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Introduction

Midtown Detroit was once the sort of neighborhood targeted for demolition by the fire marshal, police chief, and other public health and safety authorities, one of dozens of neighborhoods attesting to Detroit's staggering population and economic collapse. Of the nearly fifty thousand buildings deserted in Detroit since 1960, statistics published in 2019 reported that twenty thousand were demolished, more than twenty-one thousand remain boarded up, while only about eight thousand had been rehabilitated, corroboration of largely intentional urban disinvestment.[1]

Vacant and severely damaged by fire, the Garfield Manor Apartments was an all too typical property in Midtown Detroit. Designed in 1922 by Albert Kahn, then Michigan's most prominent architect, Garfield Manor became a fixture in the vibrant Sugar Hill District, home to dozens of jazz clubs patronized by Detroit's growing African American community. Like many Black enclaves across the United States, much of Sugar Hill was swept away by urban renewal, clearing land for a sprawling hospital complex.

Today, Midtown and Garfield Manor are writing a new chapter in Detroit's story, one of self-reliance, resilience, and hope. To fill the void left by institutional investors who shunned Midtown, the local community banded together. Since the merger of two previous community development entities in 1980, the area's leading nonprofit developer and promoter, Midtown Detroit, Inc., has renovated thirty derelict buildings and constructed ten new apartment buildings, providing hundreds of dwelling units to meet housing demand it proactively nurtured year after year. With the 2017 opening of the QLine trolley on Woodward Avenue, Midtown is now tethered to the rebounding job market in Downtown Detroit.

A reborn Garfield Manor houses artist live-work units, part of a thriving cultural district anchored by the Detroit Institute of Art, Museum of Contemporary Art, and nine other arts, science, and history institutions in Midtown. The resuscitation of Garfield Manor leveraged historic preservation, low-income housing, and new market tax credits as well as energy efficiency, green building, and renewable energy incentives. In addition to being a restored historic landmark, Garfield Manor is also a model of sustainable design.

For many architects, the stories of Midtown Detroit and Garfield Manor Apartments may seem unexceptional, even mundane. There are no billion-dollar megaprojects attracting so-called starchitects worldwide or iconic architectural monuments gracing the covers of design magazines. But places like Midtown Detroit and buildings like Garfield Manor are extraordinarily important for the challenges confronting architects in the twenty-first century.

"Obsolete" building

"Rescued" building

More than half a million buildings are demolished annually in the United States. Construction waste and demolition produce more tons of landfill than all municipal waste combined.

71 Garfield Street, Detroit, before rehabilitation, designed by Albert Kahn Architect, 1922. (Photo © Quinn Evans) Garfield Manor Apartments, after rehabilitation by Quinn Evans. (Photo by Phillip Datillo, © Quinn Evans)

In *Going for Zero*, I address how buildings and cities can and must help resolve the looming climate emergency. This book is not just about an increasingly familiar subject. Instead, it offers a decidedly alternative viewpoint, one informed by my architecture career rescuing buildings from senseless demolition and learning from the practices and wisdom embedded in built heritage.

Climate change is a terrible outcome from a brief period in human history, the roughly two hundred years of industrial societies powered by fossil fuels. In the context of more than six thousand years of urban civilization, our modern way of life is an anomaly, a time of experimentation incited by rejection of tradition and facilitated by technological revolution. Further, nearly half of global population today does not much share in these contemporary circumstances, something our modern-era biases cause us to view in categorically negative terms. Few in the developed nations of the "Global North" see any value in learning from premodern times and nonmodern places. This book is written as a challenge to modern-era and Global North biases.

The climate crisis is not occurring in a vacuum. It interlocks with a host of other issues jeopardizing peace and prosperity. Like climate change, many are consequences of our way of life. The modern world tolerates shockingly destructive behaviors, from damaging human health to mass extinctions, ecological collapse, and catastrophic climate change. Many of today's modern "advantages" were only possible through generations of exploitation and injustice. Climate action and climate justice are inseparable; neither can be accomplished alone. With open hearts and minds, we can comprehend a compelling truth about our time: zero is a *positive* number. Responding to climate change is humanity's chance to set things right.

Fearful of disrupting business as usual, most accepted approaches to building-sector decarbonization employ the same thinking and methods that produced the climate crisis. Unshakable faith in technology and innovation blinds us to possibilities beyond the confines of modernity. Lessons from a lifetime prioritizing stewardship of existing buildings and observing firsthand the inspiring achievements of traditional and heritage cultures guided me to a fuller and more inclusive path out of the climate crisis and into humanity's urban future. They led me to this book.

Definition of Insanity

Although its attribution to Albert Einstein is unfounded, doing the same things over and over while hoping for different results is insanity. Whether a genius of Einstein's caliber proclaimed it or not, the lesson this definition of insanity conveys is especially important today as the world struggles to wring carbon pollution out of industry, agriculture, transportation, and habitation. Systemic change on such enormous scale is daunting. As change agents, architects know firsthand the deeply ingrained resistance to change that impedes forward motion. But inertia is not one-directional. Designers and builders as well as the construction products industry are as wedded to the status quo as anyone. We cling to familiar approaches, nestled in our comfort zones.

An energy crisis arrived in 1973 when architecture had been fully transformed by modernism. Glass boxes competed with concrete fortresses for top design awards. Both typologies suffered from similar energy burdens. Predominant construction materials (concrete, steel, aluminum, and glass) were, and still are, the most energy-intensive to produce. Architectural character was, and still is, determined primarily by formalism, not performance, with little regard for climate or any other regional variable. Most of the tactics heralded today to improve energy efficiency are glass-half-full solutions at best.

For instance, fenestration has always been a major challenge in building envelope design. Rather than reducing the amount of glazing, curtain-wall construction remains the default for office buildings and many other commercial, institutional, and even residential structures built worldwide. With double and triple glazing, the imbedded (embodied) energy burden—and carbon footprint—to construct all-glass buildings has multiplied, not diminished. The short service life of insulated glazing units is unconscionable. In a matter of decades, today's "sustainable" glazing is tomorrow's landfill problem and unspoken mandate for another round of energy-intensive and carbon-polluting material production and construction. And yet, demolishing fifty-story buildings to construct hundred-story all-glass towers is occurring today in the name of smart growth and climate action. It is insanity.

Despite forty-plus years of so-called energy-conscious design, the built form and façade configuration of very few buildings respond effectively to their solar orientation, the most basic and effective strategy for reducing energy demand. Architects have abdicated their design authority to engineering and technology. Even many buildings that purport to incorporate solar shading like projecting window eyebrows or cornices do not stand up to technical scrutiny, instead displaying meaningless "green bling" rather than employing useful climate adaptation techniques. Operable windows, shutters, and awnings are anathema to engineering principles that rely on sensors and algorithms. In the name of energy conservation, building and energy codes favor sealed buildings that require constant and continuous energy use to remain habitable. It is insanity.

Far more than with building design, the sanity of modern-era urban planning and suburban sprawl were questioned from the beginning. The so-called battle for the soul of the city waged between Jane Jacobs and Robert Moses still reverberates as communities around the world struggle to overcome the damage wrought by decades of automobile-dominated development. Once on the fringes, urban designers like Jan Gehl, who helped transform Copenhagen into a model pedestrian- and bike-friendly city, are now solidly in the mainstream. Investigations of the urban transect by the Congress for the New Urbanism and neighborhood revitalization concepts like the 15-Minute City espoused by Carlos Moreno have, at least in theory, put citizens back at the center of urban design.

The even more socially and economically disastrous side of modern-era urban renewal has not been remedied, though. Every city in the United States grapples with conditions in struggling neighborhoods, the aftermath of intentional disruption and disinvestment often racially motivated. However, very few jurisdictions have jettisoned the land use policies and controls that were adopted explicitly to prioritize automobiles and fracture communities into enclaves separated by land use category and economic class. Instead, the same exclusionary zoning ordinances are now expected to heal wounds inflicted by their fundamentally anti-urban principles. It is insanity.

Particularly in developed countries, more than a century making buildings habituated to fossil fuels has desensitized architects to the possibilities of design that works with natural environmental factors and optimizes operability. They were the fundamental strategies that guided architecture since Vitruvius (whose *Ten Books on Architecture* were written during the dawning years of the Roman Empire), forgotten only when the myth of inexhaustible resources became doctrine. Decades of city planning and urban renewal siloed city life into single-purpose districts, trading the connective tissue of mixed-use urban fabric for hours behind the wheel and converting neighbors into traffic. This book is written to help architects recognize the unconscious biases of our brief, energy-glutted, modern era and to reconnect with principles and practices that avoid, rather than repeat, misconceptions about architectural quality and urban livability.

Past Is Prologue

Elaborately constructed environments—cities—have accommodated human societies for more than six thousand years. Although many things today were absent in the past (advances in medical science comes to mind), over millennia, civilization did not merely scrape by, it thrived, producing the ideas and capabilities that made the modern world possible, including buildings with material and cultural value more than equal to today's architecture. This rich history distinguishes the built environment from most other endeavors. Although Leonardo da Vinci's notebooks may contain astonishingly prescient visions of helicopters, the field of aeronautics does not have thousands of years of experience to draw on. Architecture and urban design do.

The vitality and scale of today's cities can blind us to the achievements of premodern and nonmodern builders. Some of the most humble dwellings make the point best. Inuit igloos and Bedouin tents provide shelter and even demonstrably comfortable conditions in two of the most extreme climates on Earth. There are lessons to be learned from every region and historic period, from every vernacular and architectural tradition. It is a knowledge base of tremendous scope and usefulness as this generation of architects contends with the interlocking climate, justice, and urban imperatives. The history of architecture is usually presented as an evolution of aesthetic styles. In the context of today's challenges, built heritage also illustrates countless examples of regionally adapted material and energy flows.

The length and complexity of supply chains for even basic construction materials, like stone and timber, surprises many architects. As the term makes clear, supply chains are linked through transportation, with most modes producing significant greenhouse gas pollution no matter how green the transported materials. Further, most of today's construction products have gone from merely harvested materials to multicomponent integrated assemblies, like the insulated glazing units noted earlier. Most present unresolved and often dreadful life cycle and waste stream impacts, with today's high-performance products becoming tomorrow's landfill problem. And with shockingly few exceptions, today's long and complex supply chains obscure intolerable environmental and labor practices.

For thousands of years, the energy to construct the built environment was provided by the labor of people and yoked animals. In the last two hundred years, steam, electricity, and fossil fuels have produced power so inexpensively and ubiquitously that energy costs and availability were largely ignored until the mid-1970s oil embargo. Contemplating this evolution in energy flows, architect and theorist Buckminster Fuller coined the term *energy slaves* to quantify energy in a human labor equivalency. He was aghast by the unseen energy burden underpinning our modern way of life, with every person supported by thousands of energy slaves every day. Fuller estimated the true value of a gallon of gasoline as $1 million worth of energy slave labor.[2]

The purpose of appreciating the lessons of built heritage is not to replicate the past. Instead, like Fuller's energy slaves, understanding the successes and failures of thousands of years of human habitation reflects on the foibles and contradictions in our world today. Much of this book is written to provide perspectives gained from studying and working with heritage buildings.

Next City

Often the metric used to illustrate the magnitude of the climate crisis is comparing current atmospheric carbon dioxide to the level prior to the Industrial Revolution—now more than 420 parts per million (ppm), then about 280 ppm.[3] It is just one example among many that divides human civilization, and even life on Earth, into eras before and since the Industrial Revolution.

So much has changed since the mid-1700s when the Industrial Revolution began. Hereditary monarchies and aristocracies ruled the world. Populations of even the most advanced nations were composed largely of serfs tending the lands of feudal lords. Colonialism exploited territories, populations, and resources in Africa, the Indian Subcontinent, Southeast Asia, Oceania, and the Americas, including colonies that became the United States.

A century later, the foundations of the modern world were being laid. Industrial powerhouses led by the United States were the dominant economies. Along with meteoric advancements in technology, millions migrated into cities seeking jobs in the burgeoning industrial workforce, on their way to becoming the middle-class citizenry that defines developed nations today. Massive infrastructure projects swept away the chaos and squaller rampant in the first generation of industrial cities. Railways provided mobility for passengers and goods both within and between cities. Building codes promoted fireproof construction and mandated minimum standards for habitable spaces.

In another hundred years, the modern world we know today was recognizable. Following World War II and the Great Depression that preceded it, architects and planners were convinced that traditional cities were dead. A tsunami of car-oriented development and suburban expansion was unleashed, dramatically altering cities across the country and around the world. While metropolitan regions grew dramatically, populations in established city centers dropped. In the United States, industry itself peaked around 1960 as the single-family house became the predominant building type.

The calendar alone suggests that now is the time for the next iteration of the modern city. Since the conclusion of World War II, the current model of the modern city has been applied worldwide, in every climate and culture, by every political and economic system, and employing every material and technological resource. By now we know what the modern city can and cannot achieve in its present form.

In the context of the three twenty-first century imperatives—climate, justice, and urban—there is urgency to redefine our goals, standards, and strategies. Conditions that compelled the global community of nations to embark on these three historic and intertwined action agendas decree that we must first start by stopping—stop exacerbating the problems that have metastasized into the climate, justice, and urban crises.

There is neither time nor space to continue ignoring the collateral damage inflicted by our modern way of life or to deny our responsibility as we enjoy its benefits. We must reconnect with the outcomes of our actions. To avoid climate catastrophe and assure peace and prosperity for eight, nine, ten, eleven … billion people, everyone must be included and vested with capacity to contribute, not only those born into sufficiency and privilege. We must reconnect with the entire human community. The scale of human activity has become so gargantuan that once tried-and-true practices have become toxic and suicidal. Humankind's dominion over nature is an obligation for stewardship, not a license for exploitation. We must reconnect with our planet Earth, on whom our lives and all life depends.

For architects—and the countless others who work together creating human habitation—the twenty-first century imperatives present a relevance revolution. They also demand a profound mode shift, from a mind-set focused on making new things to one of reintegration and healing. The places where people live shape not only how they live, but even who they are. People are inextricably intertwined with their environment. It is time for architects to reconnect with our role in the cumulative creation of places that nurture human civilization, not just making buildings for clients. Especially in highly developed countries like the United States, our approach to using, caring for, and adapting the built environment is shortsighted and outrageously wasteful. Revitalizing communities by optimizing existing resources makes social, economic, and environmental sense and directs resources where they are most needed. There are so many lessons to learn from built heritage, particularly about the cultural and multigenerational value of building and cities.

The built environment empowers the greatest human assets: engagement and cooperation. Modern-era planning principles prioritized separation and exclusion and proposed ubiquitous transportation as connective tissue in place of urban fabric. The challenges of reintegrating and healing communities ask of those who shape the built environment to see beyond the modern world. This book is written to nudge architects and those we work with beyond the modern and toward an architecture for the climate, justice, and urban imperatives.

PART 1

Climate Imperative

Climate change is no longer an abstract threat. Week after week, an already disrupted climate is impacting the lives of millions. The time available to curtail climate change is alarmingly limited. Going for zero greenhouse gas emissions requires retooling everything about industry, agriculture, transportation, and the thousands of cities and towns people inhabit.

Conditions in the built environment have never been more important than they are today. The work of architects, engineers, landscape architects, urban designers, and the countless others who shape the built environment has never been more relevant. Decarbonizing how buildings are designed, constructed, and operated is a sea change that is already altering the principles and practices we employ.

Climate change is not occurring in a vacuum, nor will the actions necessary to resolve it. Our ever-more-crowded and rapidly urbanizing world wrestles with a host of intransigent social, economic, and environmental shortcomings. The scope of change necessary to curtail climate change affords our professions opportunities to concurrently address them. It is a historic juncture.

CHAPTER 1

To Protect and Defend

In a society that puts such importance on recycling bottles and cans, the United States throws away viable buildings by the hundreds of thousands every year without a second thought. The property development economy regards demolition as no more than a cost of doing business. In reality, it is wastefulness on a scale that is unfathomable and, frankly, unforgiveable. Annual building demolition generates nearly *double* the waste landfilled by *all US cities and towns combined*.[1] Concrete accounts for two-thirds of demolition waste, a material of near-infinite durability reduced to useless rubble.

When older buildings are maintained, their value seems obvious. The term *historic preservation* can conjure images of beautifully restored structures, highly valued places treated with care. But many older and even historic buildings have not been cared for. Many exist in neighborhoods suffering from decades of intentional disinvestment, the material evidence of communities of *people* abandoned in those places. Like with all markets, real estate values fluctuate over time, leases expire, buildings are vacated. Jane Jacobs had the wisdom to recognize urban economic cycles as the key to affordability. Robert Moses used them as justification for wholesale devastation and displacement.

The social and economic damage caused by systemic urban disinvestment is substantiated by maps illustrating housing cost, household income, education level, and employment; access to healthy food, parks, recreation, and transportation; and community safety, medical services, and even life expectancy. The correspondence across these maps sends a powerful message: *where* you live indicates *how* you live and even your lifelong prospects.

Building form alone is not the issue, however. Across the United States, the most admired neighborhoods, and often the most expensive, are historic districts. Townhouses in Boston's Beacon Hill, New York City's Greenwich Village, and Washington, DC's Georgetown are cherished. Yet many were once modest dwellings fundamentally indistinguishable from the boarded-up rowhouses in the blighted neighborhoods of Baltimore, Chicago, and Detroit.

Every US city is scarred with places that embody indifference and neglect, if not distain and contempt. Many proud and productive towns of the nation's agricultural and industrial heartland have disintegrated into the crumbling remnants of the Rust Belt. For all the wonders of post–World War II progress and ascent of our modern way of life, harm to the environment and to the lives and livelihood of millions have been left in their wake. Even in the wealthiest nations like the United States, architects and the countless others who create human habitation face immense challenges as stewards of the built environment.

Onto these circumstances, looming climate catastrophe has now been layered. It can appear daunting and discouraging, yet what in the status quo of today's cities and towns is so precious and immutable that change becomes threatening? I welcome it. My views on building-sector decarbonization have been molded by practicing architecture at the intersection of sustainable design and historic preservation. Sustainability raised my awareness of the unintended consequences of accepted modern-era practices and proved that progress is possible and its benefits multiply geometrically. Preservation revealed the breadth and depth of our reliance on unsubstantiated modern-era principles and opened my eyes to the inexhaustible encyclopedia of built heritage.

The destiny of today's generation of architects is to end greenhouse gas pollution from buildings and cities. The task requires investigating everything about how habitation is designed, constructed, and operated. It demands that we alter what we do and how we do it. It begins by reconnecting with the outcomes of both our processes and products.

Sustainable, Really?

Sustainability rating systems like the United States Green Building Council (USGBC) Leadership in Energy and Environmental Design (LEED), Green Building Initiative (GBI) Green Globes, American Institute of Architects (AIA) Committee on the Environment (COTE) Top Ten, or International Living Future Institute (ILFI) Living Building Challenge, to name a few, have changed architectural practice for the better in many ways. Concepts including low-impact sites, transit-oriented development, water and energy conservation, envelope performance, green materials, healthy environments, design innovation, and following an integrative design process are all essential in making better buildings. But after closely observing and meticulously conserving buildings hundreds of years old, many details of the solutions endorsed by these rating systems do not stand up to close scrutiny.

Today's design professions and construction industry have utterly capitulated to modern-era design ideas and materials, products, and methods that are, in reality, unsubstantiated by the test of centuries and deeply suspect when measured by the standards of built heritage. If climate change is caused primarily by consuming energy, why favor airtight buildings that must consume energy for ventilation? Without power, many modern-era buildings are, literally, uninhabitable. Why not favor climate-adapted design? Why not provide occupants at least the option of opening a window? Was anything learned from the coronavirus pandemic?

If the fundamental precept of sustainability is meeting today's needs without limiting the ability of future generations, why favor material systems with only decades-long service lives that are neither repairable nor recyclable? Modern-era fascination with all-glass buildings is one of the greatest blunders in the history of architecture. A "high performance" all-glass building is an oxymoron. Even the best curtain-wall assembly performs like a rather mediocre solid wall.[2] Modern glazing and curtain walls are complex, integrated assemblies of multiple components with very different service life expectations. Once the weak link fails (sealants), the entire assembly (glazing and typically window framing, too) must be replaced in its entirety. Curtain walls cannot be recycled. That is *not* sustainable building technology. It is time architects held manufacturers to account.

Working with existing buildings taught me how much better traditional building materials and technologies are than many of their modern-era counterparts. Yes, you read that correctly. Although a modern double-glazed window carries a higher thermal rating than a historic single-pane wood window, traditional windows perform much better than replacement window manufacturers would have you believe. More importantly, traditional single-pane wood windows can be fully restored to their original condition and operation. In the United States, there are buildings with three-hundred-year-old fully functional wood windows, something that will never be said about modern-era buildings with insulated glazing.

Most traditional architecture has a window-to-wall ratio of at most 30 percent, acknowledging the inherent trade-offs in fenestration. In the United States, heritage buildings had a nearly universal hierarchy for façade materials: wood siding for modest buildings, brick for more substantial buildings, and stone for the most important structures. Among the oldest buildings still standing in the United States, all three materials are represented. As homeowners can attest, wood siding needs repainting at five-to-ten-year intervals. The tyranny of repainting is arguably the factor that has given traditional materials a (mostly undeserved) bad name. In contrast, every fifty to one hundred years, a brick or stone façade needs to be cleaned and its mortar joints repointed. The maintainability of these traditional materials is terribly undervalued.

Even robust brick and stone materials are subject to damage from acid rain and polluted air. For example, many of Brooklyn's once-gorgeous brownstones—nineteenth-century townhouses with sumptuous red sandstone window surrounds, belt courses, quoins, and elaborate cornices—are terribly defaced. A common take on brownstones is that their red sandstone is deficient. But after decades restoring buildings, my view on the deficiency of the sandstone has flipped. The problem is with the air more than the stone. Fix the air, which is an avoidable consequence of fossil fuel use, one that damages far more than sandstone. It is a telling example of our unquestioning acceptance of the avoidable environmental harm that Rachel Carson described so compellingly in her book *Silent Spring* published in 1962.[3]

Reacting to these incongruities in our modern-era ideas and practices, I came to appreciate that extending the useful service life of existing buildings is the most sustainable act. It led me to my now oft-quoted proclamation: The greenest building is … one that is already built.[4] As sustainability goals morphed into climate imperatives, the importance of building reuse has only magnified. Building reuse is climate action. Indeed, decarbonization goals can only be achieved rapidly and completely by prioritizing building renewal.

What puzzles me most about society's failure to sufficiently value building reuse is how practical and affordable it is to renew existing buildings and how beneficial and rewarding the outcomes. Obviously, reuse conserves existing resources. When it comes to buildings and urban infrastructure, the quantity of those resources is gargantuan. Renovation can yield fully renewed buildings with service life and performance expectations equivalent to new construction. There is a sizable and rapidly growing portfolio of completed retrofit projects across the United States, across climate zones, and across building types that serve as powerful proof points that even zero net energy performance is readily achievable.

There is a disproportionate need to reinvest in existing properties in towns and neighborhoods too long neglected. Building renovation is the most direct approach to improving lives in underserved communities. The first principle of building reuse is to do only what is necessary. Not coincidentally, that is the guiding principle for affordability and should be for sustainability and climate action as well. Even the most aggressive retrofit plan keeps far more than it modifies. Less work requires fewer dollars. Less work produces lower environmental impacts, including lower greenhouse gas emissions.

And not to be overlooked, the character and authenticity of spaces and places that are created by repairing and adapting existing buildings cannot be achieved through any other means. Built heritage can be experienced today as it was centuries, even millennia, ago. Regardless of cultural background, places that evolved over centuries resonate deeply with people. Seeing and feeling the layers of time—and generations of our forebearers—is what makes cities from Quito to Kyoto so greatly cherished.

Architectural Time

A truism I have discovered about buildings, especially those of the less monumental sort, is that their real value is not fully comprehended until they have been used and reused over multiple generations. The original designers and occupants presumably succeeded in creating a place that served their purposes. Often, the next generation still acknowledges the original design intent and makes necessary adjustments to serve somewhat differing needs and aspirations. Eventually, though, a generation of inhabitants comes along for whom the original purpose of the place has lost its relevance. They take the building for what it is. In my experience, at the century mark, the utility and adaptability of most buildings has been established through this process. It does not mean that newer buildings lack value, but—quite the opposite—it means that buildings should be given at least a hundred years for their value to be properly appreciated.

Modern culture struggles to find true value in the constructed environment because it has such difficulty adjusting to an appropriate flow of time. The greatest architectural monuments worldwide were commissioned by people with little expectation of living to see their completion. Both benefactors and beneficiaries understood the intergenerational exchange expressed in buildings. Antonio Gaudi's awe-inspiring Sagrada Familia in Barcelona, whose construction commenced in 1882, is a present-day example.[5] After more than 140 years, its soaring towers and westworks have yet to be completed. Finishing Gaudi's masterwork has become arguably the most visible and earnest expression of the cultural resolve of the Catalan people.

The National Historic Preservation Act of 1966 established the "fifty-year rule."[6] Once buildings reach that age, they become eligible for historic status, a formalized assessment framework for acknowledging their cultural value. Intentionally or not, the fifty-year rule is a capitulation of sorts to the modern-era habit of ripping down buildings almost as quickly as they are erected. Demolition is questioned only after fifty years. Demolition should be questioned no matter how old a building is. The vast resources—material, energy, carbon, financial, and human—needed to construct buildings deserve a much, much, longer presumed service life. That applies to *all* buildings, not only those deemed to have cultural importance.

Codes require buildings to be fireproof, earthquake proof, hurricane proof, and even bomb proof. Structural and life-safety elements must be constructed with extremely durable materials like concrete and steel—materials that can last hundreds, even thousands, of years—yet nothing in the codes provides guidance on how to design buildings to retain their value over the long haul. It is a profound disconnect, demanding yet not truly providing for permanence in the built environment.

The climate emergency is telling us, especially those of us who shape the built environment, that such contradictory, wasteful, and harmful habits of the modern era can no longer be tolerated. Long service life measured in centuries defines the value of buildings and cities, defines *architectural time*. Modern-era economies throw resources at the built environment without clear expectations for the full value they can return.

The Global North has launched headlong into a climate action agenda that promotes glass-half-full solutions that are not, in fact, sustainable. A deeper appreciation for the intergenerational exchange inherent in the making and inhabiting of buildings and cities provides a pathway forward. We need only to follow it. Understanding the lessons of built heritage is indispensable as we confront the climate crisis.

CHAPTER 2

Carbon, Carbon, Everywhere

To curtail climate change, greenhouse gas emissions from industry, agriculture, transportation, and the built environment—also commonly referred to as carbon emissions, or simply carbon—must be eliminated, primarily by not burning fossil fuels. In the building sector, it requires modifying, at times minimally and other times substantially, how buildings and cities are designed, constructed, operated, reused, and adapted. Going for zero also requires making these adjustments across the economy and around the world.

Many climate advocates, notably Greta Thunberg, are extremely frustrated by how difficult it has been, and continues to be, to inspire action. Global average temperatures have reached historic highs, with new records set year upon year. Unprecedented wildfires are raging around the globe. Extreme weather events have both intensified and their frequency multiplied. "Sunny-day flooding" caused by sea level rise in coastal cities—notably including Annapolis, Maryland; Norfolk, Virginia; and Miami, Florida—is occurring at ten times the rate of only a few decades ago.[1] How much more will it take?

What difference does it make if average global temperatures rise by 2.0°C (3.6°F) above preindustrial levels? What difference does it make if Earth's atmosphere contains 280 or 420 parts per million (ppm) of carbon dioxide (CO_2)? For architects, engineers, and others who shape the built environment, it can be difficult to connect global average temperatures and atmospheric carbon dioxide levels to our work.

There is an inside joke among architects and engineers about our different intellectual tendencies. Architects are required to synthesize an absurdly broad spectrum of information to make design decisions. To the contrary, engineers are required to understand minute details about extremely specific issues. The anecdote concludes: eventually, architects know nothing about everything and engineers know everything about nothing. Like all humor, a kernel of truth is what makes it work.

In fact, decarbonizing the built environment will require both the ability to fuse information across diverse fields and to assimilate microscopic detail. The differing capabilities that architects and engineers bring to the table are essential. Our ability to synthesize complex requirements into synergistic solutions that not only work and stand the test of time, but also inspire and delight, is irreplaceable.

Understanding climate change is not easy. Even after three decades of intense internationally coordinated research, science does not have all the answers. Indeed, some point to the inability of the scientific community to break out of its own bubble and communicate effectively as a significant factor in the slow pace of climate action. Other perspectives are needed. As experts on the built environment, we cannot shirk our responsibility nor be bashful about contributing our unique viewpoints and skillsets.

In his classic book, *American Building: The Environmental Forces That Shape It*, architect, preservationist, and educator James Marston Fitch recounted the story of the acoustic shortcomings of Philharmonic Hall in New York City's Lincoln Center for the Performing Arts.[2] Designed using the cutting-edge science of acoustics, the hall's architects confidently dismissed centuries of design tradition dating back to Greek theaters. Between its opening in 1962 and the publication of Fitch's book in 1975, Philharmonic Hall was modified four times to improve its acoustic deficiencies. None were fully satisfactory. In fact, now renamed David Geffen Hall, it reopened in 2022 after yet another comprehensive acoustic remake.[3]

To the contrary, the Musikverein in Vienna, Carnegie Hall in New York, and Jordan Hall in Boston are often cited as among the greatest concert venues ever constructed. All were designed within a century of Philharmonic Hall, strictly adhering to traditional rules of proportion developed over many generations. The decades ahead will show whether sixty years of development in the science of acoustics between the failures of Philharmonic Hall and the renovations that produced Geffen Hall measure up to the achievements of centuries-old design traditions at the Musikverein, Carnegie Hall, and Jordan Hall.

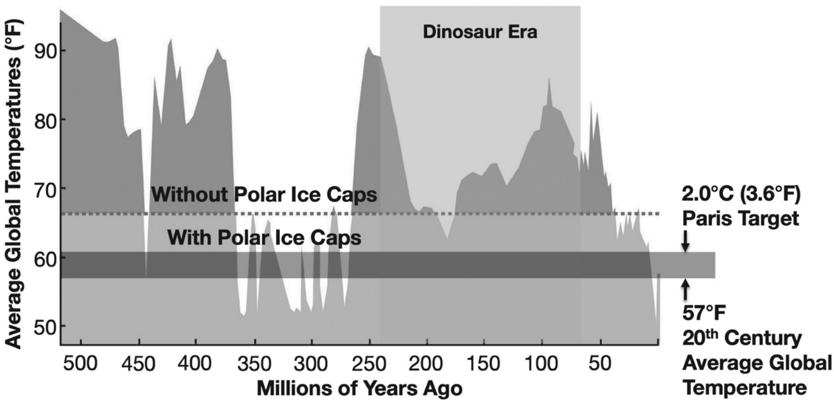
Global Warming in Proportion

Architects and engineers would be helpless to comprehend the world or design without measurement and proportion as frames of reference. They are deeply ingrained into both of our disciplines. One of the most powerful illustrations of this reliance is portrayed in a short film produced in 1977 by Ray and Charles Eames titled *Powers of Ten*.[4] It takes viewers on a magic carpet ride from a picnic blanket on the shores of Lake Michigan, at ten-to-the-power-of-one meters (10^1)—roughly thirty-three feet above the ground—and shoots out into the cosmos. Astonishingly, at only ten-to-the-power-of-seven meters (10^7), Earth appears like the famous blue marble photograph taken from *Apollo 17*. If playing to type, engineers may find the negative powers of ten more relevant—diving into the microscopic universe of the molecule, atom, and electron.

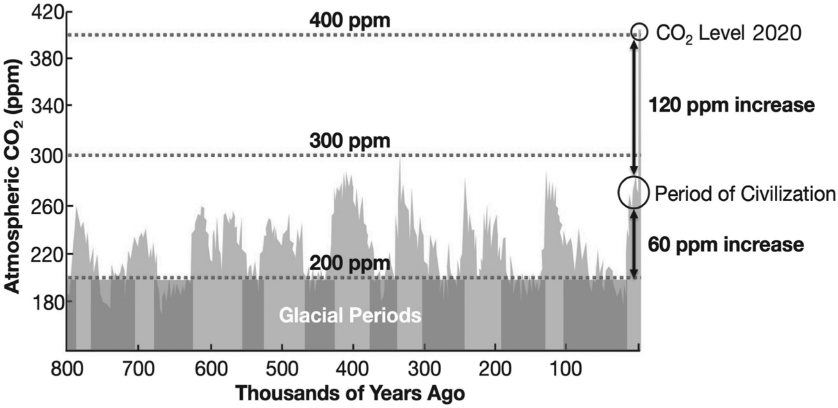
Appreciating the essential factors of climate change in proportional terms helped me understand the importance of rising average global temperatures and atmospheric CO_2. Studying two graphs, a sort of temperature and CO_2 powers of ten, provided me with a snapshot of the proportions of global warming and corresponding risks more clearly than anything I have read in climate science literature.

The first graph records average global temperature (AGT) for the past 500 million years. Over that period, the AGT fluctuated between about 50°F and 95°F.[5] What's the big deal? I experience far more than a 45°F range in temperature every year. But AGT is drastically different than the daily and seasonal temperature fluctuations we experience. When the AGT exceeds 66°F, a mild temperature found comfortably between the summer highs and winter lows I experience every year, the polar ice caps and glaciers disappear.

An iceless world existed for more than half of this 500-million-year period, including during the relatively recent Age of Dinosaurs. Polar ice caps began reappearing about 45 million years ago and have existed ever since. The twentieth century AGT was 57°F, only 9°F below the maximum AGT limit that supports



Average Global Temperature



Atmospheric CO_2 Levels

Average global temperatures over the past 500 million years. Even if global warming is capped at 2°C (3.6°F), the gap to an iceless world closes by 40 percent. (Data from US National Oceanic and Atmospheric Administration)

Atmospheric carbon dioxide levels over the past 800,000 years. The increase in atmospheric CO2 since 1900 is double what separates pre–Industrial Revolution climate from the Ice Ages. (Data from Mauna Loa Observatory)

(continued...)

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