

# “What to Build and Rebuild, Whom to Protect?": Digital Technology, Climate Justice, and Housing Affordability

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**The intersection of housing affordability, climate change, and social inequity in the mature years of the digital age raises a series of critical questions concerning the design professions. How can building designers adapt the urban environment to improve access to affordable housing? What opportunities exist for the integration of digital technologies throughout the design and construction process? How can these adaptations be applied in historic urban centers to reduce material consumption and preserve existing morphology? Most importantly, who benefits from these processes and how? In this paper, we address these questions by outlining a multiyear, interdisciplinary research and design project that uses Baltimore as a case study. While the specific nature of the built environment in Baltimore dictates much of the research and design process, the purpose of working with digital tools is to promote a wider application of our findings in broader and more diverse contexts. The project builds on a growing catalog of research regarding the integration of digital technology in the design professions, and while we aspire to contribute to this catalog with novel methods and new insights, our motivations remain guided by philosopher Olúfemi O. Táíwò's critically important question, clearly articulated: "what to build and rebuild, whom to protect?"**

## BACKGROUND

In 2023, housing affordability in the United States reached historic lows. According to the most recent National Housing Market Summary published by the Department of Housing and Urban Development (HUD), indices for both homeownership and rental affordability sunk to their lowest in recent decades. And while much debate productively explores the true costs of housing, what constitutes affordability, and how policy and finance participate, the prevailing view asserts that affordable housing remains in a state of crisis. To this end, in his closing remarks to the Housing Affordability Summit at the National Building Museum in September 2023, former HUD Secretary and current CEO of Enterprise Community Partners Shaun Donovan underscored the severity of the crisis, declaring that housing affordability "has been a chronic affliction for decades,

with affordability challenges only getting worse. But the crisis we have experienced in these last few years is acute in a different way, bringing it more profoundly into the national conversation." As integral players among the affordable housing team, design professionals have an opportunity to contribute to this critical conversation in meaningful and perhaps transformative ways.

Alongside the immense challenges posed by housing affordability, the increasingly dramatic impacts of climate change pose additional layers of complexity for the future of design. Moreover, these impacts are not evenly distributed as they disproportionately affect historically oppressed and marginalized communities. For the feminist geographer Farhana Sultana, the "extremely uneven and inequitable impacts of climate change mean that differently-located people experience, respond to, and cope with the climate crisis and related vulnerabilities in radically different ways." As a result, the tasks of tackling climate change and advancing social justice become cojoined. In recent years, the concept of climate justice has gained traction among a diverse audience as a platform for equitably addressing these cojoined challenges. In Sultana's framing, climate justice "is about paying attention to how climate change impacts people differently, unevenly, and disproportionately, as well as redressing the resultant injustices in fair and equitable ways. The goals are to reduce marginalization, exploitation, and oppression, and enhance equity and justice." Broadening the scope of design beyond the building envelope and building site, the conceptual framework of climate justice invites designers to foreground downstream impacts to critically examine "who benefits, who loses out, in what ways, where, and why" in the vast network of sites and actors involved in the design process. As design professionals tackle issues of housing affordability amid rising social inequities and worsening climate impacts, climate justice encourages a more critical examination of design decisions and their cascading effects. Embracing the concept of climate justice in his call for a widely redistributive project of reparations, philosopher Olúfemi O. Táíwò outlines the stakes in what he describes as "the constructive view":

Whether we want to undo what has been done (e.g. destroying or altering levees) or do something else (e.g. "managed retreat" from the waters), we will have to execute either



Figure 1. Retrofitting historic buildings often involves significant costs due to high demand for skilled labor. Image: Brent Sturlaugson

choice with hands, feet, and shovels—not with recognition or symbolism. We will have to change the distribution of wealth, of housing, and of water, not of apologies or memorials. We have to decide what to do from here: where to fortify and what to abandon, whether or not to flee, what to build and rebuild, whom to protect.

For *Táíwò*, reparations occur in and through climate adaptation. An equitable world cannot exist if climate change and social justice are treated as separate issues. Rather, only by uniting them under the banner of climate justice can a viable future be achieved. And for design professionals, the question of “what to build and rebuild, whom to protect” serves as a lens through which climate justice might materialize in the built environment.

A key tenet of designing for climate justice involves working with what already exists. Since the networks of production for new materials remain entrenched in relationships that have themselves contributed to the climate crisis and its uneven impacts on communities, alternative networks that rely on existing materials offer fruitful possibilities for designers advancing climate justice. Many preservationists endorse these possibilities, and elaborate the gains that accompany material reuse in the fight for climate justice. Under the banner of “retrofit,” Fallon Samuels Aidoo and Daniel Barber argue that reuse strategies suggest “a viable if not venerable path forward for preservationists’

inquiries and interventions in climate change and energy transitions.” Dispelling some popular myths, Jessica Morris asserts the importance of working with what already exists in pursuit of equitable adaptation, contending, “preservation and sustainable development are perhaps allied. Preservation is the agent of the *soft*, cultural work of social science, driven by the machine of planning, and forged from the *hard* science embedded in climate change. The places that compel action must at once remain and enhance the authenticity of that which is at stake.” Retrofit and reuse not only create meaningful connections with the past, but also make way for a more livable future. As before, however, working with what already exists must consider who gains and who loses in the process. [Figure 1] In this respect, preservationist Susan Ross underscores the opportunities for design professionals, writing, “Most critically, those promoting the retrofit of the built environment should also look at how our projects can help empower those whose lands have been taken, whose voices have been silenced, whose traditions are being erased, and whose poverty is not helped by developments exclusively planned by others.” Rather than impeding progress toward climate justice, working with existing resources plays an integral role in achieving it.

Designing for climate justice also requires a thorough embrace of digital technology, now considered an integral part of the “fourth industrial revolution.” The fourth industrial revolution describes

the technological leaps enabled by computation, particularly in manufacturing. In architecture, these leaps accompany similar advances in design technology, or what architectural historian Mario Carpo qualifies as “beyond digital.” Architect Ben van Berkel asserts that the fourth industrial revolution, and its attendant suite of design and construction tools, has prompted “the most significant expansion to the discipline of architecture in recent years.” This expansion offers new potential for not only the customized design solutions often associated with computational design, but also for addressing “specific urban challenges” made visible through remote sensing and digital scanning. Housing design in particular has seen a sustained engagement with industrialized production that now includes a vast array of computational tools, including mass customization, robotic prefabrication, and digital twin representation, to name only a few. Among the many issues attending the fourth industrial revolution in housing design is the potential for increasing affordability. In a recent example, one winner of the 2020 Housing Affordability Breakthrough Challenge, MiCASIa, prospective homebuyers use an app to customize their design with immediate feedback showing the implications of these design decisions on overall cost. Far from the only factor influencing housing affordability, computational design tools offer yet another point of leverage in a complex system of policy proposals, financial instruments, and construction technologies. Moreover, prominent nonprofit organizations and financial institutions continue to show great interest in housing design and offsite construction in pursuit of affordability, as the \$20 million renewal of the Housing Affordability Breakthrough Challenge demonstrates. Often slow to adopt significant changes, the construction industry has also embraced the fourth industrial revolution, which promises “to create a new paradigm for the design and construction of our built environment assets.” Despite this promise, a recent study found that the labor productivity observed in related sectors has largely bypassed the construction industry. However, a proliferation of research in construction automation is underway, and in early 2023, the Office of Policy Development and Research at HUD released “Offsite Construction for Housing: Research Roadmap,” which presents a structured approach to bridging the labor productivity gap in the design and construction, specifically for housing. Among the many areas highlighted for expanded research, the authors note “that there continues to be a disconnect between design software and manufacturing software that follows the conventional practice, which contractually and culturally separates design from the means and methods of construction.” As digital methodologies grow increasingly germane to everyday building practices, the cost savings associated with increased labor productivity will contribute to a more efficient and affordable process of housing production.

## CONTEXT AND METHODS

The intersection of housing affordability, climate change, and social inequity in the mature years of the digital age raises a series of critical questions concerning the design professions. How can building designers adapt the urban environment to improve

access to affordable housing? What opportunities exist for the integration of digital technologies throughout the design and construction process? How can these adaptations be applied in historic urban centers to reduce material consumption and preserve existing morphology? Most importantly, who benefits from these processes and how? In this paper, we address these questions by outlining a multiyear, interdisciplinary research and design project that uses Baltimore as a case study. While the specific nature of the built environment in Baltimore dictates much of the research and design process, the purpose of working with digital tools is to promote a wider application of our findings in broader and more diverse contexts. The project builds on an immense catalog of research regarding the integration of digital technology in the design professions, and while we aspire to contribute to this catalog with novel methods and new insights, our motivations remain guided by Táiwò’s critically important question, clearly articulated: “what to build and rebuild, whom to protect.”

In Baltimore, the affordable housing crisis reflects the “chronic affliction” Donovan mentioned in his closing remarks. Specifically, the acuteness of the crisis lies in a confluence of forces, “offering neither low costs nor high incomes, Baltimore renters face burdens as high as families living in cities with tight housing markets.” Furthermore, in 2023 the Housing Authority of Baltimore City received a record number of requests for housing support, seeing 29,800 applicants for a supply that serves only 5,700 residents. From rent burdens to low wages, disincentivized developers to insufficient public support, housing affordability in Baltimore reflects many of the patterns observed throughout the country. Also reflecting broader patterns, climate change affects Baltimore communities in uneven ways. While some of these impacts remain largely invisible or diffuse (e.g. elevated risk of lung disease or asthma), others grow increasingly violent and visible (e.g. heat related deaths, catastrophic flooding). As housing affordability worsens and climate impacts accumulate, the built environment must adapt. Unique in the scale of both its dominant housing typology and number of vacant properties, Baltimore has the opportunity to illustrate how widespread adaptation can be achieved while “spatializing justice.” Additional questions posed by architect and theorist Keller Easterling in her recent book, *Medium Design: How to Work on the World*, further guide this project:

“Can shrinking cities, floodplains, garbage gyres, or sprawling urban peripheries—with all of their alarming consequences in the form of fires, hurricanes, and thinning atmospheres—enter into new interdependencies with each other? Is it possible to identify a productive ecology between the very precipitates of political and environmental crisis? And does this interplay of problems have any chance of gaining sufficient scale to be effective?”

Rather than a collection of separate issues to be tackled independently, this project proposes a “productive ecology” that



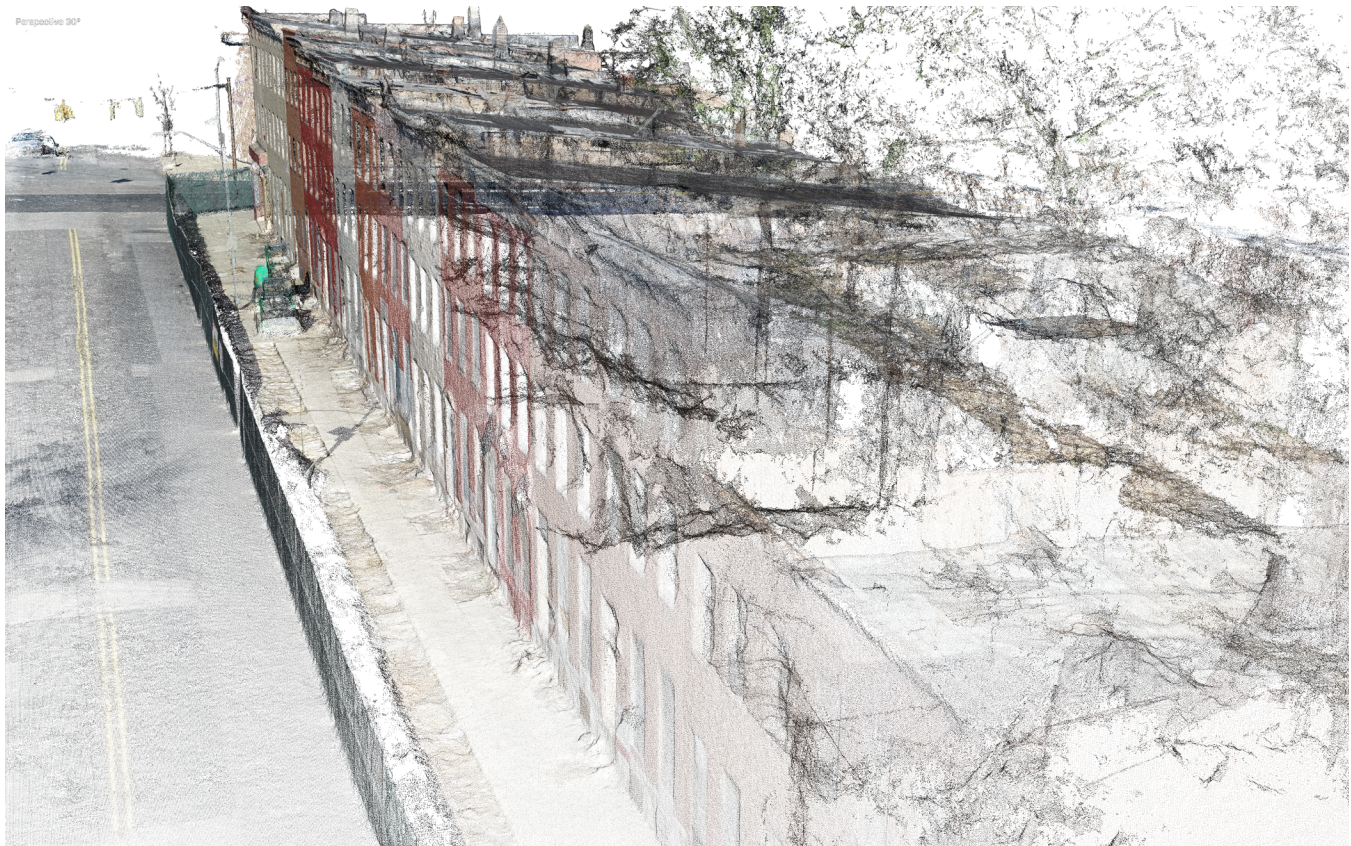


Figure 2. Point cloud generated from aerial photogrammetric scans. Image: Brent Sturlaugson

harnesses the specific conditions in Baltimore to unlock new opportunities for transforming the built environment.

Drawing inspiration from the confluence of tangible and intangible forces operating in Baltimore, the project consists of three phases. In phase one, we created detailed digital models from aerial scans of vacant rowhouses in Baltimore to serve as representational samples of units fit for renovation. Using a DJI Phantom 4 Pro equipped with a one-inch sensor capturing 4K images, we completed a series of high-resolution photogrammetric scans, which were then processed in Agisoft Metashape to produce 3D point clouds and textured meshes. [Figure 2] These digital models facilitated a forensic analysis of existing conditions with a high degree of detail that captured subtle variations between units. Built nearly 150 years ago, the seemingly identical rowhouses often vary in imperceptible ways, made visible only through computation and digital reconstruction. Typically, renovations to rowhouses in Baltimore require customized solutions to these imperceptible variations, thereby raising the costs of design and construction. Through this project, we aim to demonstrate that these costs of customized solutions can be reduced or eliminated through mass customization enabled by a suite of digital tools, beginning with 3D scanning.

Phase two involves the design of housing components suitable for mass customization and robotic prefabrication. Drawing on

a wide range of scholarship into scalable systems of component design, we propose a “product platform” specific to the dominant housing typology in Baltimore. Recognizing that the overwhelming majority of Baltimore’s 30,000 vacant properties are rowhouses, we propose a systematic approach to their renovation, rather than individualized treatment or indiscriminate demolition. [Figure 3] In this respect, our research not only provides a potential pathway to the provision of affordable housing at scale, but also presents a viable solution to the many challenges posed by vacant buildings. Furthermore, the process preserves the architectural and urban character of the city. In addition to a reflection of “social and economic pressures felt in every American city,” rowhouses, in the words of architectural historian Robert L. Alexander, were “a common, long-lived vernacular, it is built up from the basic unit, the brick, in clearly defined blocks. Its rectilinear openings pierce the façade wall sharply and with absolute regularity, having stone sills and lintels that perform structurally and provide a minimal ornamental touch. The whole front has the functional rhythm of a work song.” Echoing the sentiment, for historians Mary Ellen Hayward and Charles Belfoure, the rowhouse is synonymous with Baltimore, observing that “few other cities’ psyche and identity are so closely tied to this architectural form.” To lose 30,000 rowhouses to demolition would fundamentally reshape the city, cause enormous stress to already overburdened landfills, and expend excessive carbon emissions in the preparation





Figure 3. Widespread demolition has irrevocably changed the urban fabric of Baltimore. Image: Brent Sturlaugson





Figure 4. Digital models created from point cloud data, separated into individual units for mass customized retrofit design. Image: Brent Sturlaugson

of alternate housing sites. Moreover, when asked what type of housing would be most appropriate, residents in East Baltimore clearly expressed their preference, “Give us rowhouses...We just want to live in the same kind of housing that everybody else has.” Rather than experimenting in the relatively unencumbered territory of greenfield sites, this project grapples with the unpredictability and irregularities of existing building stocks. [Figure 4] Using techniques originally developed to satisfy individual consumer preferences, we enlist mass customization tools to navigate the unique characteristics of historic buildings.

In phase three, we will analyze the resulting system and build a digital tool that integrates the various software platforms into a streamlined workflow. For the analysis, we will perform a detailed cost estimate that accounts for a wide range of housing affordability metrics (i.e. construction costs, transportation costs, labor costs, energy costs) and establish a scale at which the proposed method would achieve affordability. Additionally, we will analyze the potential energy savings of a retrofitted rowhouse against a typical Baltimore rowhouse. Integral to the third

phase of this project is a digital tool that reduces commonly cited points of friction between design and construction practices. We envision this tool to receive, as its data input, a 3D point cloud that serves as the variable parameter in a mass customized design process. Through selection of curated product platforms, the resulting design will be communicated with prefabrication facilities for offsite manufacture. While still under development, phase three represents a critical juncture in the project, when we learn how the process benefits those with the most extreme housing affordability challenges.

## CONCLUSION

Treating Baltimore as a case study, this project demonstrates the possibilities for widespread climate adaptive design that confronts longstanding iniquities. “How can we possibly succeed at a task as immense and contested as building the just world?” asks Táíwò nearing the end of the book *Reconsidering Reparations*. While the undertaking remains undeniably immense, Táíwò urges concerted efforts that leverage collaborative action that will likely span generations. “For better or worse,” he concludes,





"our ancestors constructed this world in their image. We owe it to our descendants to rebuild it, in a new one." This project contributes to ongoing efforts that redistribute burdens and benefits in a rapidly changing climate by leveraging digital technologies in the design and construction of affordable housing in pursuit of climate justice. As design professionals, we have valuable tools to lend, if not lead, in longstanding struggles of "building the just world."

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