Adaptive Reuse

DEBORAH
BERKE
PARTNERS

atelier ten

Contents

Introduction

The imperative to reimagine old buildings for new futures

The architecture of adaptation is uniquely potent. Reimagined buildings can assume a new stance by wearing the changes made to their use and character. Their transformations are made more profound and their impact is amplified by a nuanced dialogue between past and present. Adaptive reuse both sustainably extends the life of buildings and helps reestablish their relevance to the communities they serve.

Communities across the country have rebuked the hallowing of racial hierarchies within their institutions. Following these calls for change, institutions have asserted their commitment to equity and justice; this commitment extends to the experience of the built environment. Too often, buildings and campuses feel like they require "insider knowledge" to navigate their spaces and grounds. Exclusionary signaling can range from the overt—honoring histories of discrimination and subjugation—to subtler gestures of unwelcome. Understanding and open-minded discourse are vital steps toward change. Can buildings contribute to this constructive discourse? Can campuses extend equal welcome to all? We think they can.

When razing a building to start anew, the new building may indicate, even commemorate, what was there before, but it stands as a forthright expression of the present. On the opposite end of the spectrum, when an entirely faithful act of historic preservation, the conservation fortifies and memorializes the past. We are primarily focused on the messy middle—adaptive reuse projects that are neither pure acts of establishing something new, nor the safeguarding of something old, but rather complex negotiations between the past and present. When you adapt a building for a new future, the very act of adaptation—critical reflection of the building's past and current postures, developing consensus on what should remain and how the existing fabric is expressed, and reimagining the building for contemporary use and values—offers a platform for constructive dialogue. Architecture can convey this dialogue, and in doing so, present a far richer and more nuanced response to the charge.

Just as adaptive reuse is uniquely positioned to confront and reexamine social and cultural paradigms, the practice holds promise to address the performative shortcomings of our existing buildings. According to the UN Emissions Gap Report from 2020, the most effective approach to staving off a rise in global temperatures in excess of 1.5°C is for the world to systematically reduce emissions within the next 10 years, by 2030.[1] Given the carbon debt incurred by demolishing to construct new and efficient buildings, this 10-year window brings an urgency to the problem that adaptive reuse is well-positioned to address. Close to two-thirds of the building area that exists today will still exist decades from now;[2] improving the performance of existing buildings will have substantive impact.

Clearly, there may be site-specific rationales to build new, to preserve, or to adapt. But to assume a path of deliberate understanding toward purposeful reinvention, we should consider thoughtful and ambitious transformations of existing buildings.

Sustained Impacts

Adaptation invites nuanced dialogue between past and present

Buildings, particularly historic buildings, can convey to some a sense of integrity and awe. To those marginalized in our society, they can convey repressive authority and power. Buildings can outlive their original functions or lose their cultural relevance. Their signs and modes of exclusion may be subtle, though no less corrosive. The answer is not to do away with old buildings, but to recontextualize them, to modify them to be deliberately inviting and inclusive, and to provide evidence of their change. Reinvention avoids memorialization and museumification, which are closed-off interpretations. Adapting these buildings opens the door to new possibilities and configurations, creating more open-ended and culturally-accessible spaces.

The first step in transforming an existing building is to develop an empathetic understanding of its historic and social context. Determining what to preserve and how to interpret its cultural heritage is a process of decipherment and translation. Stakeholders are asked to navigate and confront various "webs of meaning."[3] As the ambitions for future buildings are considered, so are the ways the present fabric may impinge on those ideals. When approached thoughtfully, this process of marrying old and new can lead to productive dialogue. The dialogue is most substantive, and the built result is most impactful, when diverse voices and experiences are invited and accepted.

Above and Below:

The original 1930s Art Deco building was designed by the architects Shreve, Lamb & Harmon, as a YMCA for sailors and merchant marines. The building was sold to New York State and operated as a women's prison from 1974-2012. The prison reported high rates of abuse and was a site of pain and confinement. Following its decommission, the building was envisioned as The Women's Building, a new global hub for the women's and girls' rights movements.

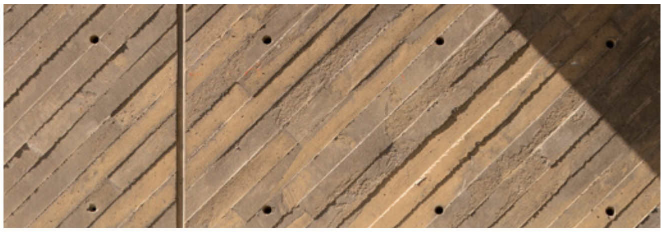
DBP and the NoVo Foundation led an inclusive community engagement process that grappled with the building's checkered history.

A newly common setting

Adapted buildings can help create "bridging ties,"[4] linking together people with various backgrounds. They offer a common setting for broad groups—one that gives presence to the past while assuming an intentionally equitable stance that is open to the future. These layered buildings elicit thoughtful engagement, extending discourse in ways that are approachable and reinforcing.

Ties to the community

Renovating existing buildings establishes a purposeful continuity that values a community's local environment and history. Celebrating the craft and artisanship that went into the original building, rehabilitation can tap local labor skills to support a regional economy. Adaptive Reuse can help strengthen ties rather than build new fences.



Above:

Our design of the Rockefeller Arts Center at SUNY Fredonia adds to a 1968 I. M. Pei building with long concrete walls punctured with metal and glass. The addition inverts the language using a lighter palette where concrete is reserved as an accent. Working closely with local skilled concrete workers, we developed a distinct diagonal boardform patterning.

Below:

NXTHVN is a not-for-profit arts and community incubator founded by artist Titus Kaphar in the Dixwell neighborhood of New Haven, Connecticut. By reusing the fabric of two existing factory buildings, NXTHVN expresses itself as a continuation of the community.

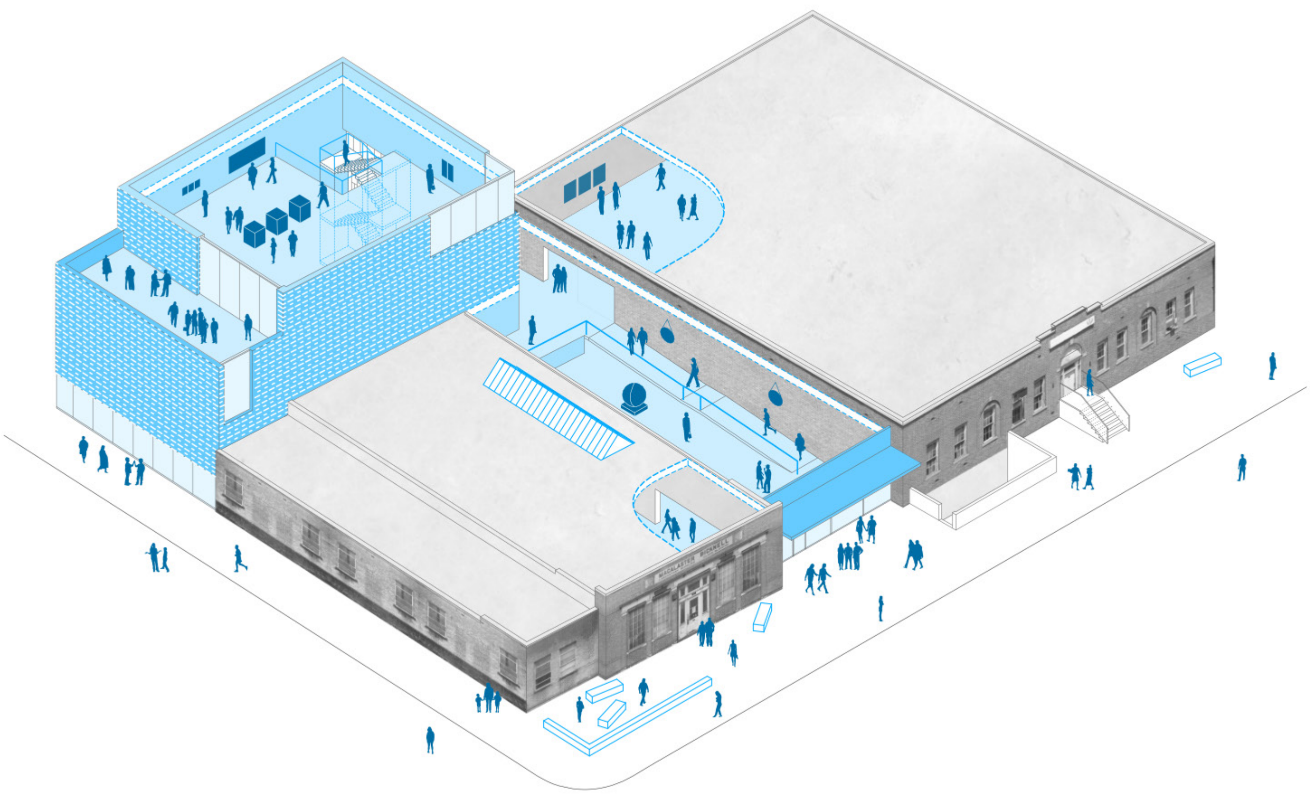
Adaptive reuse both sustainably extends the life of buildings and helps reestablish their relevance to the communities they serve.

Above and Below:

NXTHVN is dedicated to providing affordable workspaces for artists, mentoring local youth, and contributing to the revitalization of the Dixwell neighborhood of New Haven. It occupies two abandoned factory buildings and includes a luminous new addition.

The design celebrates the found conditions of the old buildings. Timber beams, brick walls, and concrete floors are cleaned and left exposed, and some industrial elements are retained. The Great Hall is reopened to a double height space with sawtooth skylights.

The new addition's facade is composed of glass and staggered gray brick, creating a clear distinction between old and new. Illuminated at night, the new addition acts as a beacon for the center, and signals renewed investment in the neighborhood.



A Harmonious Collage

Layered environments that elicit curiosity and connection

Working with old buildings has been at the center of our practice for reasons both opportunistic and ideological. Buildings—whether loved or maligned by those who use them, whether attributed to a famous architect or without an author—are complex things, with histories and implicit meanings. We see their renewal and reinterpretation as an active and intelligent act. The existing building is more than a scenic backdrop, adding quick cachet to a new program — it is a source of inspiration and a point of departure.

The result can be intricate and layered. Bearing visible traces of its earlier form, the transformed building becomes something nonetheless new. There is room for discovery and ingenuity and the reconsidered whole can be greater than the sum of its parts. There is no singular roadmap to adaptation, only the underlying premise of a complex negotiation. We approach each project on its own terms, determining a response to the existing fabric that sits somewhere between reverent to irreverent. When we describe an intervention as reverent, we refer to a subtle design move that is often constrained by preservation rules. These moves can, however, still be powerful. An irreverent intervention can change a building more fundamentally, to create possibilities for new programs or unprecedented combinations of programs. In all instances, we look to make impactful interventions that address manifestations of societal prejudice and exclusion and to introduce clear signals of welcome and inclusion.

Our approach to adaptive reuse may involve intervention or unveiling and be framed as interruptions or refractions. We highlight and heighten the productive tension that is derived from the immediacy of old and new. In the following pages, we describe our toolkit for converting old buildings, to breathe new life into them, and to offer equal respect to all users.

Above

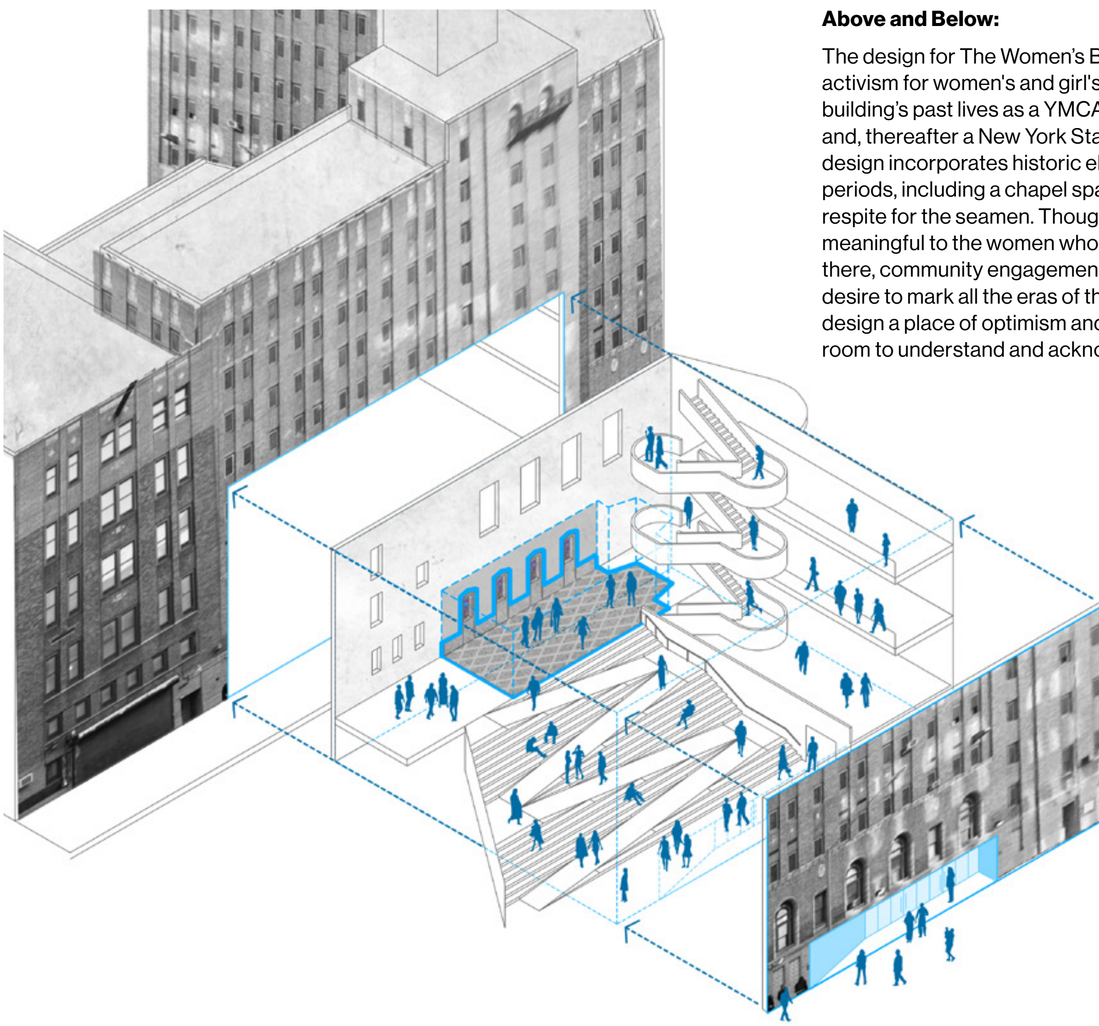
Our design for the Meeting and Guesthouse at the University of Pennsylvania preserves the street-facing residential character of the original buildings and adds a new interlocking addition with a high performance terracotta building envelope in a contemporary architectural language.

Below:

At the 21c Museum Hotel Louisville, our straightforward, modern insertions weave five buildings together, highlighting elements of the original fabric and providing opportunities to display dramatic, large-scale contemporary art.

Understanding and Acknowledgement

We begin by developing an understanding of the building's history—from its original cultural context through to the present. Most buildings do not belong to any single group of users nor do they rigidly embody a single set of values. They are often comprised of a messy agglomeration of histories and compounded aspirations. We examine the varied experiences and sometimes conflicting meanings that are associated with the building. We do this without preconceived notions of restoring one outlook versus another, and shepherd the dialogue away from nostalgic restoration and towards one framed through critical reflection.[5] The goal of this process is to explore new possibilities that can both strengthen existing bonds and establish new ties between a building and its community of users.



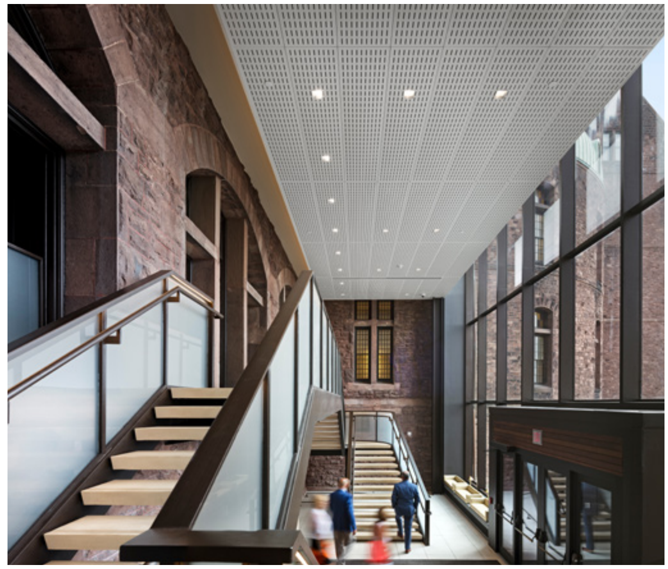
Above and Below:

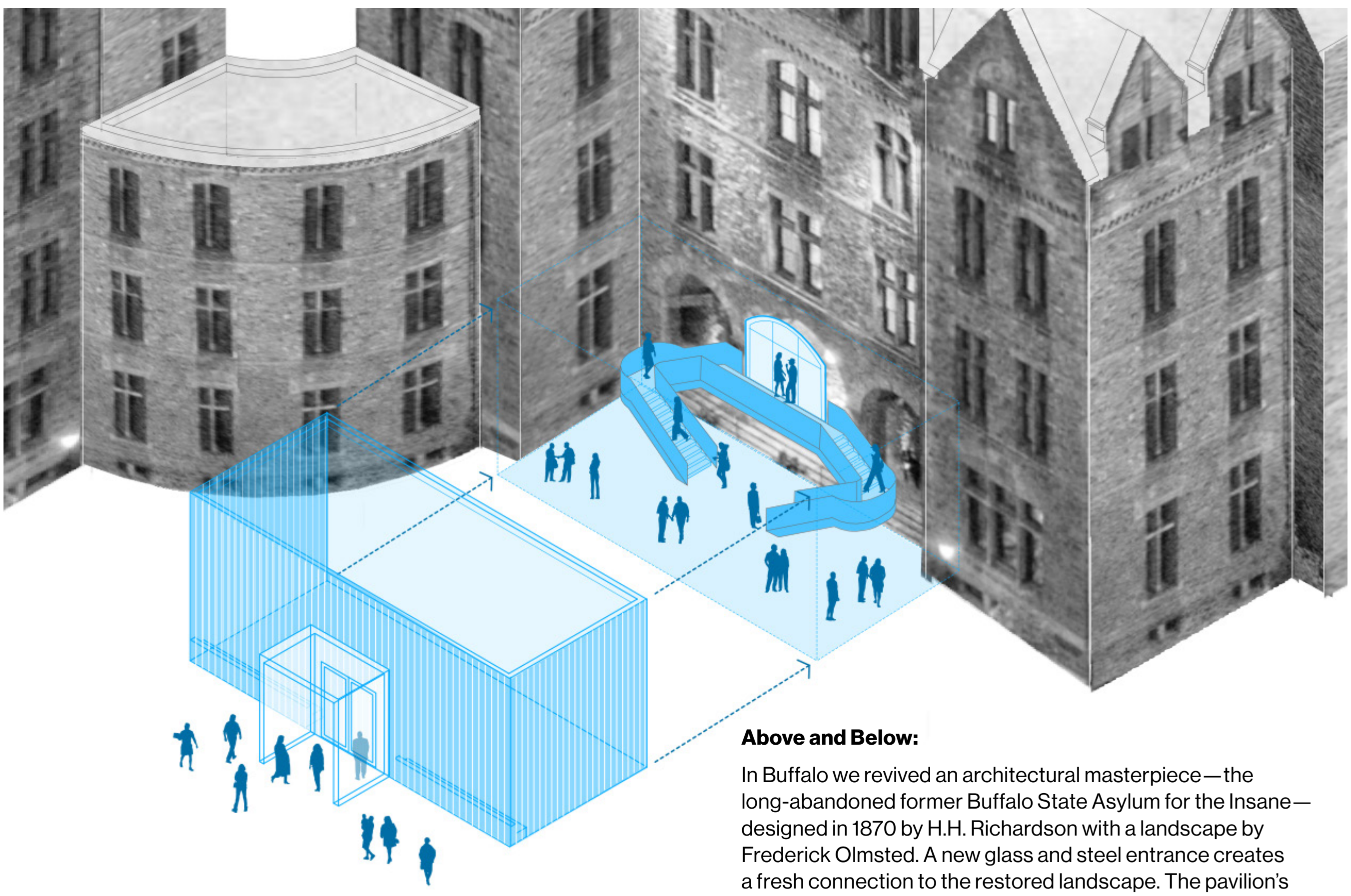
The design for The Women's Building, a place of activism for women's and girl's rights, acknowledges the building's past lives as a YMCA for merchant marines, and, thereafter a New York State prison for women. The design incorporates historic elements from the various periods, including a chapel space that was a place of respite for the seamen. Though the space was less meaningful to the women who had been incarcerated there, community engagement revealed a common desire to mark all the eras of the building's history. To design a place of optimism and idealism, we would make room to understand and acknowledge the past.

Unveiling and Contrast

With this understanding, and often in consultation with users, stakeholders, and specialists, we determine elements of the building that ought to be revealed. We avoid recreations through mimicry or fakery. But rather than blanket erasure, we favor selective incorporation of historic fabric; dialogue cannot continue without some semblance of the past.

We set the new against the old, retaining old fabric and adding new elements that are clearly legible and contemporary. We express the seams between old and new. The result is a *harmonious collage* that is in keeping with an ideal that values differences. The transformed building should be idiosyncratic and uniquely authentic. Overwriting and layering results in an architecture that is not overly precious, granting users permission to engage, participate, and, overtime, to develop a sense of ownership.





Above and Below:

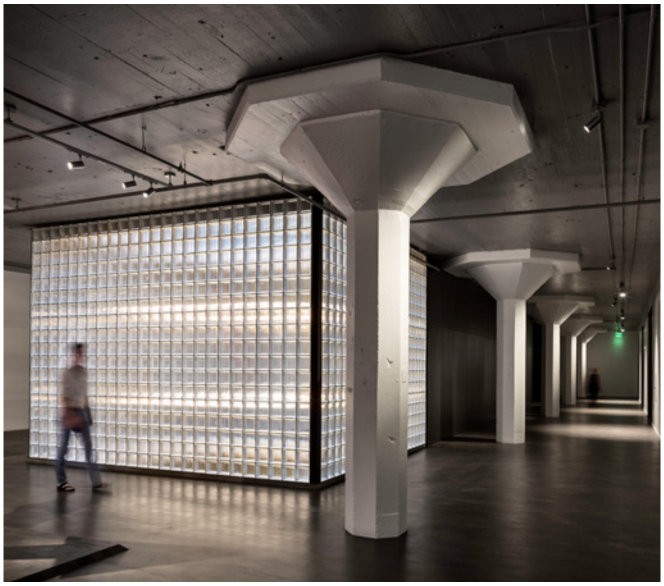
In Buffalo we revived an architectural masterpiece—the long-abandoned former Buffalo State Asylum for the Insane—designed in 1870 by H.H. Richardson with a landscape by Frederick Olmsted. A new glass and steel entrance creates a fresh connection to the restored landscape. The pavilion's light and transparent architectural language reads as a legibly contemporary intervention against Richardson's masonry. Our design approach to this historic building preserves its past by contrast—through the successful juxtaposition of old and new.

Intervention and Discovery

At the onset of the design process, we challenge ourselves to fundamentally rethink the buildings we plan to convert. We pull them apart to reveal their underlying logic and to discover new spatial and programmatic possibilities. Subtraction can be more impactful than addition—removing floors to connect spaces or to bring in natural light. Interventions can subvert the original stance of a building and instantiate openness and welcome; they can be extensive, though most often are surgical and precise.

Fitting new programs into an existing building is much like a hermit crab occupying a cast aside shell—it is not a tailored fit. Spatial inefficiencies are inherent to adaptive reuse and may be a boon rather than a compromise. They allow programs to grow and adapt over time. The extra room gives venue to small informal gatherings and supports sociability. Laying out programs within existing confines can force unexpected adjacencies and interconnections. An open attitude towards discovery and a view of the existing structure as a collaborative force can reveal potentials that would otherwise elude themselves in a custom-built structure.

There is an undeniable richness to the experience of the layered environment of an adaptive reuse project. One that elicits delight, curiosity, and connection. Adapted buildings can reinforce a sense of place while displaying deliberate action that makes them relevant and accessible to the diverse populations they serve.



Above and Below:

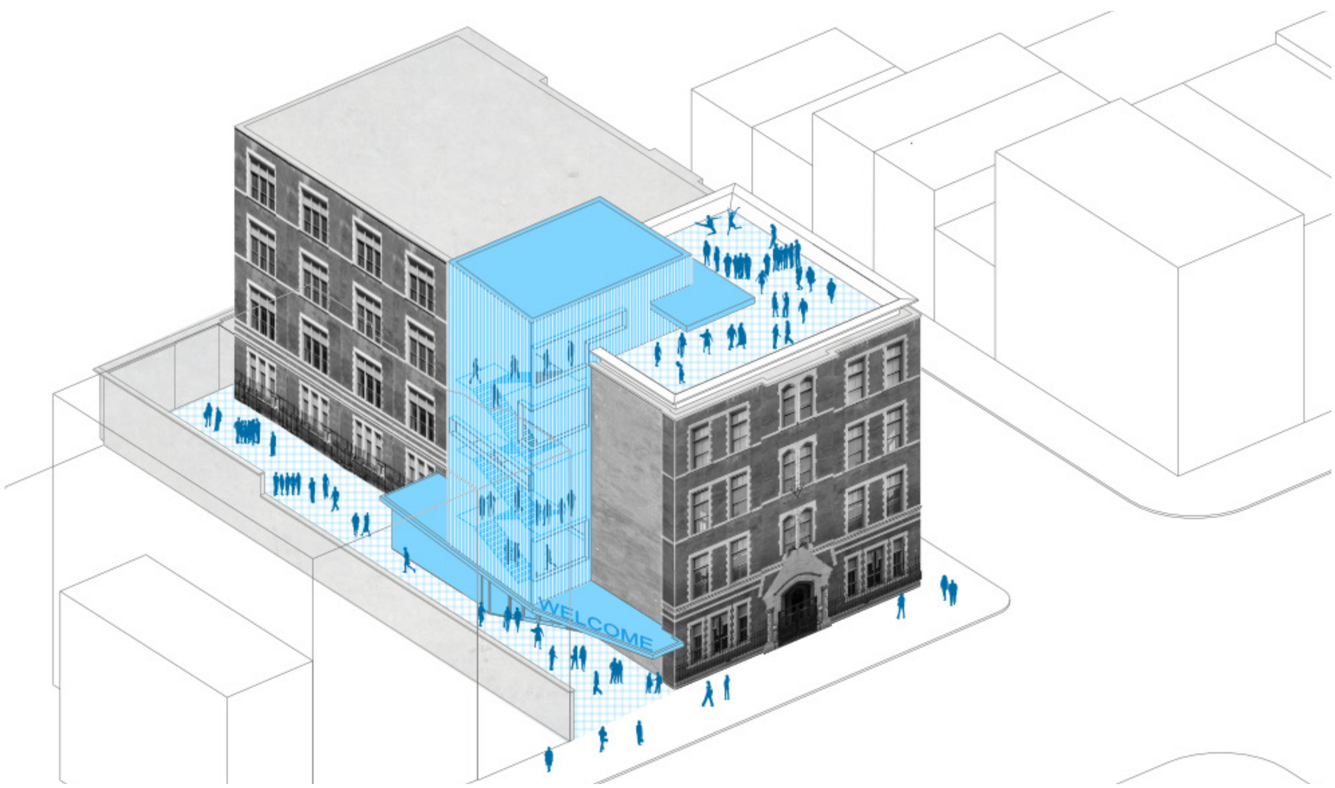
Building on the mission of engaging the public with contemporary art and supporting the revitalization of American downtowns, our design for the 21c Museum Hotel Oklahoma City transforms the historic Ford Motor Company Manufacturing Building that was originally designed in 1916 by Albert Kahn, master of modern industrial architecture in the US.

Considering precise moves to connect floors and bring in natural light, we cut through the concrete floorplate to insert new glass block lightwells that bring daylight into the core of the building.

There is an undeniable richness to the experience of the layered environment of an adaptive reuse project. One that elicits delight, curiosity, and connection.

Above and Below:

A new canopy extends past the historic masonry facade and connects to a veiled and glowing addition that holds new modes of movement up through the building. The new entrance signals welcome and draws the public into the 122 Community Arts Center in New York. The addition makes wayfinding clear and straightforward, giving users autonomy to navigate the floors held by various arts organizations. In turn, users feel permission to explore, to participate, and to engage with the art and artists.

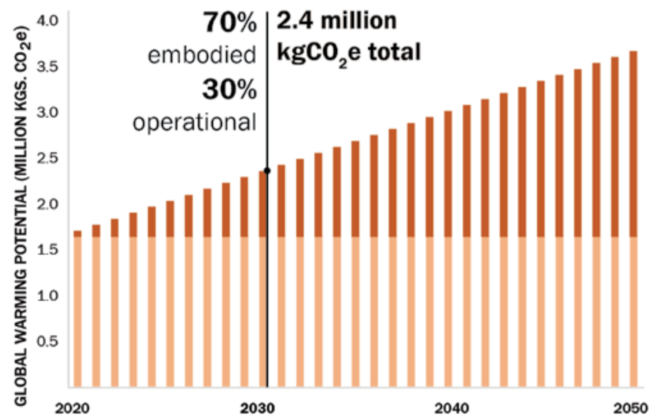


Climate Change and Decarbonization

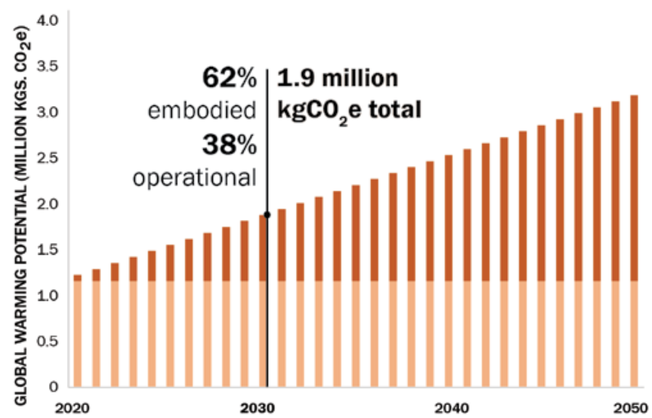
The Outsize Role of Existing Buildings

Around the country, institutions and municipalities have put in place comprehensive plans to achieve carbon neutrality with tandem plans for growth. Their plans include emission reductions, energy generation, and purchasing green power or carbon offsets, but often leave untapped the opportunities available through the operation of their existing building stock. Most American cities have a higher proportion of aging building stock than plans for new construction. Consequently, energy efficiency improvements through retrofits can play a critical role in reducing operational carbon while presenting embodied carbon savings. The push toward carbon neutrality is most effective when the optimization and improvement of existing buildings is addressed.

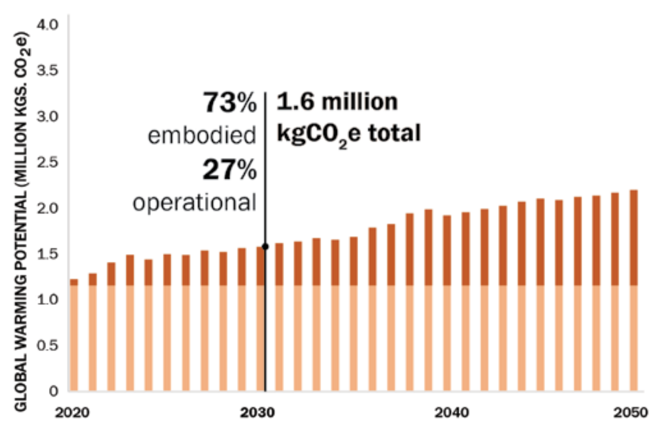
New Construction



Adaptive Reuse



Adaptive Reuse and Decarbonizing Grid[6]



Cumulative Carbon Emissions Over Time

Adapted structures emit less carbon over their lifespan compared to new construction that accepts a carbon debt from preceding demolition. As building technology becomes more efficient, and the energy grid continues to eliminate fossil fuels, the impact of embodied carbon increases.

This study considers several scenarios for the construction and operation of a typical academic building. The cumulative operational carbon emissions assumes an all-electric building and uses current and projected New York State grid emissions.

Operational Carbon

Embodied Carbon

Considering the Whole Life Carbon Impact of Buildings

In its lifecycle, a building is responsible for two types of carbon emissions: operational and embodied. Operational carbon relates to building energy use, resulting from both fossil fuel consumption on site as well as emissions associated with grid-purchased electricity. Embodied carbon is emitted during the manufacturing, production, and delivery of the materials used in the construction. In comparison to new construction, repurposing an existing building significantly reduces embodied carbon emissions. Our approach considers a building's carbon emissions through its whole life, analyzing both operational and embodied carbon.

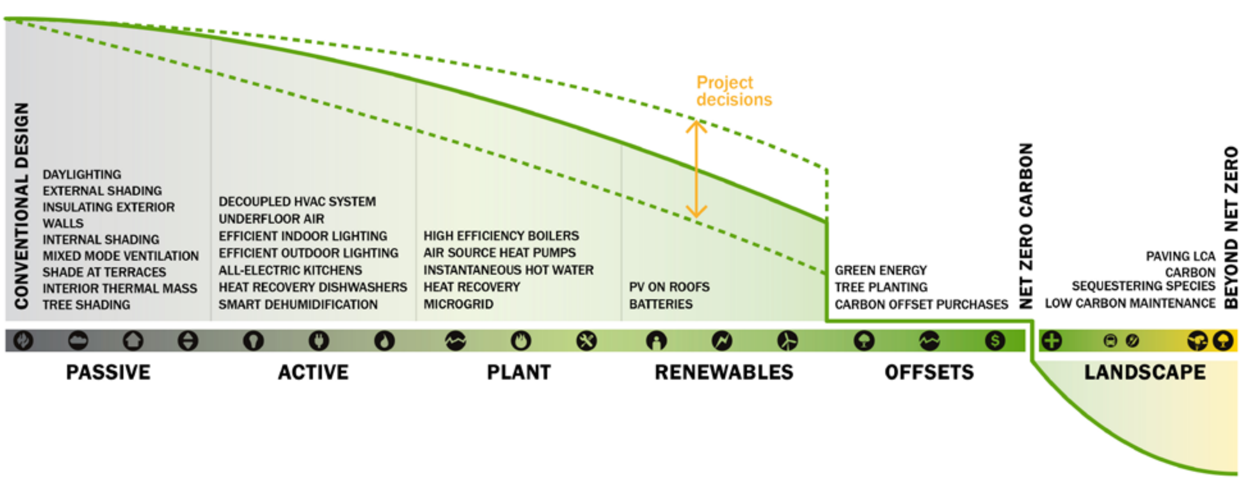
Operational Carbon

The path towards carbon neutrality focuses on reducing operational carbon compared to a given baseline. But even the most efficient buildings still use energy. Utilizing on- or off-site renewable energy, preferably in the project's grid region, compensates for the remaining energy demand and will offset the annual carbon emissions associated with the building operation.

High-performance buildings, whether new or repurposed, can substantively lower their operational emissions if their energy supply is clean. Renewable energy generation at the utility-scale has grown from 10% of total electricity generation to 18% over the last 10 years.[7] As the production of electricity gets cleaner, the justification for all-electric buildings gets stronger, as does the potential to lower operational emissions. This progress reverts attention to embodied carbon.

Path to Zero Carbon

Similar to new construction, existing buildings must (re)introduce passive approaches with active strategies to reduce energy consumption. Adding renewables can drive a building toward net zero carbon and beyond.



Embodied Carbon

Broadly speaking, understanding a building's embodied carbon profile begins by surveying the existing building and its components, including quantifying primary material assemblies and their remaining useful life. An embodied carbon characterization of the existing building is created and evaluated alongside a range of criteria, such as the structural integrity of existing materials, potential hazardous contamination, and aesthetic or historical character, to make decisions as to whether to retain or replace building components. The embodied carbon characterization must be reviewed in conjunction with the operational carbon emissions for a complete assessment.

Outside the building footprint, salvaging and reusing existing materials like concrete pavers, asphalt, stone, or steel edging effectively reduces embodied carbon emissions. Maintaining existing trees and plantings may provide a carbon benefit through carbon sequestration, although research on this is still being developed,[8] and offers other gains to natural habitats, biodiversity, outdoor thermal comfort, and reduced urban heat island effects.

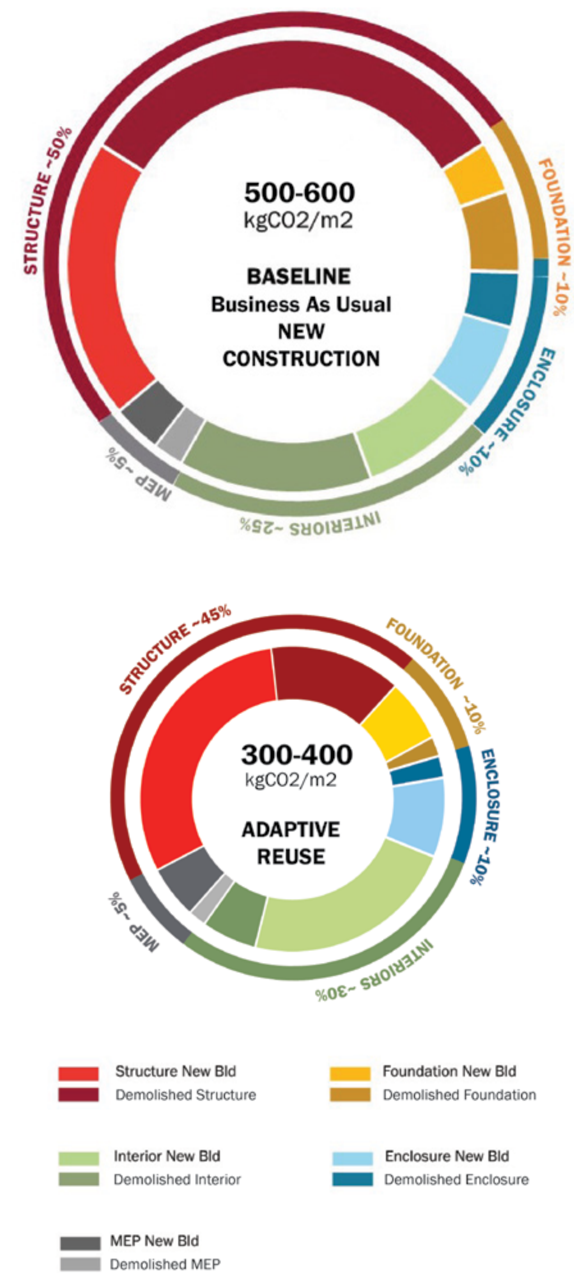
Social Cost of Carbon

The social cost of carbon is a measure of the harm resulting from climate change, such as devastating weather events, sea level rise, and increased food insecurity. For example, New York City's Climate Mobilization Act assigns a capital value of $268 per mtCO2e.[9] When analyzing a building's potential for adaptive reuse, a more holistic assessment considers the social cost of carbon for the emissions saved from renovating an existing structure. This social and environmental impact equivalence may bridge shortfalls in payback derived through an analysis of life-cycle costs alone.

More cities and some higher education institutions are investigating means to utilize carbon pricing and integrating social costs of carbon to consider costs holistically.

Embodied Carbon Footprint by Building Category

Through these embodied carbon profiles, we can compare a new construction project that accepts the carbon emissions from demolition to that of an adaptive reuse project. This type of study can also guide decisions regarding the reuse of building components based on their contribution to the embodied carbon profile.



Considering the Whole Life Carbon Impact of Buildings

Conducting a Gap Analysis

When assessing an existing building for a renovation or retrofit, we perform a gap analysis to understand the building's current condition. We study existing envelope conditions, structural integrity, and age of the HVAC system, among other components, and review historical energy use to determine the building's energy profile.

A gap analysis may incorporate observations from operating and maintaining the building. Interviewing the facilities staff can offer insight into the challenges of operating the building, such as an inability to maintain space temperature and comfort, or inconsistent performance of mechanical equipment. A good picture of the current state of the building will help identify strategies to close performance gaps.

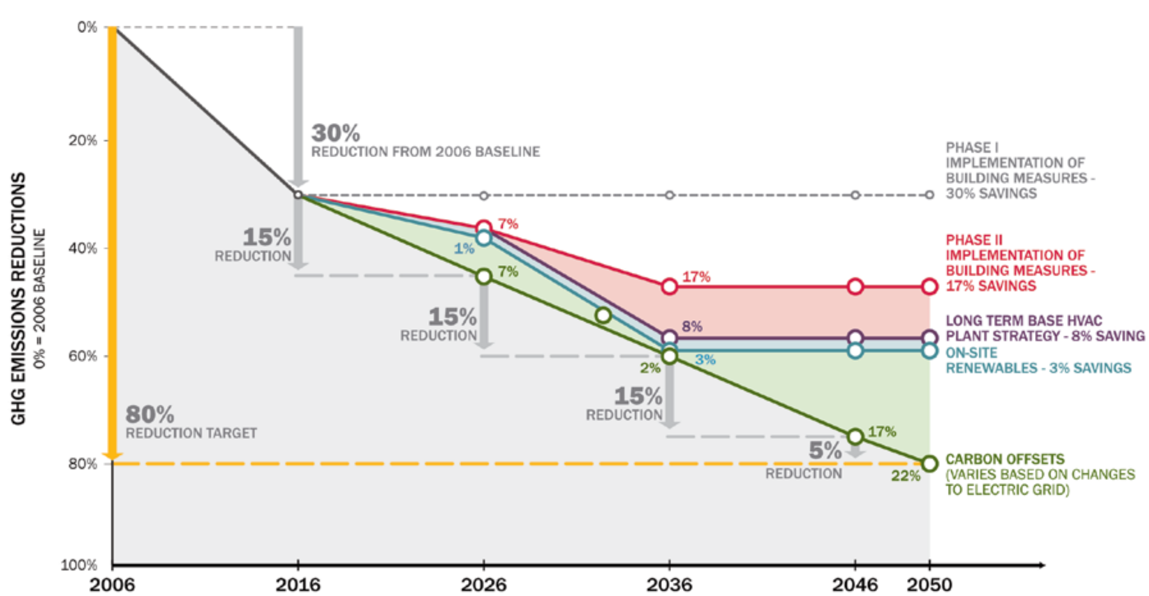
Roadmap to GHG emissions reductions

The Gap Analysis helps to establish a timeline for an incremental and phased approach to meeting overall performance goals. In this example, building measures include improvements to the envelope and lighting. The HVAC plant measures address improvements to heating, cooling, and ventilation systems, as well as controls.

Deep Energy Retrofits and Comprehensive Renovations

Existing buildings are composed of multiple systems that have varying lifespans. For example, a structure built in 1930 is a layering of various systems since day one. A 1930s building is likely to have had its façade updated at least once, its mechanical systems updated at least twice, and lighting replacements at least 3 or 4 times. Most likely, none of these upgrades were likely done simultaneously, by the same designer or under the same ownership. Consequently, the building becomes a patchwork of systems that are once again outdated and cannot meet the stringent requirements of the increasingly demanding energy codes.

Major institutions and municipalities increasingly rely on Comprehensive Renovations and Deep Energy Retrofits of existing buildings to accelerate progress toward their carbon emission goals. Deep Energy Retrofits take a whole-facility approach to make buildings more energy efficient, aiming to achieve a 50 percent or greater reduction in building energy usage and carbon emissions reduction of 30 percent or more.[10] These renovations focus on achieving major energy efficiency improvements while considering capital investments necessary over the life of the building. Phased plans are developed to meet project goals based on the findings of the gap analysis. Improvements need not occur at once but may be phased to achieve maximum benefit.



Passive Elements and Surgical Interventions

There are inherent energy-saving opportunities that ought to be considered in deep energy retrofits. Many existing buildings lend themselves well to the reinstatement of their passive design elements. For instance, most turn of the (20th) century structures are comprised of heavy masonry and can take advantage of thermal mass effects. Existing buildings may have originally been designed with passive design elements that manage solar heat gains through eaves, shades, appropriate window to wall ratios, or by their use of landscape and planting. They may have been designed to take advantage of natural ventilation but were later sealed to be airconditioned. Renovations can reinstate the passive design elements which may have been diminished over time or removed entirely.

Older structures historically have a lower window-to-wall ratio and darker interior finish materials, such as wood. These smaller apertures and low-reflectivity finishes make it challenging for ample daylight to permeate deep into the space. Optimizing daylight and visual comfort is a common priority; for an existing building, creative design solutions, such as the introduction of skylights or interior light-shelves, can be considered.

Understanding the indoor conditioning criteria and the building's program is critical to making a Deep Energy Retrofit successful. Transitional spaces may be assigned a wider thermal comfort range. These transitional spaces can act as buffers to spaces with stricter comfort ranges that can be set further inboard; this planning solution offers users comfortable environments without a dependance on significant interventions to the facades. The strategy has other benefits that include the protection against occupant thermal shock as they move from extreme outdoor conditions to conditioned indoor spaces, maintaining the integrity of intrinsic and existing plan features, and minimizing energy use while being responsive to user comfort expectations.

Thermal Nirvana

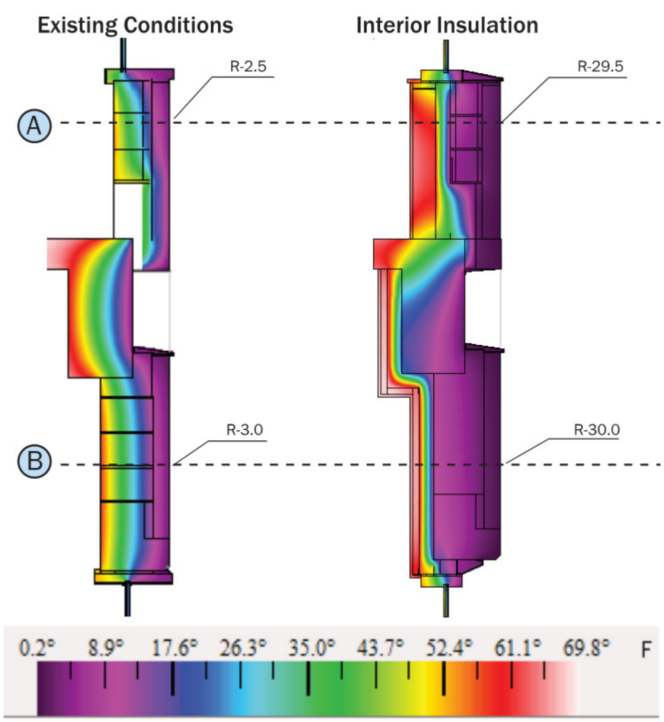
Creating spaces that allow our bodies to adjust to wider temperature swings is a means to modifying our definition of 'comfort,' increasing energy savings, and thus achieving Thermal Nirvana!

Passive Elements

DBP and Atelier Ten's design of Harvard Law School's Lewis Law Center, converts a library stacks building into a 21st century learning and work environment for students, faculty, staff, and law clinic clients. The 1959 modernist building, originally designed by Shepley Bulfinch Richardson & Abbott, limited the amount of light entering the space by design and in response to its original program. A light metal and glass addition complements the original limestone façade while introducing more daylight into the spaces. Skylights bring light deeper into the building footprint and into shared spaces.

Facade and Moisture Considerations

Improvements to the building envelope, while costly, can be the most effective strategy for reducing a building's energy use. Establishing an air barrier improves occupant comfort and building thermal performance by reducing leakage and infiltration, and therefore contributes to passive survivability[11]. Insulating the interior-side of the façade improves thermal performance while maintaining the character and integrity of the historic façade. There is a concern of masonry spalling due to the new separation between the exterior and the interior heating and a risk the masonry and grout will perform poorly by experiencing new freeze-thaw cycles. Detailed hygrothermal and heat-transfer analysis can help inform decisions regarding the insulation type and thickness required to achieve the desired envelope performance and to mitigate these risks.



Improving Historic Facades

THERM analysis illustrates the effect of having a solid masonry wall with minimal to no insulation. Once insulation is added to the interior side of the wall assembly, its thermal performance is significantly improved while maintaining the integrity of a historic facade.

MEP System Retrofits and All-Electric Systems

Many existing institutional and commercial buildings were not designed with centralized cooling or ventilation. Providing new centralized infrastructure, often augmented with energy recovery and advanced controls, offers energy efficient conditioning and better indoor air quality. With mechanical system retrofits, the envelope must also be upgraded to control moisture migration and infiltration.

Designing buildings to be nimble to adapt to the changing carbon content of the grid is key in reducing operational carbon; highly efficient all-electric systems can take advantage of a cleaner grid. To make electrification economically feasible in cold climates, winter heating loads must be significantly reduced. Buildings that are connected to a combustion-based central energy plant should put in place a long term decarbonization strategy, addressing the building and campus scales.

Responsive Design with a View to the Future

Digitization allows users to assess their usage and emissions in real-time, against similarly granular time-of-use carbon emissions data made available by utilities. Thermal and electric storage and on-site renewables can also play a role in mitigating peak use.

Backward-looking weather data can misinform building design, making buildings more vulnerable to future changes in climate. Designs that refer to statistically derived future climate data can better mitigate climate-change risks. Strategies and adaptation measures which address long-term climate impact make buildings more resilient.

Conclusion

We must assign proper value to the resources that have gone into the making of our existing buildings—the human effort, the craftmanship, the materials, and their carbon footprint. The EPA has estimated that U.S. construction generated 600 million tons of debris in 2018; of that, more than 90% came from demolition, with only 10% attributable to new construction processes.[12] When considered through the lens of embodied carbon and sustainable materials management, the argument for adaptive reuse is straightforward; and when coupled with the social resonance these projects can have, that argument becomes particularly compelling.

Altered in form, posture, and purpose, the transformed building is newly positioned to better respond to the needs and ideals of the people it serves. The existing structure forms an expressive framework within which unexpected, idiosyncratic, and nuanced spaces can emerge. Reinvention is rich in possibility and stakes an optimistic claim on the future.

Notes

1. United Nations Environment Programme, Emissions Gap Report 2020 - Executive Summary, https://wedocs.unep.org/bitstream/handle/20.500.11822/34438/EGR20ESE.pdf?sequence=8

2. "Why the Building Sector?", Architecture 2030, accessed December 15, 2020, https://architecture2030.org/buildings_problem_why/

3. Erving Goffman, The Presentation of Self in Everyday Life, (New York: Doubleday, 1956).

4. Danielle S. Allen, "What We Should Be Doing With Diversity on Our College Campuses", Institute for Advanced Study, last modified 2013, https://www.ias.edu/ideas/2013/allen-bridging

5. Svetlana Boym, The Future of Nostalgia, (New York: Basic Books, 2002), 49.

6. NREL Scenario Viewer and Data Downloader, https://cambium.nrel.gov/?project=c3fec8d8-6243-4a8a-9bff-66af71889958. Assuming reference scenario (called the Mid-case) that uses default or median assumptions in the models, including existing policies as of June 30, 2020.

7. "Alternative Renewables Cost Assumptions in AEO2020", U.S. Energy Information Administration, last modified January 29, 2020, https://www.eia.gov/outlooks/aeo/section_issue_renewables.php

8. Leigh J. Whittinghill, D. Bradley Rowe, Robert Schutzki, Bert M. Cregg, " Quantifying carbon sequestration of various green roof and ornamental landscape systems", Landscape and Urban Planning, Volume 123 (March 2014), 41-48, https://doi.org/10.1016/j.landurbplan.2013.11.015.

9. For purposes of clarification, we will refer to carbon emissions in terms of metric tons of CO2 equivalent emissions, or mtCO2e. This is a way to standardize the greenhouse gas emissions to that of one unit mass of carbon dioxide, based on the global warming potential (GWP) of the gas. It may also be referred to as "carbon emissions", or simply "carbon".

10. "NYC targets nine facilities for deep energy retrofits", Smart Cities World, las modified October 4, 2019, https://www.smartcitiesworld.net/news/news/nyc-targets-nine-facilities-for-deep-energy-retrofits-4652

11. Passive survivability is the ability for a building to critically function in the event of a loss of utility and infrastructure services.

12. "Sustainable Management of Construction and Demolition Materials", Environmental Protection Agency, accessed January 7, 2021, https://www.epa.gov/smm/sustainable-management-construction-and-demolition-materials.

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Richardson Olmsted Campus, Page 4, Page 10
122 Community Arts Center, Page 13
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Rockefeller Arts Center, Page 6
University of Pennsylvania Meeting and Guesthouse, Page 8
21c Museum Hotel Oklahoma City, Page 11
Photography by Chris Cooper

21c Museum Hotel Louisville, Page 8
Photography by Catherine Tighe

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