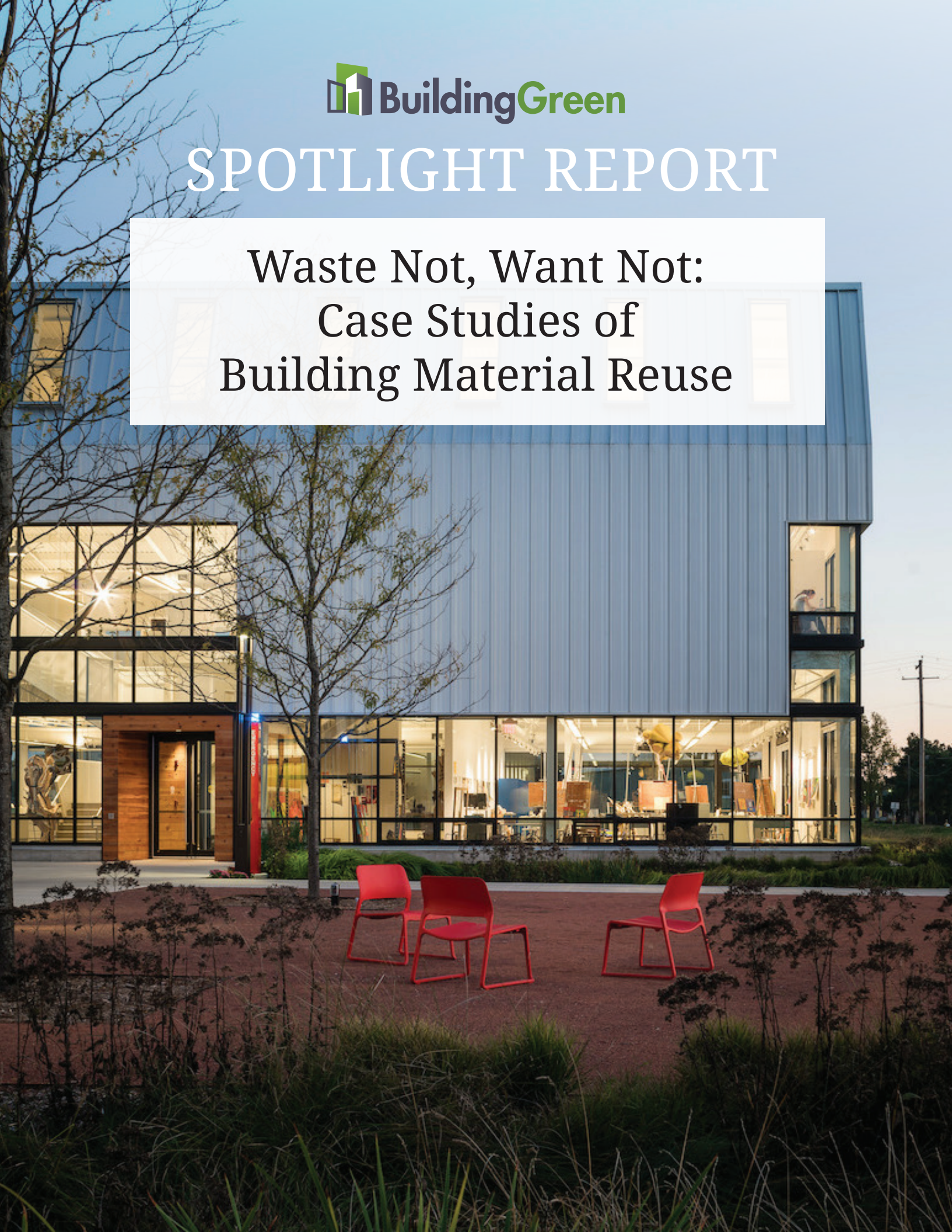
BuildingGreen

SPOTLIGHT REPORT

Waste Not, Want Not: Case Studies of Building Material Reuse



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BuildingGreen, Inc is an independent consultancy committed to providing accurate, unbiased, and timely guidance to help building industry professionals and policy makers improve the environmental performance of buildings and reduce their adverse impacts.

We offer consulting, training, facilitation, and online resources to help our customers design and build from a whole-systems perspective. Our integrated design approach minimizes ecological impact and maximizes economic performance.

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Waste Not, Want Not: Case Studies of Building Material Reuse

Reclamation and reuse of building materials can be a tough sell and hard to design for, but many project teams have learned to make it work. Here's how.

By Katharine Logan

The construction sector's take-make-waste approach to materials needs an overhaul. Materials and construction account for an estimated 11 percent of global greenhouse gas emissions annually, according to the World Green Building Council. At the other end of the life cycle, demolition in the United States annually generates 90% of some 600 million tons of construction-sector debris, according to the U.S. Environmental Protection Agency's most recent report—that's more than twice the amount of municipal solid waste from all other sources—and 145 million tons of it goes straight to landfill. Getting trashed alongside are the cultural, economic, and environmental values those materials embody. Indications are, though, that this staggering, decades-long profligacy is about to change.

"We simply can't afford demolition after 2050," Julian Allwood, professor of engineering and the environment at Cambridge University, said in a keynote address at a summit hosted recently by the Royal Institute of British Architects and the climate initiative Architects Declare. That's because the climate emergency requires reducing buildings' embodied emissions, as well as their operating emissions, to net zero: use less overall, and reuse more. (Embodied emissions are greenhouse gases generated during materials' extraction, manufacture, and transportation, and during construction and disposal.)

Photo: Photo: Lincoln Barbour Photography

Mahlum wanted its new 7,500 square-foot Portland office, located in a former metal-stamping facility, to express the firm's long-standing commitment to design for health and sustainability.

It's also because the expected doubling of global gross building area by 2060 will take a lot of material. And finally, in a zero-emissions world, there will be fewer new materials available: the techno-fixes that would allow emissions-free energy to supply current consumption levels have no real hope of being fully developed and implemented at scale in the available time, Allwood said. We'll have to live well with less.

In the coming decades, local availability of materials will transform the design process, and reclamation and reuse will be significant factors, says Felix Heisel. Heisel is the director of the Circular Construction Lab at the Cornell University College of Architecture, Art, and Planning, where he is an assistant professor of architecture. "I see this not as a limit to our design capacity, but as an advantage," he says. "By starting with the local

availability and specifics of materials, and letting these conditions drive the design process, we shift to an architectural language that's more economic, more ecologic, and, most of all, more meaningful."

Shifting to reclamation and reuse presents design teams with two main questions: How do we make use of materials in existing buildings that were not designed with reuse in mind? Salvaging from fixed assemblies is such a dirty process—one that releases toxins, pollutes water, and moves large volumes of material—that it is sometimes described as "urban mining." So the second question becomes: How can we build differently starting now so that, in the future, buildings function as materials banks or depots, rather than as urban mines?

Salvage: Opportunities and Obstacles

Preserving the multiple forms of value—history and skills, carbon and water—embodied in materials requires careful deconstruction. It's not uncommon to hear responsibility for indiscriminate demolition placed on contractors—for being resistant to changing their process, for not caring, for a "just get it built" attitude.

But contractors are the ones who see those 145 million tons of waste in person. Talk to them, and you'll hear that it's a shame, it's offensive, and it's heart-wrenching for everyone who touches these materials to know that they're going straight to landfill. "We have finite resources on this earth," says Laura Soma, project manager and sustainability specialist with Seattle-based GLY Construction, "and in the Seattle area, our landfills are running out of space. The goal for us is to help encourage a more circular economy, looking at

Images: Ricardo Barros (top), Michael Slack (bottom), both courtesy JZA+D

The adaptive reuse of a 100-year-old masonic hall in Princeton, New Jersey, entailed the removal of interior structural old-growth white pine, with well over 100 rings in a 12-inch section. "To even think of throwing it out is just mind boggling," says Joshua Zinder, founding principal at JZA+D. Through an in-house design competition, the firm developed a line of furniture to give the timbers new life as benches, stools, tables, and lighting fixtures. Produced and sold by a local housewares store, the pieces give the historic material a contemporary expression. "One of the core tenets of sustainability is 'Use what you have,'" says Zinder. "This is something we strive for on every adaptive reuse project we do."

how we can reuse things instead of just gut and go."

Common opportunities for salvage that Soma identifies (assuming they're free of hazardous materials, such as asbestos and lead paint) include:

Wood and hollow metal doors – Replace the hardware if moving parts are shot. And even if a wood door has been banged, you can fix it for a relatively small cost.

Acoustical ceiling tile – You have to be super careful removing them, but then stack them, keep them dry, and when you put them back up, just paint them if you want to. For projects that meet a required minimum quantity, the manufacturer may take them back.

Countertops and casework – If you don't like the look of the box, you can paint it or sand it down and stain it.

Acoustic wall panels – If they're hideous, take them off the wall—assuming they're not glued—and send them to a local shop to have new fabric put on, or paint the fabric that's there.

"The challenge is that not every client wants to spend the extra money to save existing materials," says Soma. Taking ceiling tiles down individually, for example, can take three times the work hours compared to trashing them. "So while we consistently try to have the conversations—we ask the client, we ask the architects, 'Do we want to reuse any of these materials?'—either the schedule or the budget won't allow for it."

Schedule, budget, space to store the stuff, and the logistics of incorporating salvage into project processes present significant obstacles to more widespread use of reclaimed materials, but they're not the final word. As disassembly methods become more streamlined and efficient—combined in some cases with gains from not having to wait for a demolition permit—deconstruction can be time-neutral compared to demolition. Salvaged materials can offer significant cost savings. Storage issues can (sometimes!) be solved. And while getting what you want when you want it can take some effort, reuse can also help solve supply-chain issues that have emerged during the pandemic, while providing high-quality or unique items that wouldn't otherwise be available.

Demolition isn't the slam-dunk it may seem either: it's complicated, expensive (average tipping fees of about $55/ton on 145 million tons of landfilled demolition waste total about $8 billion), and it's not a good story. "More of our clients today are cognizant of the concerns with CO_2," says Soma. "They'd be proud to tell a story about reusing materials to minimize their effect on the environment." Design teams that are able to quantify a return on investment that works for the client—whether it's cost, schedule, or corporate social responsibility—are adding value to their services as well as reducing their project's impact.

Success Stories: Project by Project

For success stories of materials reclamation and reuse, BuildingGreen spoke with pioneering designers about strategies, achievements, and lessons learned on exemplary projects:

Adaptive reuse design-builds from Alabama-based Rural Studio

Living Building Challenge (LBC) materials petal-certified office fit-outs from Minneapolis-based MSR Design and the Portland office of Mahlum Architects

A new arts center on the campus of Knox College by San Antonio-based Lake | Flato

And the Kendeda Building for Innovative Sustainable Design at Georgia Tech, by the Miller Hull Partnership (Seattle) and Lord Aeck Sargent (Atlanta)

Rural Studio: a culture of thrift

The industrialized materials and globalized supply chains that transformed the materiality of urban environments over the last 75 years or so—and, in the process, social attitudes toward waste—passed many poorer, rural communities by. Now, the values of thrift and frugality that some of these communities held to are values whose time has come again.

Since the design-build Rural Studio at Auburn University was founded by Samuel Mockbee and D.K. Ruth in 1993, its work in Hale County, Alabama, has been known for the practice of elevating reclaimed and ordinary materials through thoughtful use. "Culturally, it's in the DNA of the studio: you value what you have at hand, and you figure out how to make it even more beautiful than you found it," says Andrew Freear, the studio's director and a winner of the Global Award for Sustainable Architecture given by the Cité de l'Architecture et du Patrimoine under the patronage of UNESCO.

Rural Studio's philosophy of being inventive with what's locally available is born of practical necessity: "Fundamentally, we live in the middle of nowhere, and like farmers, we need to use what's around us," Freear says. As an extension of that necessity, "we'd rather not move things," he says. The studio's reluctance to waste, transport, or even move materials offsite results in an architecture that resonates in the collective memory of the community. "If you re-invent and reuse materials, people feel them to be of the place," says Freear. "They recognize them—and kind of *re-recognize* them."

Photo: AU Rural Studio

This courtyard is part of Project Horseshoe Farm, a community-based non-profit and life-enhancement organization located in Greensboro, Alabama.

As an example, Freear highlights the Newbern Library, which transformed a former bank building into a community hub. At the outset of the project, the crawl space under the historic structure had become a pond, in which beautifully cast bricks supporting the bank vault were wicking water up into the building. Rural Studio deconstructed the vault and its foundation and used the bricks to define an outdoor room beside the library. "And then it's all in how you stack the bricks," Freear says of the low walls' open fretwork. Wood salvaged from the rotted floor was used to line a deep window nook that looks out on to the courtyard. Beadboard taken in poor condition from the walls was painted and used to clad the library's new restrooms.

Other examples include the Safe House Black Historic Museum, in a shotgun house in Greensboro, Alabama, where the Reverend Martin Luther King Jr. once sought refuge from the Ku Klux Klan. During the renovation, the project team uncovered an interior wall cladding of distressed and variously painted boards; with the client's agreement that the uneven finish was beautiful and should be exposed, "we 'reclaimed' it before we even took it down," says Freear,

and edged it with bright white trim to make it "a little bit more precious."

At the Horseshoe Farm Courtyard, for a non-profit leadership development and service organization, bricks from an adjacent building that had been demolished into the space now pave it; a galvanized steel armature supporting ropes made from recycled plastic bottles surrounds the patio as a climbing frame for vines. And for the Hero Knowledge Cafe, the headquarters of a local non-profit, Rural Studio deployed donated window rejects to compose what Freear describes as "a very large Mondrian" for the rear wall of the space.

"There's a joy to this kind of improv that doesn't normally exist for architects," says Freear. "That's because in the contemporary world, we throw too much away. We don't often say, 'Well, we've got all of these things: what are we going to do with them?'"

Photo: Lara Swimmer Photography

The project team for MSR Design's new Minneapolis office set a stringent carbon budget of ten pounds per square foot, and the use of salvaged materials on the project was a major strategy in achieving that goal. The photo shows a biophilic art installation incorporating construction waste, plastics from the Mississippi River, and foraged plant materials.

Architects' HQs: talk the talk and walk the walk

510 Marquette

When MSR Design moved into new 13,700 square-foot premises on the second floor of a 1925 building (expanded in 1974) in downtown Minneapolis, the firm wanted its new space to manifest its social and environmental values. The project team set a goal of achieving Living Building Challenge materials petal certification—as well as beauty and equity petals—on a carbon budget of ten pounds per square foot. (Studies published by the Carbon Leadership Forum estimate that the embodied carbon of tenant improvements ranges typically between 9 and 28 pounds per square foot.) The use of salvaged materials on the project, completed in 2019, was a major strategy in achieving that goal.

Starting with the space's existing materials, which included traces of historic travertine floors, brick walls and piers along the exterior, and fireproofing-clad columns and ceiling structure, the design team generated a simple materials palette, with the intention of adding as little as possible to create a bright and supportive workplace. The aesthetics of material reuse were a particular focus. "A lot of the precedents look a little hodge-podge: you *know* everything's salvaged," says Emily Gross, an interior designer with MSR. "The challenge for me as a minimalist was, 'How do we make everything look clean and new?'"

Particularly ingenious is the use of manufacturers' samples from other MSR projects to create new finishes. The studio's carpeting consists of black and grey samples pieced together to form a new whole; bathroom wall mosaics are made from tile samples; and cushion covers were once fabric samples. Additional salvaged elements include marble tables, sliding panels, shelving standards, welded steel desk frames, task chairs, conference room tables, mechanical ducts, steel framing studs, lighting and controls, column covers, glass entry lites, and some grungy marble slabs that one of the contractor's other projects had no use for and that cleaned up magnificently. Instead of sending construction waste such as fireproofing and gypsum wall

board to landfill, the team loaded it into partition walls for extra soundproofing. Expressing the ethos of the whole undertaking is a biophilic art installation visible from the street: incorporating construction waste, plastics from the Mississippi River, and foraged plant materials, it's surprisingly delightful.

To facilitate further reuse and same-cycling in the future, materials were installed without adhesives. A wood wall and cabinetry system is mechanically fastened; carpet tiles are taped together; glass, metal, and salvaged marble elements are held with clips.

All told, the embodied carbon footprint of the project's salvaged materials represents 33,000 pounds of emissions saved, a 28% reduction compared to using all new material, with task chairs the biggest-ticket item. The calculus includes casework, even though Tally, the embodied carbon tracking software MSR used, doesn't specifically account for it. (MSR has developed a workaround using wall and floor families, modified in terms of thickness and assembly, with typical casework substrate and finish materials assigned from the Tally library.)

Beyond the environmental advantages, using salvaged materials helped the project to meet its LBC target on a tight schedule. Here the project's contractor, Stahl Construction, proved especially helpful—sourcing lighting fixtures from an electrical subcontractor's surplus, for example, when a manufacturer was slow to provide LBC-required product information. (LBC has a lower documentation threshold for salvaged materials.) According to Deborah Aldrich, project manager with Stahl, the company now routinely includes in its project orientation meetings an invitation to subcontractors to bring forward surplus and reclaimed materials, and suggests examples to get the ideas flowing.

On top of these successes, there's the human aspect. "The contractors put so much of themselves and their ideas into this project," says Simona Fischer, an associate at MSR. "They're really proud of this job." As for the design team itself, "it

NINE STEPS TO INTEGRATING RECLAIMED MATERIALS: A CHECKLIST

- ❑ Identify salvage as a project priority early. Engage the entire project team in identifying design opportunities for, and availability of, salvaged materials. Especially involve the contractor.
- ❑ Identify project-specific challenges to the use of reclaimed materials—such as storage space—and begin putting solutions in place. Does the owner have space nearby? Can the municipality make a temporary loan of vacant space to help eliminate waste?
- ❑ In the case of an adaptive reuse, walk the site to identify salvageable materials before design or deconstruction begins.
- ❑ Research local sources of salvaged materials, including in-house.
- ❑ Design around available materials.
- ❑ Design to facilitate disassembly and reuse.
- ❑ Find or develop language for incorporating reclaimed materials into project specs.
- ❑ Ask the contractor to highlight the salvage priority in project orientation meetings with trades, and to invite their contributions. Suggest examples to get people thinking.
- ❑ For best results, remain flexible: focus on how project components need to perform, rather than the specifics of how they're executed.

became more fun," she says. "This is a more hands-on way of making that we as architects have maybe lost connection with."

Custom Blocks Studio

Like MSR, Mahlum wanted its new 7,500 square-foot Portland office (2019), located in a former metal-stamping facility, to express the firm's longstanding commitment to design for health and sustainability. Targeting LBC materials—as well as place, equity, and beauty—petal certification, Mahlum approached the challenge as a firm-wide capacity-building opportunity, supporting staff in taking on aspects that interested them. These included researching materials and products, overhauling the firm's materials library and developing criteria for its contents, working with local fabricators and salvage brokers rather than buying off-the-shelf systems and products, conducting a cradle-to-grave life-cycle assessment of the project (going beyond LBC's cradle-to-gate requirement), and developing wording to integrate salvaged materials into the firm's master spec.

The spec required a mind shift, says Jay Hindmarsh, associate principal at Mahlum: "It's almost like we had to develop a new language around salvaged materials."

For example, having connected with several salvage brokers in the Portland area and identified some options for the wall cladding, the team wrote the specifications to provide an allowance (section 012100) for bidding. This gave the architect and the contractor flexibility in making the final selection, and allowed the contractor to purchase only as much material as required, with a surplus from the allowance returned as a credit at the end of the project. For framing, the architect developed "kind of a performance spec," says Hindmarsh, working with the contractor to identify good, better, and best options—including FSC lumber, salvaged wood studs, and salvaged metal studs—to put out to bid.

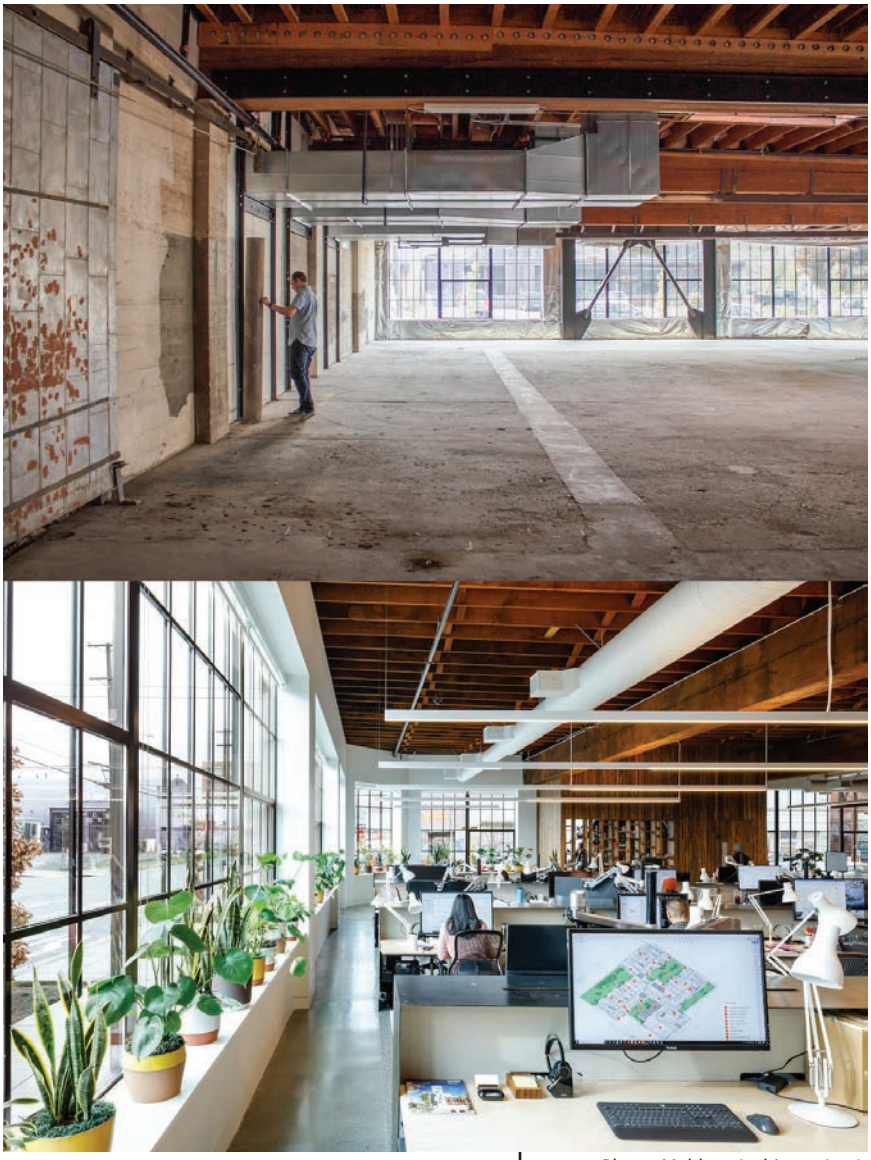

Photo: Mahlum Architects (top), Lincoln Barbour Photography (bottom)

The Mahlum office project team worked together to identify good, better, and best options—like FSC lumber, salvaged wood studs, and salvaged metal studs.

As well as developing capacity in-house, Mahlum helped the contractor to understand the range of options the new paradigm implied. "You could almost see when the lightbulb went on," says Hindmarsh. The contractor, Perlo Construction, became a contributing partner, identifying such reuse possibilities as steel studs and insulation, temporary construction barriers and cladding screen, lighting fixtures, and some scraps from another project that were just right for a tiny amount of exterior wall that the project touched.

Other examples of salvaged items in the final design include existing overhead steel trolley beams, which were suspended from the structure in the new common area, with their patina left on and seismic bracing added, as an armature for lighting, power, and data. The beams can also be used for hanging art or audio-visual equipment to support larger gatherings. Additional reclaimed materials include wood framing, decking, and wall cladding from the removal of buildings from a national historic site nearby, as well as salvaged-in-place doors and relites that were repurposed along the space's demising wall, and systems furniture brought from Mahlum's old office.

"What got us over the finish line and helped keep cost overages down was flexibility in how the design concept was delivered," says Hindmarsh. "Knowing what the end goal was, and how it needed to function, but not being super rigid about the specifics, meant the design was nimble, and we could flex to accommodate what we needed."

Higher Education: integrated solutions

Whitcomb Art Center, Knox College

The 29,500-square-foot Whitcomb Art Center (2017) at Knox College, in Galesburg, Illinois, consolidates the college's art history and studio art departments in a single daylit, cost-effective, and modern building while creating a new, community-facing gateway on the campus's northern edge. "Reusing salvaged materials was a great way for us to use modern forms and materials, but still connect to Knox's historic campus," said Heather Holdridge, sustainability director at Lake | Flato, the project's architect.

A pre-engineered metal building system meets budget and performance requirements, while locally reclaimed materials soften the building's aesthetics and help it belong. What Holdridge calls "a scrappy assemblage of humble pieces" provides warmth, texture, and contextual associations throughout. Hardwood flooring from the renovation of a campus building and wood siding from a lumberyard shed formerly on the art center's site were reused as exterior wood cladding and interior wood paneling. Locally made Purington brick pavers from previously demolished Galesburg sidewalks and streets were stockpiled during an earlier campus renovation and redeployed here to clad the public-street-facing façade.

In addition to giving the building a sense of fit, salvaged materials contributed

Photo: Andrew Pogue

For the Whitcomb Art Center at Knox College, a pre-engineered metal building system met budget and performance requirements while locally reclaimed materials soften the building's aesthetics and help it belong.

to design for durability and longevity. "Knowing we were using materials that had been able to weather Galesburg's very cold climate for decades assured us that they would perform," said Holdridge. They also helped with budget: except for some local labor and transport costs, many of the salvaged materials were essentially free. And yet their value totaled 5.4% of material costs, contributing a point to the project's LEED Gold certification.

Holdridge credits the project's integrated design process with enabling the team to identify salvage as a priority early on and to act quickly when opportunities came along. Even so, the logistics of finding the right thing at the right time proved a challenge, and there were some opportunities that the team wasn't able to realize. "Right now there's not a standard database that everybody's using to get these materials," Holdridge says. "I hope that's where the industry is going because, on a firm-by-firm basis, our opportunities are somewhat limited."

Kendeda Building for Innovative Sustainable Design, Georgia Tech

Early identification of salvage opportunities was also a priority for the 47,000-square-foot Kendeda Building for Innovative Sustainable Design at Georgia Tech (2019), designed in collaboration by the Miller Hull Partnership and Lord Aeck Sargent Planning and Design (LAS). The southeast's first Living Building Challenge-certified project of its type, Kendeda's big move is its mass timber structure—a system selected for its lower embodied carbon compared to concrete and steel as well as for its biophilic qualities. "As soon as we started designing," says Joshua Gassman, sustainable design director at LAS, "we were asking ourselves, 'How much could we reasonably build out of salvaged wood?'" The answer, it turns out, is quite a lot.

Photo: Jonathan Hillyer Photography

Early identification of salvage opportunities was a priority for the 47,000-square-foot Kendeda Building for Innovative Sustainable Design at Georgia Tech, which incorporates salvaged wood in multiple applications.

Nail-laminated wood decking, which was panelized off site and craned into place, incorporates 25,000 linear feet of 2x4 dimensional lumber cast-offs from short-term use in Atlanta's film industry. Kendeda's contractor, Skanska USA, coordinated with Atlanta's Lifecycle Building Center, a salvage non-profit that has diverted some 5.6 million pounds of building materials from landfill since it began in 2011, to capture and store as much of the film industry's lumber outflow as it could. Assembling the

panels required only entry-level carpentry skills, so Skanska partnered with Georgia Works!, a non-profit workforce development program, to provide formerly homeless or incarcerated community members with trade skills and work experience to help get them back on their feet. “We wanted the building to be integrated into its place on multiple levels: site, history, community, and curriculum,” says Gassman. “All of these create layers of richness and depth.”

Alternating the salvaged 2x4s with new 2x6 lumber creates a ridged under-side in which only the 2x6s are resting on the trusses below. Technically, that makes the 2x6s the only structural elements, which meant that the 2x4s didn’t require testing under the building code. The fluted surface also improves the acoustics of the space. Off-cuts were made into seat-steps in the building’s atrium.

In addition to the structural elements, wood salvaged from trees felled on campus was used for countertops and furniture, and large heart-pine joists salvaged from one of the university’s 19th-century load-bearing masonry and timber buildings have been refinished to form the treads of Kendeda’s central staircase.

For LAS, the biggest takeaway from the project is the importance of asking, “Do we really need this?” says Gassman. For others in the industry, he hopes Kendeda demonstrates that salvage is a viable way not just to reuse material but also to improve the aesthetics, the environmental performance, and the community impact of buildings. “What we need is for all these things to scale up and prove out a circular economy,” he says. “As more and more people do it, they make the systems easier to work with, and put the economies of these components in place.”

Systemic Solutions: Organizations and Initiatives for Change

While design teams are tackling the challenges of material reclamation and reuse project by project, other organizations and initiatives are addressing the issue at a systems level.

Circular Construction Lab

The work of Cornell’s Circular Construction Lab (CCL), for example, aims to advance the shift from linear to circular economies with a two-pronged approach: investigating ways both to design and to construct buildings as material depots for the future, and to activate the potential of the built environment as a material mine in the present.

An innovative inventorying strategy is an example of a mine-focused initiative now under development. The goal is to make information about materials coming up for salvage available earlier, to give design teams a longer lead time for integrating them into a new project, and to shorten the period the materials need to be stored. The inventory approach consists of low-tech surveys (a matter of asking the right questions) in combination with broadly available tech-based information gathering methods, such as LIDAR scanning. Algorithms are being developed to process the generated data and to assess how much and what type of material will be coming available from an inventoried building. “One challenge lies in the question of where this information gets saved, and how it is made available to—for example—an architecture office,” says CCL director Heisel. “A completely new marketplace needs to be developed to bring material mines and design ambition together.”

BuildingGreen Peer Networks

To help make much-needed connections between design teams and reclamation organizations and initiatives across North America—whether programs like the CCL's, companies dealing in salvaged materials, contractors with expertise in deconstruction, or jurisdictions developing waste-diversion policies, to name a few—without having to duplicate investigations other teams may have already done, a crowdsourced initiative arising out of BuildingGreen's 2020 summer summit of sustainable design leaders is mapping them. A particular goal for the mapping initiative is to build on salvage's traction in the residential sector and increase capacity for commercial projects.

"Part of the benefit of crowdsourcing is that we can each populate information for the areas we know best, since this work is inherently local and place-based," says Yarden Harari, an associate at CallisonRTKL, who is coordinating the effort. The initiative began as a shared Google My Map, and populated quickly: version 1.0 now pinpoints more than 200 entries. Behind the scenes, a spreadsheet master database is under development and has so far catalogued more than 500 organizations, including such information as function; collaboration opportunities; product focus (aligning with construction specification divisions); status as a public, private, or non-profit entity; and diversity and equity factors. Version 2.0 of the mapping exercise is imminent, says Harari, and will further refine its rigor and ease of use.

ANEW

An example of a resource on the map is Los Angeles-based ANEW, one of very few salvage organizations focusing on commercial materials. Founded in 2005 by a commercial interior designer, Rose Tourje, the nonprofit works with companies in a process it calls "surplus stewardship" to direct workplace assets away from landfill. By matching companies' surplus to charities, non-profits, public agencies, and underserved communities, ANEW diverts an average of three million pounds annually of carpet, furnishings, and other assets—although Tourje is quick to point out that with an estimated 1.7 billion pounds of office assets ending up in landfill annually, there's still a lot to be done.

In the last couple of decades, ANEW has served more than 2,000 recipient organizations in 20 countries, with an often

Photo: Tom Jersø

A Danish pilot project that's pushing the frontiers of circular economies in construction is Circle House, a 60-unit, 59,200-square-foot social housing development scheduled to begin construction in March 2022. This full-scale mock-up of a Circle House unit formed part of an exhibition outside the Copenhagen headquarters of the developer-client, Lejerbo.

profound effect. “As a non-profit you can’t always afford all of the things that you might want to create a comfortable place of business where your staff can be its most effective,” says Fred Kramer in a video created by ANEW’s award-winning media production arm. At the time, Kramer was the executive director of Jewish World Watch. “What we got—and I absolutely couldn’t believe it—was beautiful, brand-new carpeting for the entire office. Everybody was happy and really felt like they were moving into appropriate office space, given the seriousness of the work,” he says.

Rheaply and Gensler

Coming at the challenge from another perspective are a pair of initiatives Gensler is developing in collaboration with Rheaply, a technology company that combines an asset management system with an online marketplace. (Rheaply is a BuildingGreen Top 10 Building Products winner for 2022).

The first initiative, in the form of a toolkit which Gensler will roll out as a pilot in the first quarter of this year, aims to make reuse a standard practice in commercial interior design. “How does a designer go from the existing path of outreach to manufacturers, getting samples, cut sheets, and CAD background to bring a product into a project?” says Marcus Hopper, a senior associate in Gensler’s San Francisco office, who is leading the initiative. “How do you start to build another system that creates comfort all around?” Responding to those questions, the kit will provide Gensler’s designers with guidance on incorporating reclaimed materials and products into drawings and specifications, suggest legally and technically vetted language for proposals and contracts, and build illustrative case studies. Gensler is also exploring with Rheaply the possibility of developing an in-house asset management sharing platform.

The second, related initiative is an online resources exchange, called the Building Resources Innovation Center (BRIC), that Rheaply is developing in partnership with the City of San Francisco, with funding from the Carbon Neutral Cities Alliance. BRIC is intended as a model for the diversion of commercial materials from the waste stream and an exchange in which designers, contractors, and owners interact to optimize the reuse of these resources. Commercial interiors materials coming to BRIC will be catalogued through an asset management system, where designers will be able to log in and see what’s available. BRIC is expected to be ready to demonstrate by November of 2022.

Gensler is advising on how to make the system effective and appealing for designers to use. An essential aspect of the challenge is the perception of reclaimed materials. “It’s almost a branding effort,” says Hopper. “Issues such as logistics, risk, or previous, unsatisfactory experiences with ‘second hand’ are all legitimate and all need to be addressed.” When materials arrive at the BRIC site for cataloging, they need to be quality checked. Designers need to be able to get a sample and photos that they could present to a client and feel comfortable recommending—“not some badly photographed thing on a construction site,” says Hopper. “It has to be on par with new. It has to be [that] there’s no difference.”

Minnesota Pollution Control Agency

Another jurisdiction tackling waste reduction through a materials reuse program is the Minnesota Pollution Control Agency (MPCA). Based on extensive consultations with industry members in the state—including manufacturers, researchers, construction contractors, recyclers, deconstruction firms, and architects—to identify obstacles to reuse and

develop solutions, the agency has made five major recommendations. These are:

- Statewide, state-funded deconstruction training, especially directed toward disadvantaged community members, and delivered in both urban and rural areas
- Incentives for building preservation without regard to building age or type
- A statewide diversion requirement on building removal (the use of the word "removal" is deliberate as the agency tries to normalize alternatives to demolition)
- A rebate program for the reuse of building materials in new construction and renovations
- A three-tiered system of deconstruction ordinances with templates that cities and counties can adopt at the level best suited to their circumstances

"We think we're fairly holistic on those five with regard to supply and demand," says Melissa Wenzel, a built environment sustainability administrator with the MPCA. And although the pandemic has interrupted implementation of the recommendations and has limited funding opportunities, Wenzel says the program now has a strong foundation of support from people in many different sectors of the built environment system. "We've built a lot of momentum even without a lot of state resources," she says.

Toward a Circular Economy: Circle House

The ultimate goal for materials reclamation and reuse is a comprehensive series of circular economies.

Photo: Tom Jersø

The interior of Circle House was set up as a curated exhibition of circular materials, products, and solutions.

In 2015, the Ellen MacArthur Foundation, McKinsey Center for Business and Environment, and the Danish Environmental Protection Authority published *Delivering the circular economy: a toolkit for policymakers*. With Denmark as a case study, the report identifies the building sector as one of the industries with the most to gain.

A Danish pilot project that's pushing the frontiers of circular economies in construction is Circle House, a 60-unit, 59,200-square-foot social housing development scheduled to begin construction in March 2022. Located in a sustainability-focused development district in the city of Aarhus, with funding from the Danish Environmental Protection Agency and the Realdania philanthropic association, the project brought more than 60 construction-sector companies and organizations together with the goal of developing a circular system that could be tendered on competitive market terms.

The $16.8 million project budget, including $9.2 million for construction, is comparable to that of a conventional social housing project. An additional $1.5 million was used to reduce project risks through upfront collaborative design research, resulting in tender materials

that included more comprehensive documentation of potential circular solutions than would otherwise have been possible.

Consisting of a mix of two- and three-story terraced houses and five-story tower blocks, Circle House is designed so that 90% of its materials can be reused at the end of their service life on the project with no significant loss of value. "That means we've got to design everything for disassembly from the inside out," says Kåre Poulsgaard, a partner and head of innovation with GXN, the independent research and consultancy firm of Copenhagen-based 3XN Architects. Both firms are part of Circle House's four-firm design collaborative, which also includes Vandkunsten and Lendager Arkitekter.

All of the materials, systems, and products selected for Circle House are commercially available. A key strategy in designing for circularity was to select them with regard to building layers' varying cycles of use. Finishes and furnishings, for example, are assumed to have a zero- to five-year cycle. A manual with suggested products for this maximum-churn layer includes a wood flooring system that clicks together without adhesives and can be returned to the manufacturer to be re-milled into wall paneling; carpet tiles and wall-to-wall carpet that can also be returned to the manufacturer, where the yarn (incorporating recycled ocean plastics) and backing (from recycled plastic bottles) are separated and put back into production; and lime-wash paints that contain no organic solvents, preserving agents, heavy metals, or microplastics, meaning they can be safely returned to the biosphere.

The space-plan layer is assumed to have a five- to fifteen-year cycle of use. Examples of products in this layer at Circle House include oriented-strand board and fiber-gypsum wallboard systems that are designed so that the panels can be disassembled and reused whole, without having to undergo the energy-intensive recycling process of being crushed and reconstituted.

Components of the project's services layer—designed for a 15- to 25-year cycle—are accessible and demountable, making it easier to maintain them, optimize their performance, and renovate them at cycle end. Service pipes, for example, are ducted openly inside skylit stairwells, in a sort of reverse-Pompidou, as functional, expressive elements of the interior design.

The demountable façade system (25 to 50 years) accommodates a range of material options—including wood, metal, and fiber cement—which are used in pieces that are either as large as possible or as small as possible to maximize their reusability. Windows are demountable as whole frames, with the team currently exploring an option designed for disassembly into constituent components, 93% of which can be recycled. Another option under consideration is a Cradle-to-Cradle-certified roofing membrane that uses recycled bitumen in an endless loop.

The project's structure (50 to 100 years) consists of modular concrete panels with mechanical, rather than cast-in-place, connections with a 100-plus-year lifespan. To close the gaps between panels, the system uses a porous cement mortar that can be removed without a trace.

A full-scale mock-up of a Circle House unit formed part of an exhibition outside the Copenhagen headquarters of the developer-client, Lejerbo, where it was used as a meeting and event space to inspire collaborators, business partners, and the public. The interior was set up as a curated exhibition of circular materials, products, and solutions along with descriptions, contact information, and links to websites to make it a small step from inspiration to implementation.

Taken together, Circle House and the other projects, practices, organizations, and initiatives highlighted here are making significant steps towards a more circular built environment. Working both project-by-project and at a systems level, they are salvaging the multiple forms of value embodied in materials that were assembled with no thought for disassembly. And at the same time they are looking ahead, designing buildings of the future for materials reuse.

As this progress continues, says Poulsgaard, the next big step is to realign the business and organizational relationships in the industry—within project teams and, especially, between large financial players in the market, such as developers, building owners, and large tenants—to serve the processes that are needed for the building sector to adapt, to change, and to retain value over time. "We don't need a full-scale revolution," he says. "We just need to be smarter about how we do things."

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Description:

The construction sector's take-make-waste approach to materials needs an overhaul. Materials and construction account for an estimated 11% of global greenhouse gas emissions annually. At the other end of the life cycle, demolition in the United States annually generates 90% of some 600 million tons of construction-sector debris. Getting trashed alongside are the cultural, economic, and environmental values those materials embody. Indications are, though, that this staggering, decades-long profligacy is about to change.

Reclamation and reuse of building materials can be a tough sell and hard to design for, but many project teams have learned to make it work. Learn how through five case studies of building material reuse, and also find out about emerging systemic solutions.

Learning Objectives

Upon completion of this course, participants will be able to:

1. List three practical reasons why building demolition—rather than environmentally preferable deconstruction and salvage—will cease to be an option in the future.
2. List four barriers to the sustainable practice of using reclaimed materials.
3. Explain the importance of and practical considerations associated with finding systemic, environmentally preferable solutions to the take-make-waste culture of the building industry.
4. Define "circular" economy and explain how Circle House provides a real-world example.

QUIZ QUESTIONS

1. Materials and construction account for ____ of global greenhouse gas emissions annually.

- ☐ a. Less than 1%
- ☐ **b. More than 10%**
- ☐ c. Nearly 20%
- ☐ d. Over 25%

2. Demolition in the United States annually generates ____ of some 600 million tons of construction-sector debris.

- ☐ a. Less than 50%
- ☐ b. 75%
- ☐ c. 80%
- ☐ **d. 90%**

3. Construction-sector debris makes up ____ the amount of municipal solid waste from all other sources.

- ☐ a. A quarter
- ☐ b. Half
- ☐ **c. Twice**
- ☐ d. Three times

4. Current barriers to material reuse include

- ☐ a. Contractors "just get it built" mentality
- ☐ **b. Schedule constraints**
- ☐ **c. Budget constraints**
- ☐ **d. Storage constraints**

5. Common opportunities for salvage include:

- ☐ **a. Wood and hollow metal doors**
- ☐ **b. Acoustical ceiling tiles**
- ☐ **c. Countertops and casework**
- ☐ **d. Acoustic wall panels**

6. Buildings in a circular economy are designed to ___.

- ☐ a. be easily modified to fit new uses
- ☐ **b. serve as material depots for the future**
- ☐ c. withstand changing environmental impacts
- ☐ d. sequester carbon

7. Circle House is designed so that ___ of its materials can be reused at the end of their service life on the project with no significant loss of value.

- ☐ a. 50%
- ☐ b. 75%
- ☐ c. 80%
- ☐ **d. 90%**

8. Materials with a short use cycle ____.

- ☐ a. Have no place in a circular building
- ☐ **b. Should be chosen from a manufacturer with a take-back reuse or refurbish program**

9. Designing a building for a circular economy includes ___.

- ☐ **a. Planning for reuse of each material**
- ☐ **b. Allowing for maintenance and refurbishing or building components**
- ☐ **c. Using modular systems in all aspects of the building**
- ☐ d. Thrifting

10. An essential aspect of the challenge of building systems for the diversion of commercial materials from the waste stream is ___.

- ☐ a. Materials not being up to code
- ☐ **b. how to share the data of available materials**
- ☐ **c. the perception of reclaimed materials**
- ☐ d. legal issues

TAKE THE OFFICIAL QUIZ

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