) do not have a neighborhood park within a 10-minute walk from home. The good news is, progress is being made. It's part of a concerted effort called the 10-minute Walk, a nationwide movement championed by The Trust for Public Land, National Recreation and Park Association and the Urban Land Institute. The program is enlisting mayors from across the nation to improve access to parks and greenspaces.

It Takes a Green Village: Weaving Greenspace and Nature into the Built Environment

Along with increasing equitable access to public parks and recreational amenities, urban designers and architects in cities across the country are increasingly looking for innovative ways to weave greenspace into the built environment.

BRINGING NATURE INSIDE WHEN YOU CAN'T GO OUTSIDE

Most people in North America spend approximately 90 percent of their time indoors, either at home, work, or in spaces like retail stores, restaurants, schools or other public buildings. In response, designers are bringing the great outdoors inside by integrating natural elements into building design, sometimes referred to as biophilic design. This approach is increasingly used in built environments to boost occupant well-being through connection to nature and the use of natural elements like views of nature, natural light, plants, water and exposed wood.[14]

Photo credit: ©2013 Darren Bradley, courtesy MAD

Gardenhouse: Recreating a Hillside Village in an Urban Context

Gardenhouse, a mixed-use multi-family project in Los Angeles, California, is a recent example of this trend, making the integration of greenspace central to its design.[15] Conceived by MAD Architects to feel like a naturally vegetated hillside village, the 18 residential units, completed in late summer, feature the country's largest green wall of its kind.

With seamless transitions between indoors and out, members of the Gardenhouse community enjoy expansive, open-concept floor plans with towering window walls and outdoor living spaces. Gruen Associates, who served as both the executive architect and landscape architect for the project, worked closely with the designers to bring a vision of nature-infused urban living to life.

The multi-family residence includes a purposeful mix of housing types to encourage a diverse community-feel: two studios, eight condominiums, three townhouses and five villas. The development's concrete podium is crowned with a shimmer of white pitched-roofed units constructed of light-frame wood construction, while the interior finishes pay tribute to California's woodworking heritage. A second floor courtyard forms a central landscaped gathering space for the complex.

In many respects, the development acts as a demonstration project of what is possible. "Gardenhouse represents a

KEEPING YOUR COOL WITH VEGETATION AND ORGANIC MATERIALS LIKE TIMBER

In the face of rising temperatures and a warming planet, weaving greenery into urban infrastructure not only offers biophilic benefits, it also can help offset the heat island effect—urbanized areas that experience higher temperatures due to closely packed and paved surfaces—afflicting so many of today's cities.[16]

WHAT IS PARTICIPATORY DESIGN?

Participatory design is the idea of directly engaging users in a design process. An article on regenerating public spaces defines it as: "the model of direct involvement of different social groups in the design from functional tools to environments, social institutions and businesses."[20]

unique opportunity to impact not only the architecture of Los Angeles but to introduce a new paradigm of living where humans are more emotionally connected to nature, particularly in high-density cities like Los Angeles," said Ma Yansong, founder of MAD Architects.

Drs. Julian and Raye Richardson Apartments: Bringing the Healing Power of Nature to Transitional Housing

Biophilic design and greenspace is also connecting marginalized communities with the healing power of nature. One notable example is the Richardson Apartments.[17] The 120 residential studio units, combined with common areas and program space, provide accommodation to formerly homeless individuals.

The architect used wood as the primary structural material because of its relative cost savings compared with concrete and steel. Wood was also left exposed throughout the interiors to add warmth, variety and texture to the common spaces.

The social housing is complemented by a courtyard and topped with a vegetable roof garden. Giant chain ferns, Japanese painted ferns, western sword ferns and wood sorrel form an urban oasis. These plants were selected for their low-maintenance and adaptability to the extreme solar conditions of full sun and deep shade. Five stories above the courtyard, a roof deck offers a space for residents with seating areas, succulent gardens, raised beds for vegetable gardening and a green roof.

Garden City 2.0: Building Long-Term Resilience and Health

In times of hardship and crisis, city dwellers throughout history have turned to nature for hope and healing. Today, equipped with a growing body of research and compelling data, city builders are beginning to confirm what folk wisdom has taught us—that nature and greenspace woven into the fabric of our urban environments is good for our health.

As Will Allen, director of strategic conservation planning at The Conservation Fund in Chapel Hill, NC writes, "…if a post-COVID world can move towards more people-centered social infrastructure investment, with ambitious goals for nature in cities and biophilic design, then our financial investments in nature will be rewarded with less crowded and more resilient cities, which will hopefully also lead to a more equitable and healthy country."[18] This investment may very well begin with a walk in the park, just ten minutes from home.

The concept of a garden city is one practical response to building stronger, more resilient cities.

THE ARCHITECTURE OF COMMUNITY: PARTICIPATORY DESIGN AND PLACEMAKING BUILD CONNECTION

Along with well-designed equitably planned greenspace, participatory design has the potential to strengthen the health and resilience of communities. A growing number of architects and planners are turning to community engagement—an approach that puts occupants at the heart of the design process. In doing so, they're creating architecture that connects people and strengthens community, something that is perhaps more important than ever.

Participatory design offers a number of benefits, as pointed out by *Participate in Design (P!D)*. It mitigates the risk of failure and helps a community buy into and own a design solution. It can help reduce resistance to change and encourage realistic expectations of a design, while fostering stronger bonds and greater community involvement. And finally, it can boost the overall confidence and resilience of a community.[19]

Co-creating Where You Live | La Borda Cooperative Housing, Barcelona, Spain

La Borda is a building designed by the community, for the community. A cooperative housing project in Barcelona, Spain, La Borda featured a lengthy community engagement process as part of the project's development. Each resident served as a working group member, contributing to elements of the building's design, function and management. Active participation from building residents was crucial to La Borda's co-design process, aimed at maximizing human connection.

La Borda Cooperative. Photo credit: Lluc Miralles, courtesy Lacol Arquitectura Cooperativa

The process aligns with La Borda's values: "active participation, collective ownership, affordability, and sustainability."[21] Just as each member of La Borda's collective serves a purpose and a role, so too do the architectural elements.

The Spanish cross-laminated timber infuses the building with a natural and organic ambience. Cristina Gamboa, a cooperative member, explains that they "tried to have a more global understanding of the implications of this material decision," with mass timber offering a climate-friendly alternative to more energy intensive materials. And, at its heart, a central courtyard unifies the building, creating a flexible meeting area that invites residents to gather, connect and socialize.


Lubber Run Community Center. Photo credit: Tom Holsworth, courtesy VMDO Architects


The Barn. Photo credit: Chad Davies

Finding Common Ground | Lubber Run Community Center, Arlington, Virginia
The Lubber Run Community Center[22] is an expanse of lush green space that draws you toward the net-zero center at its core. The building emerges organically out of the park and features a living roof adorned with trees and park benches. Initially, local residents were set on plans for a three-to-four-story building, tucked into the background of the surrounding park. To find common ground, the design team undertook a lengthy participatory design process that lasted an entire year. Jay Fisette, former Arlington County Board Chair, says that "there was lots of community involvement and excitement surrounding the new design and plan."[23]

Designing a replacement to the original 1950s-era community center presented a challenge for VMDO Architects. Community members felt strongly that park space be maximized and building space minimized. Yet, through community engagement, the VMDO team was able to demonstrate how architecture can integrate and blend building and landscape, "ultimately creating public space that is greater and greener for residents."[24]

Nina Comiskey, architect at VMDO, says, "This was about understanding what the community wants, rather than specific design guidelines. We were able to guide [the people of Arlington] to a better way of getting what they wanted."

Lubber Run's design focused on promoting equitable access to the center and the park and engaging cross-generational communities and hard-to-reach groups. A series of workshops, meetings, online feedback sessions and on-site engagement activities contributed to the project vision.

A Modern Barn Raising | Barn Pavilion, Sacramento, California
Placemaking can revitalize underused urban areas, inviting social connections between diverse citizens and demographics. Located in Sacramento's once struggling Bridge District, the Barn Pavilion[27] is a modern take on a community barn raising. The sinuous, wood-shingle-clad timber structure, now known simply as the Barn, gives new life to Sacramento's once deteriorating Bridge District.

The Barn features a curvilinear design that emerges out of the pavement, welcoming passersby into its shaded nooks. The public plaza below the Barn hosts gatherings, while inside you can shop, wine and dine, or wander, making your way out to the extensive open-air breezeway. The Barn's multifunctionality and warm organic atmosphere turns this public space into a community place that is both beautiful and functional. Its fluid, sculptural form makes for ambidextrous architecture, adaptive to a multitude of uses.

Design choices can have big impacts on community health and well-being—a well-designed building or public space can foster a sense of belonging by creating third places between work and home that invite social connection and interaction.[28] In particular, participatory design invites community engagement and responsibility. By centering the community at the heart of the design process, participatory design can foster community ownership and pride.[29]

THIS MUST BE THE PLACE: USING PLACEMAKING TO BUILD COMMUNITY

The principles of placemaking provide tools to transform our public spaces into places.[25] What are some placemaking basics? 1) The community is the expert—people who frequent public spaces know intimately and intuitively how the area functions; what could be improved; and who uses the space and for what purpose. 2) Design of the space should facilitate programming, active use, multipurpose functionality and economic opportunity—design is important but shouldn't supersede functionality. 3) If you want to know what makes a community place, take some time to observe. For creative city dwellers, a curb can be an excellent meeting place, greeting space—or even, a clam-cooking hotspot.[26]

DESIGNING FOR DENSITY: A BUILT ENVIRONMENT TO ACCOMMODATE GROWING POPULATIONS

The Rising Need for Affordable Housing and Mixed-Use Development

For community building and placemaking to thrive, cities need safe, accessible and affordable housing, inclusive of a broad socioeconomic spectrum of people. This is becoming even more imperative as urban population growth surges.

By 2050, two-thirds of the world's population will live in urban areas.[30] Outside traditional city-centers, urban adjacent suburbs and mid-sized cities and towns also are seeing rapid growth[31], fueled in part by a shift to remote working in response to the COVID-19 pandemic.[32]

As a result, the demand for affordable housing is outpacing supply, with new multifamily units renting at prices that are cost-prohibitive for middle- and low-income renters.[33]

Without cost-effective housing options—and a diverse mix of units from rental and cooperatives to social and market housing—urban centres risk becoming destinations for "global elites."[34] In some cases, high priced investment properties sit empty, as a rapidly rising population can't find housing.[35] Nearly two-thirds of renters nationwide say they can't afford to buy a home[36], and saving for a down payment is out of reach when home prices are rising at twice the rate of wage growth.[37] These challenges, compounded by a global pandemic, have only intensified America's housing problems.[38]

At the same time, infrastructure, amenities and mixed-use commercial space is needed to support population growth. But land available for such development is costly and scarce, highlighting the need to optimize the use of existing space in urban centres. And now, these same cities must consider how to adapt mixed-use development for a post-pandemic world.[39]

Given all these challenges, how can developers, architects and contractors boost affordability and reduce multi-family housing costs? How can they make better use of available land and optimize the use of existing mixed-use commercial spaces?

What Impact Can Design Teams Have On Density and Affordability?

To answer these questions, designer and urbanist Hannah Hoyt, Gramlich Fellow at Harvard Joint Center for Housing Studies, interviewed 30 professionals working in the development sector.[40]

The findings? To help make housing more affordable, the report recommends design teams consider multiple strategies that can curb development costs in three categories: *land costs, soft costs* and *hard costs*, with a focus on what savings are within their day-to-day control and can be passed on to occupants.

Land costs refer to the cost of acquiring land—and amounts to approximately 10–20% of total development costs for a typical multifamily project.[41] Examples of strategies to maximize land value include selecting a site that offers economies of scale, considering design solutions for oddly shaped lots or scattered sites, and renovating, converting or co-locating housing with existing buildings.

A standard approach to site evaluations that considers everything from soil and site clearance to grade and zoning can, according to the report, go a long way to identifying scalability and avoiding unexpected site preparation costs.[42]

Hard costs are the costs of construction, which can be divided into four sub-categories: substructure and site prep, shell and structure, interiors and services. Hard costs amount to 50–70% of total costs. Examples of strategies that can have a positive impact on hard costs include designing units for maximum flexibility and efficiency, investigating new techniques and materials, and investing in energy and water performance to realize long-term savings for a project.[43]

Finally, *soft costs* include all other costs—financing, design, engineering, permitting and any impact fees. In this category, engaging general contractors early and as partners can help realize savings and sharing more information with subcontractors can result in more accurate cost-estimating.[44]

Case Studies: Making Housing and Mixed-Use Density More Affordable

There are a growing number of multi-family and mixed-use projects across the country using such strategies to tackle the challenges of density and affordability.

Affordable Housing in Portland, Maine

On the opposite coast, architect CWS Architects and general contractor Zachau Construction are adopting similar tactics in their affordable housing project, Wessex Woods. It's a four-story, 40-unit affordable senior housing development for Avesta Housing in Portland, Maine's Nason's Corner neighborhood.

By using mass timber, the team cut the hard costs related to long drawn-out construction schedules. "Traditionally it's always been CMU (concrete masonry unit) for elevators and stairs," said Ben Walter, president at CWS Architects. "But we were able to demonstrate that a new material, and a different set of details to install it, fit nicely here."

They compressed the shaft's expected three-week construction time to one day, reducing their budget by $75,000, while realizing additional cost savings related to lower labor, heating and tenting requirements.

Drew Wing, chief operating officer at Zachau Construction, witnessed the project's time-saving benefits of CLT and wood panel construction first-hand. "In addition to erecting stair towers and elevator shafts in a day, it also allowed the framing of the building to happen concurrently; something we could not have done with masonry," said Wing. "We also were able to easily lift and crane the panelized components into place, saving an enormous amount of time on the project schedule overall."

"The design team, construction manager and owner all worked together. That's what allowed CLT to happen in this fashion," Wing added.

Mixed-Use Infill Project in Atlanta

Infill housing and mixed-use development is a powerful way to bring more housing and amenities to community areas while enriching and blending with existing neighborhood culture and appearance.

The architects of the Emery Point project, a vibrant, mixed-use apartment complex in the core of Atlanta, Georgia, employed a number of strategies to create an affordable solution that also boosted density.

The property's central location maximizes what they can do with the site. Its access to public transit ensures that residents can live comfortably without a car, reducing local traffic and carbon emissions, as well as the need for parking.

By building with wood—which allows for prefabrication off-site and quick construction—the developers met an aggressive schedule resulting in significant cost reductions of labor and construction.

"Cost for the structural frame portion only of the building was about $14 per square foot," according to Brad Ellinwood, engineer on the project. "In comparison, a 7-inch post-tensioned concrete slab and frame would have cost $22 per square foot. So, the wood-framing option yielded about 35 percent savings in the structure."

Building on Top: Innovative Use of Urban Space in Washington DC

Another creative solution to space constraints and making the best use of urban sites is to build on top of already existing buildings—adding stories to established structures, allowing for higher density while retaining the economic value and historical significance of the original building footprint. Mass timber's light weight opens new opportunities for overbuild construction. The 80 M Street addition in Washington DC is creating additional office spaces, meeting areas, a beautiful rooftop terrace and gathering places on top of an existing seven-story office building.

FROM CARBON SOURCE TO CARBON SINK: REDESIGNING THE BUILT ENVIRONMENT FOR CLIMATE CHANGE

Amidst the urgent need for affordable housing and urban infrastructure, the culminating impacts of a changing climate demand dramatic shifts in how we design and construct our buildings. One important part of the solution—convert the built environment from a significant carbon source to a carbon sink.

The Urgent Need to Lower Building Carbon Footprints

Climate change demands dramatic shifts in how we design and construct our buildings. At the same time, the urgent need for housing and supportive infrastructure continues to surge at record rates. Buildings and their construction account for 39% of global carbon dioxide emissions; 28% of those emissions come from operational carbon—the energy used to power, heat and cool a building.[45] Buildings' operational carbon can be reduced through energy efficiency measures, and policymakers, architects, developers, and engineers have made significant advances in this arena. The remaining 11% of carbon emissions are generated from building materials and construction.[46] This "embodied carbon" can account for half of the total carbon footprint over the lifetime of the building.[47]

To reduce the greenhouse gas emissions associated with construction, specifiers and stakeholders need to act now to create embodied carbon strategies that reduce environmental impacts from buildings we'll use well into the future. The costs of delaying any longer are too high. Greenhouse gas emissions have increased by 90% since 1970.[48] A 1.5% increase in global warming will have catastrophic results for ecosystems and people around the world, including the United States.[49]

Embodied carbon is a priority for many environmental, architecture, and urban planning organizations including C40 Cities,[50] Architecture 2030,[51] Urban Land Institute,[52] and the World Green Building Council.[53] Many experts believe addressing embodied carbon for buildings and building materials is critical to achieve the goals of the Intergovernmental Panel on Climate Change (IPCC) and the 2016 Paris Climate Agreement.

Embodied Carbon in a Building's Life Cycle

Embodied carbon is determined by conducting a life cycle assessment (LCA) of a product, assembly or the building over declared life cycle stages. An LCA study returns results for a number of environmental metrics, including the potential to impact climate or "global warming potential" (GWP). Embodied carbon is the GWP result. Embodied carbon is measured for each stage of the product's life cycle, allowing comparisons across any combination of stages.

As buildings become more energy efficient, the upfront embodied carbon from materials begins to account for a higher proportion of a building's carbon footprint.[54] Very soon, embodied carbon is likely to become the dominant source of building emissions.

Embodied carbon varies dramatically between concrete, steel and wood, making product decisions key in achieving lower carbon buildings. Manufacturing wood products requires less total energy, and in particular less fossil energy, than manufacturing most alternative materials including metals, concrete, or bricks.[55]

Embodied carbon emissions
Embodied carbon emissions in construction, commonly referred to as "embodied carbon," refers to the GHG emissions associated with the manufacturing, maintenance and decommissioning of a structure.

Greenhouse gases (GHG)
Greenhouse gases (GHG) are gases that trap heat in the Earth's atmosphere. Commonly these are carbon dioxide, methane, nitrous oxide and fluorinated gases (such as CFCs, HCFCs, HFCs etc. found in refrigerants).

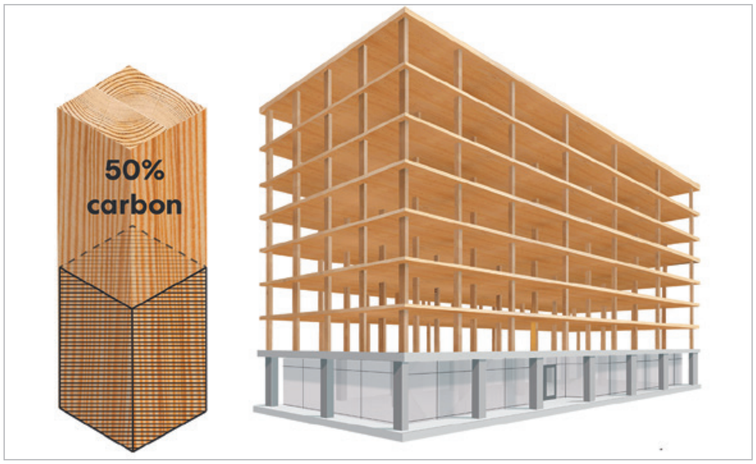
Life cycle assessment (LCA)
LCA is the compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle.

Operating emissions
Operating emissions in buildings refers to the GHG emissions that are generated from the burning of fossil fuels used to heat, cool and power a building during its service life.

Embedded Carbon in Wood Products

Embedded carbon is the storage of carbon for long periods of time. Wood products are approximately 50% carbon by dry weight.56 And wood's light-weight advantage when it comes to density and city building is making it an attractive climate-smart choice as pointed out in a research paper: *Lightweighting with Timber: An Opportunity for More Sustainable Urban Densification*.[57] The use of wood products in buildings provides an additional environmental benefit by storing carbon removed from the atmosphere. This ability to sequester, or "embed", carbon makes wood an ideal product for buildings, which are designed for long service lives. Essentially, a wood building is a large carbon sink.[58] This storage of carbon is a unique environmental attribute that does not exist in other structural products.

Timber as a tactic for curbing climate change is backed by a growing body of



Embedded carbon. Image credit: Think Wood

Model-C. Image credit: rendering courtesy Generate, Placetailor

research and advancements in calculating the carbon footprint of building materials.[59] In a recent paper published in the journal *Nature Sustainability*, experts at the Potsdam Institute for Climate Impact Research[60] in Germany delved into four possible scenarios of timber use in buildings over the next 30 years. In the first case, "business as usual," 0.5% of buildings are made with wood while the vast majority remain constructed of concrete and steel. There's a 10% timber building scenario; a 50% timber building scenario; and a fourth in which the vast majority—90% of new construction—is made with wood. Their findings suggest that the lowest scenario could result in 10 million tons of carbon stored per year, and in the highest, nearly 700 million tons.[61] "Buildings, which are designed to stay for decades," researchers write in the paper, "are an overlooked opportunity for a long-term storage of carbon, because most-widely used construction materials such as steel and concrete hardly store any carbon."[62]

While the research is limited to European wood construction, the authors of the study see global potential.[63] "This is the first time that the carbon storage potential of wooden building construction has been evaluated on the European level, in different scenarios," said Ali Amiri, one of the researchers of the study. "We hope that our model could be used as a roadmap to increase wooden construction."

Case Studies: Carbon and Climate

Design professionals across the country and around the world are increasingly constructing buildings using light-frame and mass timber structures in a commitment to combat climate change. Not only does wood continue to store carbon, its insulative thermal properties lend well to energy efficient solutions like Passive House.

Mass Appeal: CLT Passive House Demonstration Project

A Boston-based CLT Passive House Demonstration Project is a mass timber, mid-rise, multi-family, certified Passive House building that shows how cross-laminated timber systems can meet complex design and sustainability goals. It's the brainchild of MIT start-up Generate and design-build firm Placetailor.

"Mass timber buildings, like Model-C, have the ability to tackle climate change [and] are also mid-rise to accommodate urban density," says Generate CEO, John Klein.

The five-story, mixed-use demonstration project is Boston's first full cross-laminated timber (CLT) building, housing fourteen residential units and a ground floor coworking space. The project was designed to operate at net-zero carbon, which is achieved by calculating both the building's embodied energy and its operational energy, and offsetting any annual excess energy use through carbon offset purchases. The

FOREST FORECASTING: MORE TIMBER DEMANDS SUSTAINABLE FOREST PRACTICES

Researchers and practitioners emphasize that building more and taller with wood hinges on well-managed and sustainable forest practices. "Protecting forests from unsustainable logging and a wide range of other threats is key if timber use [is] to be substantially increased," says co-author Christopher Reyer from PIK. Sustainable forest practices are well established in North America. Forest management in the U.S. and Canada operates under federal, state, provincial and local regulations to protect water quality, wildlife habitat, soil and other natural resources. Deforestation in North America is among the lowest globally, and forest growth has outpaced harvesting for many decades.[64]

Net-zero energy

A net-zero building, also known as a zero-net energy (ZNE) building, net-zero energy building (NZEB), or zero-energy building, is "an energy-efficient building where, on a source energy basis, the actual annual delivered energy is less than or equal to the on-site renewable exported energy."

Net-zero carbon building

A net-zero building means all life-cycle greenhouse gas emissions from all sources derive a sum of zero or less. This includes accounting for life-cycle impacts of operational energy use, water consumption and construction (including materials extraction, manufacturing, transport to the site, installation and wastage, repair, replacement, refurbishment and end-of-life processing). It also includes benefits (avoided impacts) from reuse of materials and permanently sequestered carbon.

building is Passive House certified and meets the Boston Department of Neighborhood Development's Zero Emission Standards. It is scheduled to begin construction in spring 2021.

High-Density Mid-rise Light-Frame Construction: Yobi Microhousing

Today's wood-frame buildings can offer more affordable housing options. Four-to-six story wood-frame structures are a sweet spot for urban infill and neighborhood densification—helping to pencil out housing in bigger cities with rising costs. An excellent example is Seattle-based Yobi Microhousing.

A central strategy in the Yobi project is the creation of shared common space that contributes to an efficient building footprint. Conventional wood-frame construction with dimensional lumber shear walls combined with high insulation levels and sealed openings to create a high-performance exterior envelope for the project with energy use that is 40% lower than current energy code requirements.

The 13,689-square-foot, four-story structure accommodates 40 sleeping units built over a partially-below-grade basement. A ground floor provides common areas including a lounge, community kitchen, laundry area and media room.

"Wood makes it much easier to build an efficient envelope," says David Neiman, a principal architect for the project. Based on energy use per person, Yobi is 70 percent more energy efficient than conventional housing, according to Neiman.

Climate-Friendly Educational Design

Offering lessons in sustainability, more and more of today's education design—from elementary to post-secondary—showcases climate-smart low-carbon strategies.

At Billerica Memorial High School, timber contributes to the building's carbon-conscious design. Embodied carbon in the sustainably certified spruce timber structure offsets the equivalent of a typical school bus traveling over 460,000 miles.

The 30,000-square-foot Billerica, Massachusetts-based facility, designed by Perkins and Will, elegantly combines wood, steel and glass, to give a modernist nod to its neighboring neoclassical civic buildings, while delivering a high-tech, future-ready educational environment.[65]

T3: Low Carbon Commercial Construction

Standing at seven stories tall, T3 (Timber, Transit, Technology) was the first commercial property in the U.S. to use timber for its structure and interior finishing. It demonstrates how large timber projects can lower the carbon footprint of the built environment, while providing a warm and innovative commercial space. The 220,000-square-foot building was constructed with 8-foot-by-20-foot panels of wood that were stacked across beams of glued, laminated timber. The panels themselves were constructed using dimension lumber.

Approximately 2.2 million board feet were used in the structure, which will sequester about 700 tons of carbon for the life of the building. It was also built in significantly less time than conventional steel-framed or concrete buildings, completed in just two and a half months at an average of nine days per floor.[66]

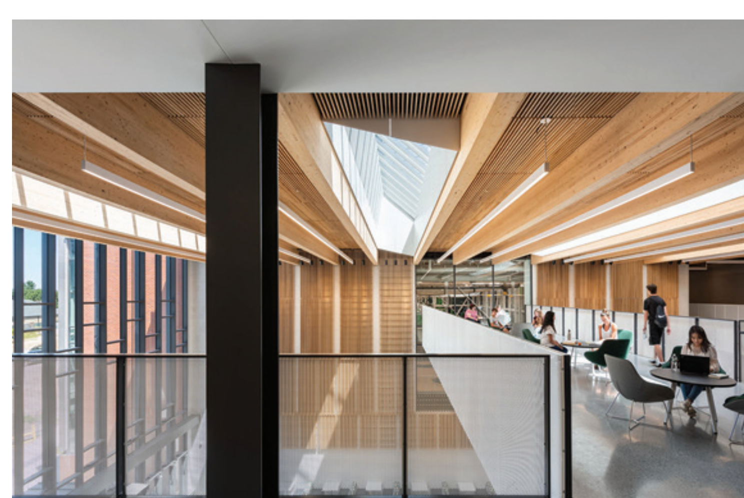
Given timber's light weight, lower production time and costs, T3 developer Hines has replicated this building prototype in Atlanta, with plans to expand to other markets including Chicago, Denver, Toronto and Melbourne.[67]

ARCHITECTING CHANGE: REASONS FOR OPTIMISM

As design professionals look to the decade ahead, there are many challenges on the horizon, from addressing pressing environmental and social issues to accommodating rapid population growth and shifting market demands. There is a growing understanding that the built environment is inextricably linked to many of the complex issues of our day.[68] While these problems are global in scale and, in some cases, beyond the influence of the AEC industry alone, there are actions design professionals are taking in their day-to-day practice that can begin to make an impact.

A rapidly evolving, post-pandemic world demands adaptive and versatile design professionals who are continually evolving their practice and looking to the latest research and methodologies to help inform their design solutions.69 Design teams are showing how we can boost

Yobi Microhousing. Photo credit: © 2015 William P. Wright



Billerica Memorial High School. Photo credit: Chuck Choi, courtesy Perkins&Will

health, affordability and wellness in today's increasingly dense urban environments through creative, nimble and flexible thinking.

There is also an urgent need to combat climate change and find advanced ways to store carbon in our buildings. Industry leaders are stepping up with substantial commitments—from conducting leading research on carbon and climate to erecting important demonstration projects. Structural timber is proving to be one significant way to sequester embodied carbon and reduce the environmental footprint of new construction. Ingenuity and smart design also can mitigate the impacts of global warming. Interweaving greenspace into the urban environment and even in and on top of buildings can have a cooling effect on our cities.

Industry leaders are committing to building for a resilient, healthy and low-carbon future—an 'architecture of optimism.' Jordan Goldstein, a design principal at Gensler writes, "Whether it's new buildings that are about to be designed or existing architecture that now needs to be reimagined, in many ways this is a time for an architecture of optimism. Optimistic architecture isn't architecture for the sake of architecture and doesn't seek to glorify form. Rather, it's an architecture that seeks to express its purpose in every aspect of the design–one that promotes wellness and celebrates life. The time to define this architecture of optimism is now. The future of our cities depends on it."[70] ■

QUIZ

1. Buildings and their construction are significant emitters of greenhouse gas emissions, accounting for what percentage of global carbon dioxide emissions?
   A. 21% B. 39%
   C. 11% D. 30%
   E. 29%

2. Which of the following statements regarding greenspace is true?
   A. Most people in North America spend about the same amount of time indoors and outdoors.
   B. In the vast majority of U.S. cities, citizens rich or poor have equitable access to greenspace.
   C. While the science is still emerging, researchers suggest a city of well-connected, attractive greenspaces may be better equipped to bounce back from crisis, natural disasters and extreme weather events.
   D. There is recent evidence that local access to greenspace and greenviews may have very little impact on physical health and mental well-being.

3. Which of the following is NOT a potential benefit of participatory design?
   A. Delivers significant time savings because fewer stakeholders are involved
   B. Lessens a community's resistance to change and encourages realistic expectations.
   C. Fosters ownership in the solutions and stronger community bonds.
   D. Boosts the overall confidence and resilience of a community.

4. By 2050 how much of the world's population is estimated to live in urban areas?
   A. Two thirds B. Half
   C. One quarter D. One fifth

5. Which of the following would be categorized as soft costs as outlined in a Harvard Joint Center for Housing Studies report?
   A. Cost of construction and interiors
   B. Financing, permitting and design
   C. Cost of acquiring land and site evaluations
   D. Substructure and site prep

6. According to the course materials, which of the following is false?
   A. Manufacturing wood products requires less total energy, and in particular less fossil fuel energy, than manufacturing most alternative materials including metals, concrete, or bricks.
   B. Many experts believe addressing embodied carbon for buildings and building materials is no longer critical to achieve the goals of the Intergovernmental Panel on Climate Change (IPCC) and the 2016 Paris Climate Agreement.
   C. It is estimated that 2.5 million new housing units are needed to make up for the nation's housing shortage.
   D. A 1.5% increase in global warming will have catastrophic results for ecosystems and people around the world, including the United States.

7. In a paper published in the journal Nature Sustainability, experts at the Potsdam Institute for Climate Impact Research in Germany delved into four possible scenarios of timber use in buildings over the next 30 years. The researchers made which of the following conclusions?
   A. In all four scenarios the carbon stored was insignificant.
   B. "Business as usual," 0.5% of buildings made with wood while the vast majority remain constructed of concrete and steel, had no carbon savings benefits.
   C. Buildings, which are designed to stay for decades, are an overlooked opportunity for a long-term storage of carbon because most-widely used construction materials such as steel and concrete hardly store any carbon.
   D. Building carbon footprint cannot be modeled at a regional level.

8. The course highlighted which of the following trends impacting the built environment and the business of architecture?
   A. Increased single-family home construction
   B. Low carbon construction and participatory design
   C. Extreme weather patterns
   D. Building information modeling

9. Which of the following statements are true?
   A. Wood products sequester carbon and are approximately 50% carbon by dry weight
   B. An insignificant percentage of global carbon emissions are generated from building materials and construction
   C. Greenhouse gas emissions have increased by 25% since 1970
   D. Access to greenspace is equal across urban populations

10. Embodied carbon is defined as:
   A. A building's entire carbon footprint
   B. A lifecycle analysis of the energy used during the service life of a building
   C. GHG emissions associated with the manufacturing, maintenance and decommissioning of a structure
   D. Fossil fuel-based energy used in the construction, maintenance and decommissioning of buildings

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