

**The Howard University Center of Excellence in Housing and Urban  
Research and Policy (CHURP)**

***Case Studies of Modular Housing Projects in  
Washington, DC***

**Draft Final Report to  
The U.S. Department of Housing and Urban Development**

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## Executive Summary

In 1969 newly appointed President Richard Nixon appointed George Romney, former Michigan governor, as Secretary of the U.S. Department of Housing and Urban Development HUD. Romney was committed to the initial HUD agenda of radically increasing the supply of urban housing that was affordable and accessible to racial minorities. Secretary Romney was also predisposed to the notion of a need for a radical increase in the use of an industrialized approach to housing construction and production. *Out of those convictions the 1969-1974 HUD Operation Breakthrough was born.*<sup>1</sup>

This was the nation's first large-scale systematic housing demonstration program aimed at explicitly encouraging the use of more industrialized methods of building houses. Nearly 2,800 housing units were constructed at nine urban, suburban, and semi-rural sites. The hundreds of developer-builder-design teams vying to build those projects was narrowed down to 22 national companies. The selected teams - already mature large-scale industrialized construction operations - had previously built thousands of offsite constructed (or modular) buildings.

Currently, there is a consensus of belief held by a broad cross section of public and private sectors of housing producers and advocates in the United States that there is a growing deficit of affordable housings units. The size of the deficit ranges between six and eight million units. There is also an emerging consensus of belief that an essential part of any credible strategy for closing that deficit must include the massive reform of the housing construction industry.

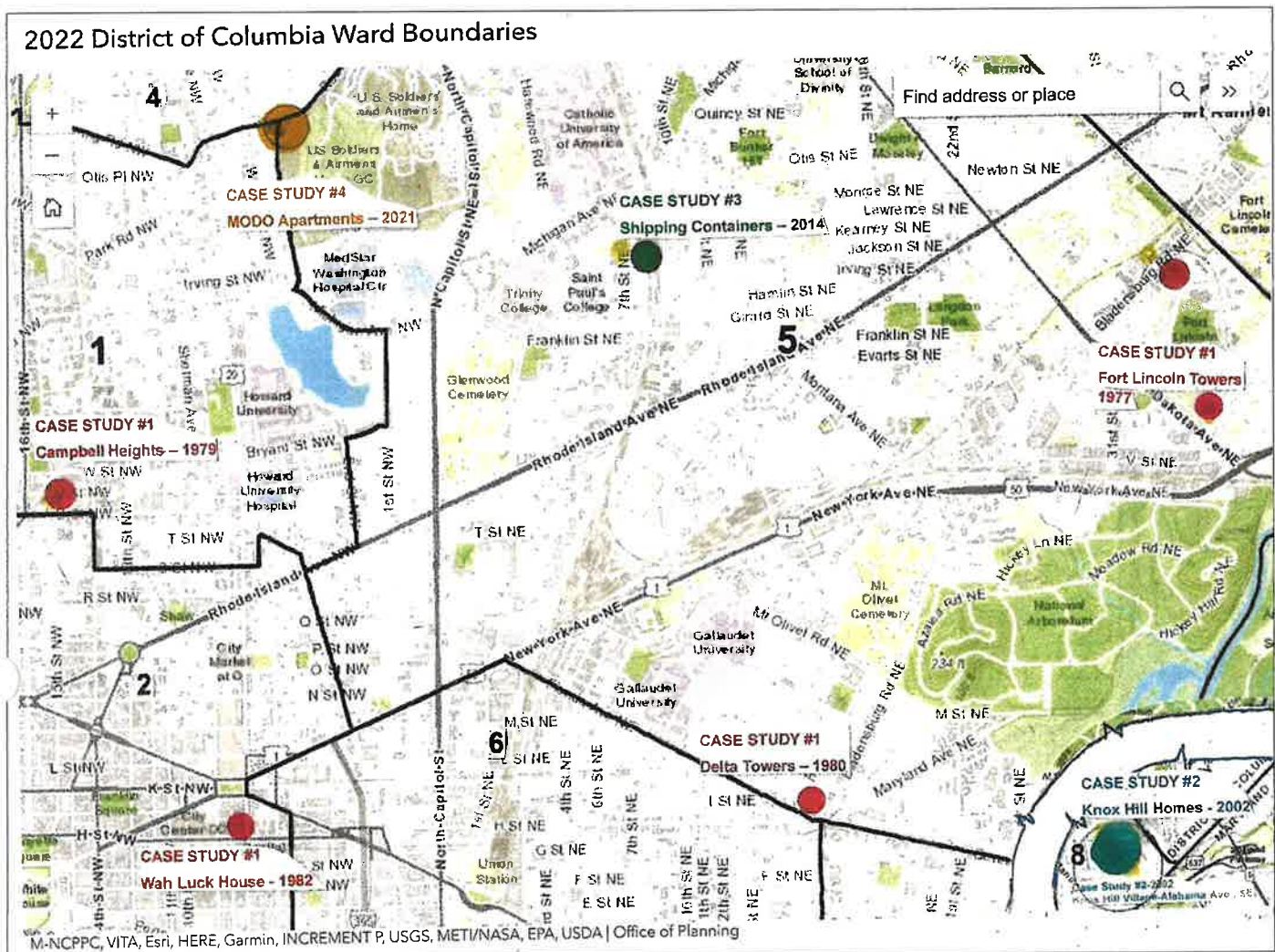
In the city of Washington, DC the national affordable housing deficit is proportionately acute. Despite the general unawareness throughout the city, there have been a number of successful offsite/modular housing projects completed in Washington, DC. The

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<sup>1</sup> Operation Breakthrough, 1969-1974. Office of Policy Development & Research (PR&R). PSAD-76-173-pdf. Operation Breakthrough: Lessons Learned About Demonstrating New Technology. A Report to the Congress; By Elmer B. Staats, Comptroller General, a 97 page report that describes in great detail the OBT program along with an assessment of the successes and failures.

objective of this research team is to unearth the actual history of those projects. Our research team focused on four projects, each framed as a case study.

## Exhibit 1. DC Ward Locations of the Case Studies



The selected projects serve as representative examples of a larger number of offsite factory-built housing projects constructed in Washington, DC over the nearly half-century time period between the 1974-completion of the HUD-funded 1969-1974 Operation Breakthrough project and today. The four case studies broadly cover the predominant typologies of residential construction, e.g., high-rise buildings constructed from factory-built concrete panels; single-family homes constructed from factory-built wood modular boxes; cargo shipping containers as the modular boxes; and a midrise structure of modular boxes supported on a noncombustible reinforced concrete slab over the ground floor space of the structure.





**Case Study #1 (Exhibit 1A)** is a total of 1,000 units on five sites built between 1976 and 1982. The first two sites are on separate parcels in the Fort Lincoln New Town northeast development on the DC-Maryland border; the third site is in the uptown U Street corridor; the fourth site in the H Street, Northeast corridor; and the fifth site is in the downtown Chinatown section.

Sales Price: \$510,000 October 2023

Knox Hill Village, October 2023



**Case Study #2 (Exhibit 1D)** is the largest entirely modular factory-built single family homes project ever developed in DC. The project is in the Congress Heights-Knox Hill neighborhood.



**Case Study #3 (Exhibit 1C)** is a 2014-completed 24-unit student walkup apartment building that utilized steel cargo shipping containers as modules.



**Case Study #4 (Exhibit 1D)** is a small 17-unit apartment building that was completed in 2021 through the project developer's combining of the established method of building affordable medium-high density apartment buildings housing with treated wood, and modular factory-built construction technology.

Each of the case studies include a historic overview of the project, followed by information on the then existing zoning and building construction code constraints, the project development team and manufacturing suppliers, site plans and floor plans accompanied by reinforcing graphic images, and a summarized narrative about the project users and critical project cost issues. The study then proceeds to list the key findings and take aways from our selected case studies research that provide a window into the progressions of receptivity to offsite and modular residential construction in Washington, DC over the timeline of this study.

Case Study #1, by far the largest of case studies, was essentially a *direct continuation of Operation Breakthrough*. However, the projects in this case study were never perceived in their surrounding neighborhoods as “factory built.” The concrete walls and panels delivered to each site and quickly assembled did not challenge the prevailing local building code that required onsite inspection and approvals of the progression of stages of construction. The finished product was fully synchronous with prevailing modernist architectural expression. The buildings were viewed favorably by the design professions, while also viewed as non-threatening by local construction industry unions and building code officials.

The five separate project sites in this consolidated case study were delivered at a time of transition by the federal government towards an ideology that favored drastic reductions of direct financial support of low-moderate income housing, despite the high level of need for such housing in Washington, DC. From the 1982 completion of the last of the high-rise senior apartment buildings, there were a number of isolated instances of modular factory built single family homes constructed in DC. Most, if not all of those projects were small-scale singular instances of an adventurous architect and progressive-minded owner collaborating on building a market-rate single family home. By 1990 the factory-built housing industry had progressed well beyond the earlier era of only producing mobile trailer homes. Growing parts of the industry were routinely producing factory-built single-family houses that were classifiable as permanent homes

by a growing number of construction and mortgage lenders.

At that time there were dozens of modular factory plants around the U.S. delivering finished home products to semi-rural and exurban sites. Several modular factories were located within 250 miles of Washington, DC. However, to builder/developers the notion of building modular single-family homes at scale in a crowded and high-traffic urban neighborhood was not deemed as practical or financial feasible. A primary reason was local building code requirements for staged intervals of on-site inspections. The added costs of long-distance transporting of modular boxes was another factor.

The number of American and European architects who were drawn to the vision of modular building had not diminished. However, the number of builders or developers who were willing to indulge an architect's compunction to "go modular" on a housing project was virtually non-existent, given the obstacles and financial uncertainties still surrounding modular building at scale in urban central city settings.

Our team concluded that to arrive at the desired level of common usage of offsite construction utilization in affordable housing there must be concerted actions initiated by coalitions of locally based municipalities, private sector companies, and civic activists. This will be a radical departure from the top down federally driven 1969-74 Operation Breakthrough. The most promising examples of the such actions can be found in locally initiated programs by the two existing municipalities of [Boulder, Colorado](#) and [Boston, MASS.](#)

We have also concluded that, while there are no remaining technical barriers to the increased use of offsite construction in the city of Washington, DC, *there is still continuing resistance amongst the local residential builder/developer community.* That resistance will only subside through demonstrable evidence that affordable and non-luxury class market-rate housing projects – using the now ubiquitous 1996 "5 over 1" mid-rise high-



density construction invention<sup>2</sup> – can longer “pencil out” (developer slang for “achieving financial feasibility”) without resort to the use of offsite modular construction.

We further concluded that the housing construction industry is now in the dawn of an era that will require the conjoining of the 1996 insight about treated wood mid-rise construction with factory-built modular construction at scale quantities as the only way to make a market-rate and affordable housing deal “pencil out.” Our team case studies research bolsters our belief that the DC government is predisposed and well positioned to emulate municipalities that are moving to positions of direct initiation and formal incorporation of actions and policies of utilizing offsite construction as integral parts of their strategies to increase affordable housing production.

## Exhibit 2. Midrise High-Density Treated Wood Invention + Modular



Source: Left, BASE4 Architects & Engineers-[www.base-4.com](http://www.base-4.com)

Right, Offsite Builder Newsletter, Vol 03-Issue 02, February 24, 2024.

Gary Fleisher, Author

<sup>2</sup> In 1996 in Los Angeles, architect Tim Smith was stumped in his attempts to make a 100 unit mid-rise housing project affordable using established national and local building codes. All such codes required the use of either reinforced concrete floors and columns or high strength structural steel floors, columns, and beams to construct mid-rise buildings (e.g. more than 2 or 3 stories high). Smith discovered a recent change in the codes that allowed the use of fire retardant treated wood (FRTW) in fully sprinklered buildings of up to five stories high. Smith consulted with his structural engineers about placing the entire five stories on top of a thick reinforced concrete slab supported by concrete columns as the first floor of the structure. The cost of his project dropped significantly. Thus the “5 over 1(or even 2)” structure became ubiquitous throughout the U.S. as the only feasible way to build high density mid-rise apartments. The next logical step is the use of factory construction of modular boxes in lieu of the conventional onsite field construction of the five floors of FRTW.

## Introduction

Our initial approach to examining case studies of offsite constructed factory built housing projects completed within the city boundaries of Washington, DC was to limit our timeline to the past twenty-five years. Upon further reflection, research, and re-examination of our own direct personal experiences we came to a realization that our timeline was too short and arbitrary. Realizing that members of our research team had directly witnessed the 1969-1974 years of HUD's Operation Breakthrough, we amended our timeline start date to coincide with the completion date of that undertaking. Those team members also recall the negative reaction to Operation Breakthrough over the two ensuing decades.<sup>3</sup> Those recollections were confirmed as largely accurate in an extensive official assessment undertaken the HUD Office of Policy Research & Development.<sup>4</sup>

### Description of the Study Issues

This project research aims at providing our team with a better assessment of the appropriate construct of the next phase of our overall research objectives regarding the future prospects of expanding the use of offsite/modular housing construction in Washington, DC. Lessening racial wealth disparities is an underlying motivation for the catalyzing of a rapid increase in the use of offsite constructed modular housing technology. Such wealth disparities are, to a substantial extent, the result of past racial policies that held back the growth of Black family wealth. Housing equity accounts for two-thirds of all wealth for the median US household and is the most common way that wealth is inherited. Offsite construction, particularly factory-built modular housing, is moving inexorably towards becoming an indispensable part of any strategy aimed at

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<sup>3</sup> Operation Breakthrough, 1969-1974. Office of Policy Development & Research (PR&R). PSAD-76-173-pdf. Operation Breakthrough: Lessons Learned About Demonstrating New Technology.

<sup>4</sup> "Factory Built Housing: A New Age of Experimentation." Todd Richardson, HUD OPRD EDGE, the OPRD Newsletter March 5, 2024 Summary of the Feb. 6-8, 2024 HUD conference of key HUD OPRD staff and outside HUD Research Partners.

significantly increasing the supply of affordable housing. In Washington, DC and similar urban communities a major increase in the supply of affordable housing is critical in wealth preservation and generation, and economic development in Black and Brown communities.

### **Research Questions:**

1. Can state-of-the-art modular housing construction technology advance the rate of housing production while decreasing development and construction costs, and also help to build intergenerational housing wealth in gentrifying urban and Black communities generally and Washington, DC specifically?
2. Will increasing the share of modular housing (including flexible modular housing) in the housing supply improve the housing and financial well-being of low-income African American families including seniors?
3. Can the increase of small Black developers and developers of color – including related businesses, professions, and labor - in offsite constructed modular housing production lessen the negative impact of urban gentrification on Black generational wealth creation in Black and Brown communities?
4. Are there past examples of offsite and modular constructed affordable housing projects in the District of Columbia that might indicate an appropriately receptive environment for a radical increase in the use of offsite modular construction technologies?

**Discussion of the Research Questions:** Modular housing (including flexible forms) can provide equitable affordable housing and sustainable housing wealth augmentation for low- and moderate-income buyers in Black communities. Most urban municipalities including Washington, DC have relied primarily on for-profit and nonprofit real estate developers and inclusionary zoning (IZ) to produce affordable housing. There are numerous (though still relatively small) numbers of projects by several developers in the DC area and elsewhere that have utilized modular factory-built technology to build

housing projects. Their success suggests that modular factory-built housing projects, at certain scale levels, can succeed in achieving increases in the production of affordable and sustainable housing units. Evidence for this hypothesis will be drawn from our teams' identification and description of a select number of representative case studies of projects that were built using modular and other types of offsite construction in Washington, DC. How to overcome the past and current remaining challenges of unproductive old attitudes and behavior, developer inexperience, and undercapitalization will hopefully be inferable from this first phase review of the case studies.

### **Study Limitations and Assets**

Over the past two decades, the DC government has digitized practically all facets of its built environment and public records, maps, and other forms of graphic depiction. In this set of case studies we limit our data collection to public regulatory agencies, e.g., DC Department of Buildings, DC Zoning, local region-based off-site construction advocacy organizations, real estate appraisal entities, tax assessment agencies, and related sources including media coverage that is available to public inquiries. Similarly, we take full advantage of our past two decades of having worked directly with established (and regionally based) off-site modular housing manufacturers. Members of our team of investigators have direct and immediate access to construction cost data and information from modular manufacturers that is rarely available to academic researchers.

In this case study report of offsite modular constructed projects our intended audience of HUD reviewers also includes DC housing officials, regulatory entitlement agencies, equity and debt-based investors, modular construction industry suppliers, and small to medium size community-based construction and development companies. The rich history of the Howard University College of Engineering & Architecture (CEA) of learning, teaching, and activism in community physical development since the early 1960s has also provided our team with added capacity to develop this research study.



## Chapter 1. Overview History of Offsite Construction in the U.S.

Prefabrication generally, including modular construction, has always fascinated U.S. architects including the most iconic figures beginning with [Frank Lloyd Wright and his Usonian Houses](#). The entire early 20th century European modernist architecture icons were obsessed with the idea of advancing an industrialization approach to the building of social housing.<sup>5</sup> Interestingly, the first movement of modular housing in the U.S. was the [Sears Roebuck catalog homes during the post-World War I era](#). That was followed by the trailer park mobile home that was disdained by the architecture profession. The spark that caught the architecture profession's eye as being of serious architectural merit was lit in the mid-1960s by young Canadian architecture student Moshe Safdie.<sup>6</sup>

### Exhibit 3. Moshe Safdie, Villa Savoye, Falling Water, and Expo '67



<sup>5</sup> Miller, Richard, Editor. *Four Great Makers of Modern Architecture*. New York: Da Capo Press. 1970

<sup>6</sup> Safdie, Moshe. *Beyond Habitat*. Cambridge, MA, MIT Press. 1970



By the time Safdie had reached his final year in school he decided to explore his passionate belief that the architectural theories and iconic houses of his two idols Le Corbusier (Villa Savoy, 1928) and Frank Lloyd Wright Falling Water, 1937) could be synergized in a dense urban context. Safdie believed that this could only be done through the use of an industrialized modular design and construction approach. He was able to attract the attention of the Canadian government to the idea of building a prototype version of his 1965 completed thesis project as an exhibit in the Montreal-based 1967 Worlds Fair. The now globally iconic project lit a firestorm. No serious discussion or treatise on the subject of modular housing can begin without starting with Safdie's Habitat 1967 project. Today, after over six decades of the continuing building of similar projects across the globe, Moshe Safdie is the most revered living modernist architect still practicing to this day.

The entire 1960s decade was a period of great change in the U.S. The 1962 assassination of a Democrat president with liberal and social justice leanings led directly to the 1964 passage of the Civil Rights Act and the 1965 passage of the Voting Rights Act. The middle 1960s urban rebellions brought about a heightened national concern about the urgency of directly addressing the problems of the nation's cities. The most high-profile symbol of a new direction was the 1965 creation of the Department of Housing and Urban Development, aka HUD. The first appointed HUD secretary was Robert C. Weaver, a distinguished Black economist.

Over the following three years, national urban unrest and violence led to a new presidential leadership that had a more politically and economically conservative attitude about the role of government. However, that new government, taking office in 1969, had a newly appointed HUD secretary George Romney. As a former governor of Michigan, Romney was committed to the initial HUD agenda that called for radically increasing the supply of urban housing that was affordable and accessible to racial minorities. Secretary Romney was also predisposed to the notion of a need for a radical increase in the use of an industrialized approach to housing construction and production. *Out of those convictions was born HUD Operation Breakthrough.*

This was the nation's first large-scale systematic housing demonstration program aimed at explicitly encouraging the use of more industrialized methods of building houses. Nearly 2,800 housing units were constructed at nine urban, suburban, and semi-rural sites. The hundreds of developer-builder-design teams vying to build those projects was narrowed down to 22 national companies. The selected companies were already mature large-scale industrialized construction operations that had previously built thousands of prefab buildings. These companies viewed Operation Breakthrough as an opportunity to expand their footprint and customer base.

One of those companies was Cleveland, Ohio-based Forest City Enterprises, Inc. (FCE) and their subsidiary construction company, Forest City Dillon (FCD). FCE's subsidiary possessed a construction system that focused on the special need category of housing for the elderly. The FCD buildings were mostly configured as ten-story high-rises. The structural nucleus was of factory precast floors and walls, combined with factory modules of kitchens and baths. The main attraction of the FCD system was its rapid assembly technology once arriving on the project site.

The lack of demand in affordable housing and middle east oil crisis of that time were further impediments to the anticipated take off in industrialized housing construction after the 1974 conclusion of Operation Breakthrough. Compounding all of that was the 1980s decade of open hostility to the idea of federal government involvement in housing production by the Reagan government. The federal government cutbacks in dollars and reversal of favorable policies towards housing production were staggering. The Reagan government made good on its campaign platform of "government was the problem, not the solution." Housing and community development funding and subsidies were slashed by 60%. The federal government's then laissez faire attitude about affordable housing is the root of today's millions of units' deficit in the supply of affordable housing.

Today, the federal government executive branch attitude about the need for massive intervention in the creation of affordable housing is a complete reversal. A May 2022 press release titled *"New Biden-Harris Administration Housing Supply Action Plan to*

*Help Close the Housing Supply Gap*” (Biden-Harris Action Plan) reveals that current collective HUD and broader federal government annual financial support of offsite construction of housing will likely exceed the entire financial support provided to the initial Operation Breakthrough over a seven-year period (\$72 million; \$420 million in today’s dollars).<sup>7</sup>

Operation Breakthrough, in retrospect, was a top-down approach to the jumpstarting of a massive transition from the prevailing conventional housing construction industry to an industrialized system. The federal government provided seed capital, predevelopment funding, and gap construction dollars to a select group of private sector construction ecosystem players. The involvement of local government and local civic action groups was virtually non-existent. In contrast, today’s 21<sup>st</sup> century version of the 1969-74 Operation Breakthrough will be a bottom up approach. The Biden-Harris Action Plan gives strong assurance that the second coming of Operation Breakthrough will be centered under the control of local jurisdictions of cities, municipalities, and county governments. Several instances of such jurisdictions acting on their own initiative to promote and fund scale offsite construction of affordable housing projects are underway. Those projects will be the demonstration and pilot projects that HUD will most likely champion.<sup>8</sup>

Meanwhile, the last two decades have witnessed an increasingly enthusiastic embrace of Artificial Intelligence (AI) driven modular and factory-building applications by significant venture capital and institutional investors, the design professions, leading-edge high-tech businesses, and critical sectors of the housing production industry. Today, all those entities view the deployment of modularized construction technology as both an opportunity and an inevitability.

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<sup>7</sup> The U.S. Comptroller General’s 97 page report – Chapter 1, page 1

<sup>8</sup> Offsite Construction for Housing: Research Roadmap. Prepared for the HUD Office of Policy Research & Development by Ryan E. Smith, Ivan Pupnik, Tyler Schemetterer, and Kyler Barry, November 2022. See also the HUD OPRD EDGE Newsletter, March 5, 2024.

Over the last decade, businesses such as Google, Apple, and Amazon have all entered the housing arena through direct investment in modular factory housing.<sup>9</sup> Most importantly, in today's average consumer's eye and mind, the aesthetic difference between "stick-built" (builder/developer slang term for conventional on-site construction) and factory constructed modular buildings is now virtually undetectable. Meanwhile, the dearth of a sufficient supply of affordable housing is commonly referred to as a nationwide housing crisis. There is general agreement that the shortage of affordable housing – defined as rental or mortgages payments that does not exceed 30% of the monthly income for low and moderate income persons of families - exceeds seven million units. Moreover, a sizable number of those millions of households are African Americans or other people of color.

The main technical and building code-related obstacles to large-scale usage of modular construction issues have been diminishing over the past fifty years. The adoption by localities of the [International Building Code](#) (IBC) was the main breakthrough. The IBC requires that modular factory- built construction meet the same standards that prevail in conventional site built construction. Proof of meeting this standard is facilitated using "third-party" engineering-architect technical inspections and reports of factory-built work. Without foregoing local on-site inspections of the means, methods, and materials of a building structure at specified intervals of construction completion, local municipal acceptance of the finished modular product cannot occur. Understandably, localities have been reluctant to relinquish such control to an offsite inspector. Operation Breakthrough can take some of the credit for the now rapidly increasing change in mindset.

The acceleration of modularization in construction to produce affordable housing can be a critical factor in the family and generational wealth creation agenda of Black and Brown low-income and (usually) underdeveloped communities. HUD is currently

committed to developing the right combination of policies and procedures required to facilitate vastly increased utilization of the entire ecosystem of traditionally excluded businesses, built-environment-related entities, and financial entities in providing affordable housing to US residents.

The most recent and current HUD-sponsored research on offsite construction has been driven mainly by HUD principal research partner organization MOD X. Key recent research studies by MOD X co-founding partners Ivan Rudnik, PhD, Ryan E. Smith, PhD, and Tyler Schemetterer include their January 2023-released report, ***“Offsite Construction for Housing: Research Roadmap.”***<sup>10</sup> This report and other similar prior HUD funded reports were preceded by those author’s academic dissertations and textbooks on the subject of modular offsite construction in housing. The first two of the MOD X partner are also credentialed professional architects and also professors, one at Northeastern University-Boston, Mass., and the other at the University of Arizona. Dr. Smith’s 2010 book, ***Prefab Architecture*** is considered by many offsite construction experts and scholars as the definitive textbook on the subject.<sup>11</sup> Dr. Rudnik and Dr. Smith each acknowledge the impact that architects Stephen Kieran and James Timberlake’s 2004 book ***Refabricating Architecture*** had on their careers and research.<sup>12</sup>

A close reading of Rudnik, Smith, and MOD X research indicates that a prospective Operation Breakthrough 2.0 (or however it will be characterized) will be profoundly different from the 1969-74 Operation Breakthrough. The differences between then and now extend far beyond merely technological and scientific advances between then and today. Among their many important findings and observations is their corroboration that HUD’s 1969-1974 Operation Breakthrough impact led directly to the immediate embrace of offsite factory-built modular housing by Sweden and Japan. Today those countries are the number one and two nations in percentage of offsite constructed housing units

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<sup>10</sup> **Offsite Construction for Housing: Research Roadmap.**

<sup>11</sup> Smith, Ryan E., Foreword by James Timberlake, FAIA. ***Prefab Architecture: A Guide to Modular Design and Construction.*** Hoboken, NJ, John Wiley & Sons, 2010.

<sup>12</sup> Kieran, Stephen and Timberlake, James. ***Refabricating Architecture: How Manufacturing Methodologies Are Poised to***



in comparison to total numbers of constructed units. Rupnik and Smith also corroborated that, contrary to the initial late 1970s assessment and pronouncement by key government agencies that Operation Breakthrough was a failure, the project led to many changes in construction over the following 50 years to this time. Those changes have set the stage for potential take off in substantively increasing the current low single-digit percentage of offsite constructed housing units in the US.

The Rupnik/Smith-MOD X research papers make clear that conditions are now ripe for a U.S. emulation of Sweden and Japan's positive reaction to the 1969-74 HUD Operation Breakthrough. Their research also shows that HUD has moved past merely funding more advocacy-oriented research support of modular housing and is now moving towards funding demonstration projects initiated by local government entities that showcase the efficacy of large-scale offsite housing construction. This repositioning is a major step towards rapidly increasing the percentage of offsite construction within the totality of the construction industry in the U.S.

There are several promising precursors to a probable direction of massive nationwide support by HUD and related federal government entities for a second coming of the 1969-74 HUD Operation Breakthrough. A small but growing number of local government jurisdictions are taking pro-active steps to include offsite construction technology in their strategies to increase their supply of affordable housing. The city of Boulder, Colorado and the Metropolitan Area Planning Council (MAPC) – representing the city of Boston and surrounding metropolitan jurisdictions – are the prominent examples. In 2023 HUD launched a new grant program titled [Pathways to Removing Obstacles to Housing \(PRO Housing\)](#), supports communities who are actively taking steps to remove barriers to affordable housing.

The central objective articulated in the MAPC-Boston application to HUD is for predevelopment funding of local efforts aimed at implementing the construction of a modular housing factory in the Boston region. While the first round of funding availability is modest, clearly a comparable ramp up of funds sufficient to assist a multitude of local jurisdictions grappling with affordable housing will have profound impact. Boulder and

Boston-centered MAPC are both pursuing the local building of modular housing factories that will become first sources in those jurisdictions' affordable housing production efforts.

## Chapter 2. Washington, DC Case Studies of Significant-Sized Offsite Construction and Modular Housing Projects, 1976-2021

### \*Case Study 1 - Forest City Dillon Seniors Highrise Apartments – 1,000 Units

1. Fort Lincoln Village, 3000 Bladensburg Road, NE - 250 Units, Completed 1976
2. Petersburg Towers, 2700 Fort Lincoln Drive, NE – 250 Units, Completed 1976
3. Campbell Heights, 2400 15<sup>th</sup> Street, NW – 171 Units, Completed 1978
4. Delta Towers, 1000 H Street, NE -- 150 Units, Completed 1980
5. Wah Luck House, 6<sup>th</sup> & H Streets, NW -- 153 Units, Completed 1982

### Exhibit 4. Case Studies #1 Photos of Buildings; 1, 2, 3, 4, and 5



Top Row: Fort Lincoln Site 1A & Fort Lincoln Site 1B  
Bottom: Campbell Heights, Delta Towers, & Wah Luck House

## Historic Overview

A January 1982 Washington Post news article about Wah Luck House, the final structure of the five projects constructed on four sites by the Forest City Dillon system, also provides a good capsule description of how each of the five separate buildings at the four sites came into being.

### Wah Luck Apartment Erected in Chinatown

By Martha Mueller

January 29, 1982 at 7:00 p.m. EST

In less than a 28-day lunar cycle, a 10-story high-rise for the elderly has been erected in Washington's Chinatown -- at a rate of about one floor every two days. When it is ready for occupancy this spring, the 153-unit Wah Luck House at Sixth and H streets NW will house residents of the Chinese community displaced by the construction of the new convention center. Forest City Dillon, Inc. of Ohio erected the structure, for the Washington Chinatown Development Co. by assembling 1,400 concrete prefabricated elements on the site, a spokesman for the company said. The Washington D.C. Housing Finance Corp. placed the tax-exempt construction loan for the Wah Luck -- "Chinese Happiness"-- project, designed by architect Alfred H. Liu. The \$8 million dollar property is owned by the Washington Chinatown Development Co., but will be leased and operated by the National Housing Partnership. The NHP is a federally chartered, private organization that frequently works with community groups to develop multifamily rental housing.

All of these projects were built in Washington, DC between January 1976 and December 1982 by a Cleveland, Ohio-based real estate and construction company, Forest City Enterprises (FCE). The company built, owned, and operated shopping centers, malls, office buildings, industrial parks, and hotels. In 1968 FCE acquired Akron-based construction firm Thomas J. Dillon & Co., Inc. Dillon owned a construction technology that specialized in factory-produced precast concrete wall and floor panel systems, and kitchen-bath modules. The panels and modules were transported to foundation-ready sites and assembled into high-rise apartment buildings. Out of its participation in the HUD Operation Breakthrough program, the company went on to erected tens of thousands of units of low-cost housing for the elderly over the next 30 years.

Shortly after the 1974 completion of the Operation Breakthrough, FCE and its FCD subsidiary was offered the opportunity to fulfill a need to meet a tightly compressed

construction schedule by building new elderly housing units at multiple sites in Washington, DC. Predevelopment and construction funds were made available primarily through a HUD program dedicated to housing seniors. FCE/FCD entered a relationship with the DC-based non-profit National Housing Partnership to build low-income housing for seniors through the use of a HUD program that provided direct construction financing. This combination of a private for-profit company, a non-profit company, and the federal government and local DC government were indispensable parts of what was an early forerunner to the concept of “public-private partnerships” formed to undertake large affordable housing initiatives.

The series of post-Operation Breakthrough projects commenced with the building of twin ten-story towers on two separate sites at the Fort Lincoln New Town redevelopment. Both of the Fort Lincoln projects were designed by Bryant & Bryant Architects, a local Black-owned architectural firm. The Fort Lincoln projects were followed a year later by a similar project on a 15<sup>th</sup> and U Street site that once contained the old Dunbar Hotel in the heart of the U Street community. The aggressively modernist architecture style of the project, by Sultan & Campbell Architects, another locally revered Black-owned architectural firm, was in keeping with other adjacent new redevelopment occurring in this culturally iconic part of Washington, DC.

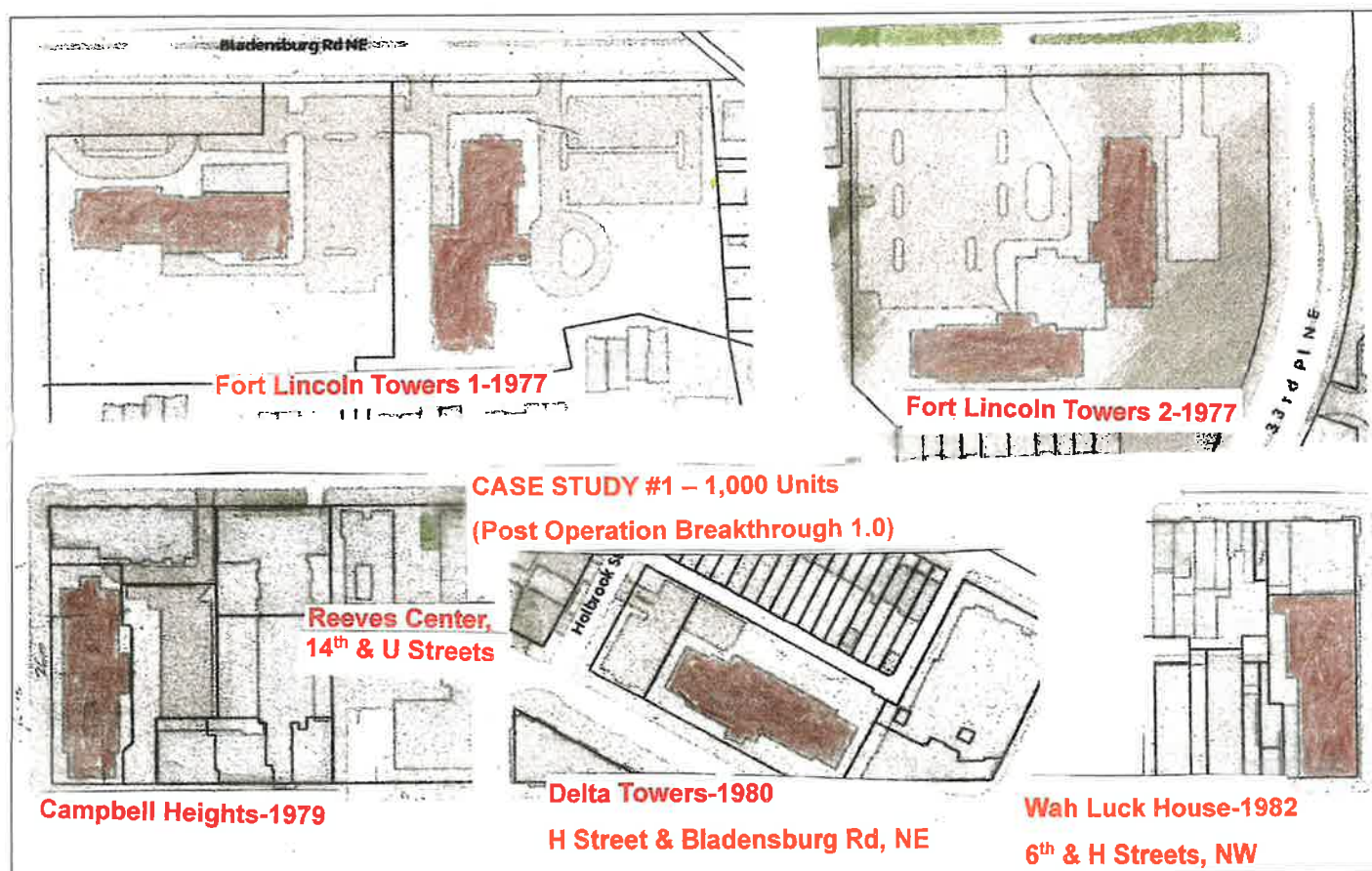
The 15<sup>th</sup> and U Street project was followed by a similarly project on a site located at the intersection of H Street and Bladensburg Road in Northeast DC. This project, also designed by Bryant & Bryant, was the first major project built in the H Street renewal area after the devastating 1968 uprisings that resulted in massive property damage. The fifth and final FCD project was built on a site located in China Town on the corner of 6<sup>th</sup> Street and H Street at the heart of old downtown DC. The project’s occupants was mostly elderly Chinese citizens. The project was designed by Alfred Liu, a highly respected Asian-American owned architectural firm. Liu used a modernist architectural style that was very much in keeping with the style of the prior projects while also aesthetically reflecting Asian culture.



For each of the FCD building sites, the timeline between groundbreaking and ribbon cutting was 12 months rather than the 2 to 2.5 years for similarly-sized structures built under the prevailing conventional on-site construction technology. Unfortunately, this was a time when the Federal government was pulling back on financial support for affordable housing. Such support could have easily led to tens of thousands of additional factory-built housing in DC.

## Site Plans, Zoning, and Building Regulatory Issues

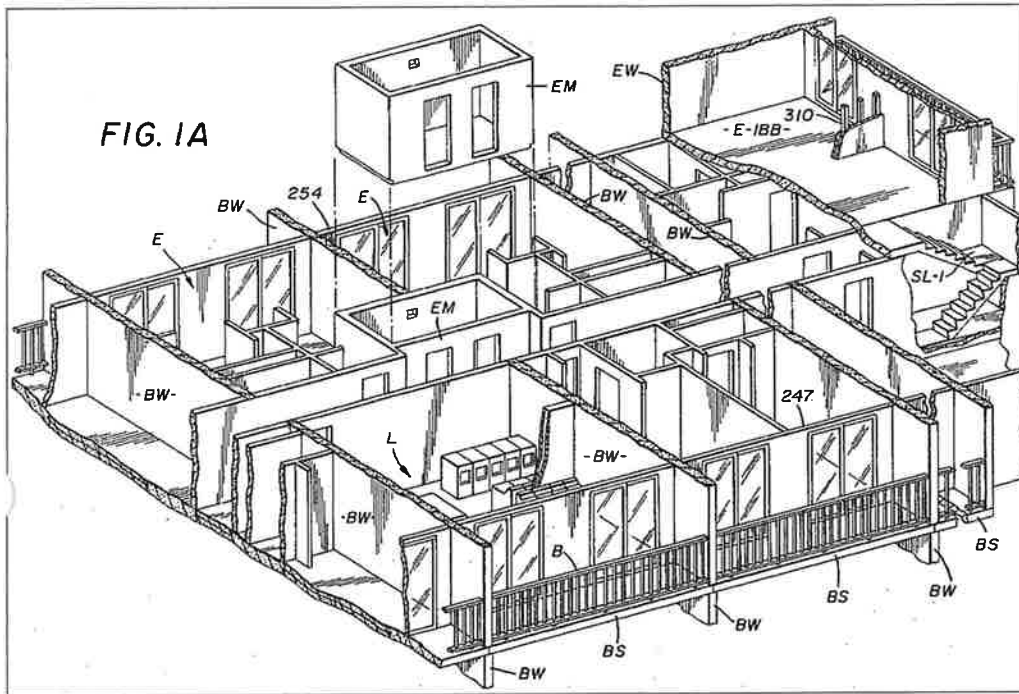
### Exhibit 5. Case Study #1 Site Plans and Buildings at Comparable Scales



During the late 1970s to early 1980s, when these five post-Operation Breakthrough high-rises for low income seniors projects were designed and processed for building permits, there were no zoning code, building code, or other restrictions to the proposed plans. Each of the sites was already zoned to permit high-density residential structures as a “matter of right.” The proposed construction methodology was a hybrid mixture of factory-built floor and structural wall panels, and kitchen-bath cores of factory-built

modular boxes. The factory-built reinforced concrete walls and floor panels were transported to the project sites and quickly assembled as completed structures on conventionally poured concrete foundations. The assembly and erection process was able to fully accommodate the prevailing DC building code requirement of multiple stages of on-site construction progress inspections as demanded by the agency bureaucracies charged with administering the local codes.

#### **Exhibit 6. FCE System Typical Composite Floor Isometric**



#### **Project Development Team and Offsite Manufacturing Company**

##### ***Principal Developers:***

The developers of the sites were, respectively, the DC-based National Housing Partners for Campbell Heights; the Fort Lincoln New Town Corporation for the two Fort Lincoln sites; the Delta Housing Corporation of DC for Delta Towers; and the Wah Luck House Development Corporation.

##### ***Architects***


Sultan & Campbell Architects - Campbell Heights,

Bryant & Bryant Architects & Planners - Fort Lincoln and Delta Towers


Alfred H. Liu/AEPA - Wah Luck House

## Floor Plans and Graphic Images

### Exhibit 7. Case Studies #1 Modular Core, Typical Floor & Unit Plans, & Floor/Wall Panels



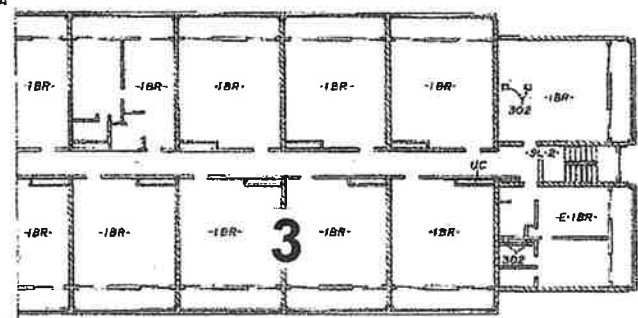
1




2

Heart module is comprised of a kitchen/bathroom unit built back-to-back on a precast concrete slab. Modules leave the plant complete with cabinets and fixtures, plumbing and wiring. The module package also contains all other elements needed to finish an apartment unit.


3



4



5



1. Kit/Bath Module

2. Factory-Built  
Floor & Wall Panels  
Assembled

3. Typical Building  
Floor Plan

4. Typical 2BR-1Bath Unit

5. Typical 1BR-1Bath Unit

## Renter/purchaser profiles, summarized project costs, and local/federal subsidies

The 1,000 units at the four sites were all occupied by senior citizens with limited incomes

or other financial means. The development of Delta Towers began when the DC Department of Housing & Community Development purchased two lots located at the intersection of Florida Avenue and Bladensburg Road, NE from the District of Columbia Redevelopment Land Agency. DHCD transferred ownership to the DC Delta Housing Corporation who was able to receive a \$6.9 million (\$34 million in today's dollars) mortgage loan from a HUD program that provided practically 100% financing to cover the land acquisition and construction costs for housing low income seniors . In addition to the HUD loan, the Delta Sigma Chi national sorority's DC Delta Housing Development Corporation provided the predevelopment funding required to unlock the HUD loan. The Groundbreaking Ceremony for Delta Towers was held on November 17, 1979. The project officially opened its doors on December 19, 1980 with 149 affordable residential units for elderly citizens. The project also included three commercial retail spaces that served the greater community.

All of the other projects were similar to Delta Towers in financial arrangements of very low or zero land costs to the developers through acquisitions from DC government agencies and the non-profit structure of the development entities. The projects were delivered at a total development costs of \$80 PSF (\$300 PSF today). Actual hard construction cost from Forest City Dillon was \$40 PSF (\$250 PSF today). The hard cost of constructing a ten-story building today made of reinforced concrete, whether conventionally constructed or offsite factory-built, would be prohibitive for affordable or middle income market rate housing.



## Case Study 2 - Knox Hill Village Homes Subdivision 1995-2002 - 109 Homes

### Exhibit 8. Case Study #2 DC Location Map and 1945 Street View Photo



Knox Hill Dwellings, circa 1945. Source; DC Public Library Archives

### Historic Overview

As Washington, DC's public housing agency, the United States Housing Authority (USHA) funded the construction of Knox Hill Dwellings in Washington, DC, in 1942 on a 26-acre parcel in the Congress Heights neighborhood of Southeast, DC. The 140 units were viewed as temporary housing and were demolished in 1985 by USHA successor agency, the DC Housing Authority (DCHA). The public housing authority immediately utilized the 10 acres of the cleared site located closest to Alabama Avenue. DCHA built a new 100-unit mid-rise public housing building for the elderly on part of the 10 acres and transferred the rest of the parcel to the DC Police Department for a new 7<sup>th</sup> precinct headquarters building. DCHA selected Sultan & Campell, a local Black-owned architectural firm, to design both structures. DCHA eventually transferred control of the remaining vacant 16-acre parcel to the DC Department of Housing and Community Development (DHCD).

In stark contrast to the DC public housing agency mission of building housing for the city's lowest and no-income citizens, DHCD had a far larger mission that was centered on increasing moderate income homeownership opportunities and community



economic development. DHCD issued a “Request For Proposals” (RFP) inviting potential design-develop-build teams to submit detailed proposals to redevelop the 16 acre portion of the site for 120 single-family homes.

The DC DHCD RFP attracted several proposals that offered varying approaches to the types, sizes, designs, and incomes of the prospective home buyers. DHCD was intrigued by the Knox Hill project proposal to utilize modular housing technology. The surrounding community groups and activist organizations that had been consulted by DHCD were adamant that the selected developer commit to building new homes that would accommodate entry level moderate-middle income homeownership rather than more housing for low income persons not actually able to qualify as single family homeowners. The new Knox Hill homes would be a first in that neighborhood. Accordingly, there were no comparable projects for appraisal and loan underwriting purposes. Local financial institutions were hesitant to commit to the construction loans required by the developer, and the mortgage financing required by the homebuyers.

The Knox Hill architect had been a colleague and admirer of Wichita, KS-based Black architect Charles McAfee who had been a relentless evangelist for modular housing construction since the late 1960s. In the 1980s McAfee embarked upon the construction of a modular factory to produce affordable homes for sale while also creating local jobs and business opportunities for members of the Wichita communities that the new homeowners were drawn from (see January 1995 article courtesy of Automated Builder Magazine).

## Exhibit 9. Case Study #2 Inner-city Modular Plant News Article

### *Inner-City Modular Plant in Wichita, KS:*

# McAfee Mfg.—‘Not Just Building Homes, We’re Building Futures and Communities’

By Gail Finney

When you enter McAfee Manufacturing Co. Inc., pounding hammers, buzzing electric saws, and busy employees dressed in blue uniforms are what you see and hear inside this unique

modular home factory in Wichita, KS. And as one employee puts it, “We are all working toward the big picture.”

President & CEO Charles McAfee often tells visitors and employees how he sees the big picture: “We are not just

building homes, we are building futures and communities.”

McAfee Mfg. is making history locally as well as nationally by creating affordable homes in communities long neglected by government and lending institutions. Nationally recognized architect Charles McAfee’s dream of manufacturing and marketing his affordable, high-quality modular homes to low- and moderate income people has finally become a reality. McAfee says the low-maintenance modular homes, in the \$30,000 to \$40,000 price range, can easily provide housing in an area that has been plagued by high crime and low economic development as in other U.S. cities.



The first home produced and erected by McAfee Mfg. and JM Ltd. serves as a model home for the modular manufacturer in Wichita, KS. The affordable, two-story home contains about 1,000 sq. ft. of living space and a detached carport. Features include



Jesse Jackson Helps Dedicate Inner-City Modular Housing Plant in Kansas

(L-R) President & CEO Charles McAfee, Marketing Director Gail Finney and The Rev. Jesse Jackson at reception celebrating the grand opening of modular home producer McAfee Mfg. in Wichita, KS.

candidate—visited McAfee Mfg. in August to be a part of the grand opening and ribbon cutting ceremony celebrat-

Case Study #2 was the first large undertaking of an offsite, factory-built, single-family homeownership development at a single site in Washington, DC. Upon award and completion of contract negotiations, the first phase of the project entailed the upgrading of the already existing infrastructure of streets, sidewalks, and utilities at the Knox Hill site by DHCD and the DC Department of Transportation. The Knox Hill development team was concurrently focused on acquiring all necessary zoning approvals and building construction permits. Gaining the essential support of the surrounding community went quickly due mainly to the Knox team and DHCD officials’ ironclad assurances that the development would be limited to qualified first-time modest to middle income home purchasers.

## Architect Helps City Officials Understand How Modulares Can Speed Up Inner-City Housing Development

By Amy Elliott

In 1980, the Washington, DC, Department of Housing and Community Development acquired a 26-acre tract of land east of the Anacostia River. It was the site of a circa-World War II public housing project. This site was now intended to be the keystone of the DHCD's plan to develop living environments in the inner city.

The plan called for between 130 and 160 lots for inexpensive, quality homes. Today, more than 15 years later, construction is underway at Knox Hill Village. Twenty homes have already been completed, and the entire 132 units should be finished within

# Automated Builder<sup>®</sup>

Since 1964

April 1997

The No. 1 International Housing Technology Transfer Magazine for Manufacturing and Marketing

The city was not immediately sold on the modular format. It was the persistence of the architect, Melvin Mitchell, that brought the project to fruition. Mitchell has been practicing in the DC area for the past 20 years. During that

The building officials were reluctant to give up their right to inspect the homes as they were being built. The fire marshal was used to enforcing the regulation 8"-thickness for the party walls.

A change in thinking and attitude was important to the efficiency of the project as any tangible change in regulations. Mitchell compared the transition of the city's part to that of a mid-career architect going from paper and pencil to computer assisted design.

The wheels turned slowly. It took more than two years to complete the infrastructure before building could finally commence. However, what required perhaps even more patience on Mitchell's part was convincing everyone to go modular.

"I had committed to go modular from the start, but the city's regulations just weren't set up for it," he said. "I had to wage a real battle to re-educate almost everyone involved, at every stage."

Eventually the city came around to accepting the BOCA code. This was the first time the District ever accepted it as it relates to modulares. This was a major

Mitchell reported that the modulares for the Knox Hill development were manufactured by Nationwide Homes, Martinsville, VA; and North American Homes, Point of Rocks, MD. The units are set on site-poured concrete walls imprinted with a brick-like textures. Once erected, the modulares are finished with a brick fascia.

Building affordable housing in a classic, urban inner-city would not seem to be the most profitable endeavor. A large part of Mitchell's satisfaction stems from the fact that his work betters the community in such a tangible way. Homes, Point of Rocks, MD. The units are set on site-poured concrete walls imprinted with a brick-like textures. Once erected, the modulares are finished with a brick fascia.

"There is no doubt in my mind that this is the way of the future in the DC area. Hopefully, we're establishing a track record to ensure a continued role in this type of development for years to come," he said.

For more information on modular homes from North American Homes, circle Reader Service No. 105.

For more information on modular homes from Nationwide Homes, circle Reader Service No. 106.

AMY ELLIOTT is a freelance writer based in New York City.

Convincing DC building permit authorities to accept third party factory approvals of finished modular sections of the homes delivered to the project site required many months of persuasion. The Knox project served a DHCD goal by igniting the development of similar homeownership projects across the two sprawling wards located east of the Anacostia River. By 1998 there were over 750 new homes under construction by more than a dozen other developer-builder teams.



## Exhibit 11. Case Study #2 Washing Post Southeast DC Housing Article

# The Washington Post

# REAL ESTATE

SATURDAY, JULY 11, 1998



*"We know the area's bad reputation and its good side, but these new houses were close to my job, not in Prince George's County where I would have a longer commute. We didn't want to look anyplace else because I think there is going to be a turnaround in the Southeast."*

—Georgia Moore  
shown at  
with her husband, J

## Moving Up and In to Southeast D.C.

*New Houses, Reasonable Prices, Low Interest Rates Are Attracting Buyers and Revitalizing Neighborhood*

By KENNETH LELAND  
Washington Post Staff Writer

On her way to work one morning this spring, Georgia Moore spied a group of town houses under construction in Southeast Washington's Knox Hill neighborhood. The three-level semi-detached dwellings, located behind the Seventh District police station on Alabama Street, were offered at prices starting in the low \$120,000s.

Moore, 51, a hospital secretary, and her husband, John Moore, 55, a federal government employee, considered the location convenient and the units affordable. More important, they said, the homes represented the opening of a door of opportunity for the pair, who have rented their home in the District for more than 20 years.

Last month the Moores moved from an \$800-a-month rental on nearby Buena Vista Terrace to a new three-bedroom house they bought at the community, a 132-unit development called Knox Hill Village.

"We know the area's bad reputation and its good side, but these new houses were close to my job, not in Prince George's County where I would have a longer commute," she said. "We didn't want to look anyplace else because I think there is going to be a turnaround in the Southeast."

The Moores represent the vanguard of renters and other residents from the District and neighboring communities who are looking for homes in Wards 7 and 8. Attracting prospective owners are 1,128 new developments that are for sale but have not been completed, are under construction or planned for building later this year. City officials, builders and local residents say they will see additional residential development and new commercial in an area of the city that has for years experienced population loss and neglect.

on the progress of these projects, we think we'll see more developers participating in this kind of home-building activity," said Richard Montell, director of the Department of Housing and Community Development.

of the new developments include houses or town houses that have two bedrooms, two or three bathrooms, carports, and range in size from 2,442 square feet. Other locations include condominiums that were created by conversion of two or more former apartment buildings. These have two or three bedrooms, two to three bathrooms and as much as 1,350 square feet of living space.

The single-family units are priced from \$100,000 to \$150,000, while the condos are priced from \$70,000 to \$85,000. Builders said most buyers for these new houses include city

See HOUSING, Page 6, Col. 1

### The District's Newest Housing

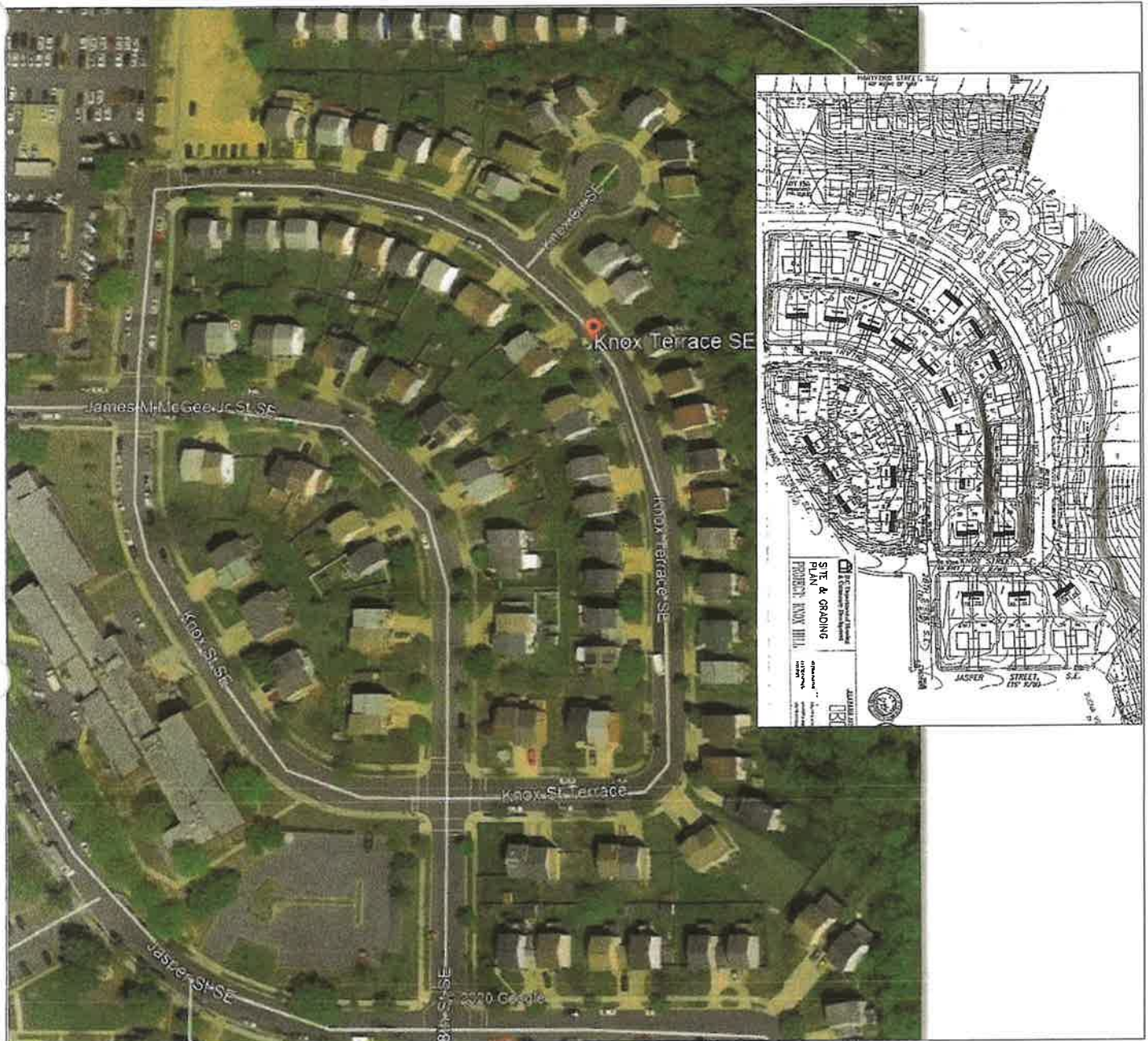


Development	Number of units
1. Walter E. Washington Estates	141 town houses
2. Parkside homes—Phase II	132 town houses
3. Knox Hill Village	132 town houses
4. Wheeler Creek Estates	134 town houses
5. Washington View	70 condominiums
6. Hillside Townhomes	56 town houses
7. Oxon Creek Townhomes	210 town houses
8. Park Skyland	34 town houses
9. Bernier Ridge	26 detached houses
10. Chaplin Woods	22 town houses
11. Hilltop Terrace	21 detached houses
12. Dearwood and Burrville Infills	25 detached houses
13. Monterey Park	63 detached houses
14. Woodcrest	62 town houses

A mid-1998 Washington Post article was highly instrumental in providing the type of exposure for the Knox Hill project that led to an eventual rethinking by local financial institutions and the private investors needed to adequately capitalize the project as required for modular factory-built construction.



## Exhibit 12. Knox Hill Village Aerial View Photo and Building Permit Site Plan



By the end of 2002 the realization of the decade earlier DC DHCD vision for the redevelopment of the entire 26-acre 140 unit Knox public housing project was fully achieved. The existing network of existing narrow asphalt streets were and above grade common public utilities were replaced with widened new concrete streets and sidewalks over new all-underground utilities. This included storm drainage lines, gas and electricity lines, and cable TV and internet lines.



## **Zoning and Building Code Regulatory Issues**

Fortunately, and similar to the regulatory environment noted in Case Study #1, in 1990 the DC zoning code was neutral on the matter of offsite constructed modular housing versus “stick-built” (builder slang for conventional all onsite construction). The zoning code governing the 16-acre portion of the Knox Hill Village site at that time allowed as “matter of right” low-medium density single-family residential uses. However, the building code was not yet structured to allow factory-built modules that would arrive at the project site completely finished, with structural wall materials, plumbing, electrical wiring, and heating/cooling lines all “closed-in,” within the walls, thus precluding on-site inspections for code compliance. The prevailing building construction codes dictated a regime of at least five onsite inspections of construction progress after the initial approval of the field-built project footings and foundations phase of work. The DC regulatory agencies refused to adopt an existing national code that permitted acceptance of third-party factory inspection conducted at a remote factory located up to several hundred miles from the DC project site. The process of getting the necessary changes in the DC building code required over a year of lobbying and persuasion by the Knox Hill Village development and design team.

## **Project Development Team and Offsite Manufacturing Company**

### ***Principal Developer***

The developer entity was a public-private partnership that was organized by the architect. The entity comprised the Knox Hill Village Limited Partnership, the non-profit Anacostia Economic Development Corporation, and the DC Department of Housing and Community Development.

### ***Architect:***

DC-based Melvin Mitchell Architects, PC

### ***General Contractor:***

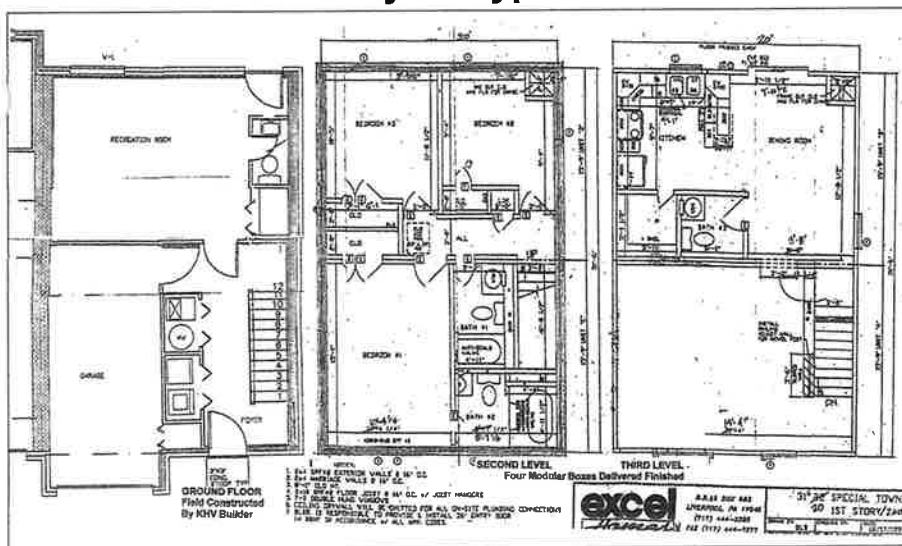
Knox Hill Village Limited Partnership, Melvin Mitchell, Managing General Partner

## Offsite Factory Manufacturer;

Over the nearly decade of time required to complete the project there was a total of four different modular manufacturing companies utilized over the period of completing the construction of the 109 homes. The first 24 homes were supplied in equal quantities of eight by National Homes, in Southern Maryland; Nanticoke Homes in Southern Delaware; and North American Homes, Point of the Rock, MD. This was the experimental phase of attempting to determine the best fit between the local development team and the modular manufacturing companies. The development of the first 24 homes stretched over a 7-year period that began in 1994 and concluded by the end of 2000. The remaining 85 homes were supplied by Excell Homes, of Liverpool, Pennsylvania and completed over a two-year period.

## Floor Plans and Graphic Images

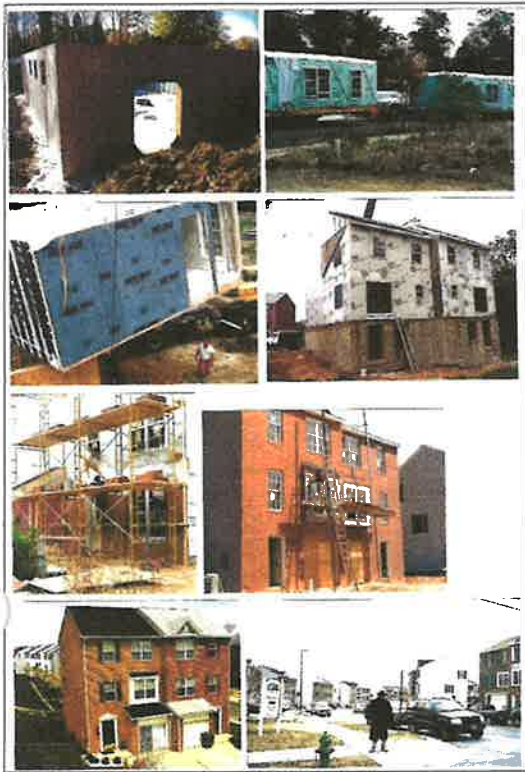
### Exhibit 13. Case Study #2 Typical Floor Plans



The preliminary plans, drawn by the Knox architect through interaction with community groups about their design preferences. Those drawings were then submitted to the modular company to prepare precision fabrication drawings of finished boxes sized for transport over public highways and streets. The initial 24 three-level homes required the onsite construction of the entire ground level including the concrete foundations and floor slabs, and masonry or concrete walls. The modular company supplied the

second and third levels of the home. Onsite ground floor construction and factory construction of the modular boxes of a house are carried out concurrently over a two-week period that is followed by an additional two weeks of onsite mating and completion of onsite construction and factory-built modular boxes.

#### **Exhibit 14. Case Study #2 Modular Construction Photos**



The photos portray an eight step process of:

1. On-site builder constructed poured concreted first level walls.
2. Modular boxes arrive on site 90% finished.
3. Modular boxes offloaded by a crane.
4. Stacking of boxes on the field-poured first level walls.
5. Exterior sheathing of boxes with masonry or aluminum siding.
6. Brick enclosed boxes.
7. Completed units.
8. The completed subdivision.

#### **Renter/purchaser profiles, summarized project costs, and local/federal subsidies**

During the early 1990s start of construction of the Knox Hill project the sales price of a typical newly constructed 1,500 to 2,000 SF home being built in the two easterly wards of the city was averaging \$150,000 (\$600,000 today). That sales price number equated to \$86 per square foot (PSF). A builder/developer treats that \$150,000 as a total development cost that must match the cost of five items, e.g., construction, land, professional and technical fees, loan interests, and profits. Of those five items, construction is the builder's largest cost - typically running 50% or more of the total development cost number. At that time, DC Department of Housing and Community

development was determined to keep the average sales price of the new Knox Hill homes at between \$110,000 and \$120,000 – 20% below the market rate of prices for low-middle income homes in Southeast DC.

Conventional stick-built construction costs of a typical house in DC for the non-luxury category was then averaging \$43 PSF (\$215 to \$225 PSF today). Offsite modular construction was then capable of undercutting stick-built construction costs by as much as 50%. The caveat was the issue of scale. A sufficiently large enough number of modular homes is the only means of drastically reducing prices that could facilitate large savings in sales prices.

By the beginning of the final two years of the Knox Hill development the under-capitalization issues of the Knox Hill development team had been resolved and 85 new modular homes were built and achieved all of the claimed advantages of offsite modular construction. The primary DHCD goal of keeping the sales prices of the homes 15% to 20% lower than average market rates was fully achieved.

Literally 2,000 affordable homes built using conventional on-site were completed in the neighborhoods surrounding the Knox Hill project during the decade-long period of the building of the 109 homes at Knox Hill Village. However, only a single other developer/builder was willing to follow the Knox Hill factory-built modular path. The typical Washington, DC home builder was just not convinced that the trade-off between cost (and time) savings on the one hand, and the loss of often long-term and profitable relationships built with local subcontractors, tradesmen, suppliers and businesses was large enough to justified *“going modular”* during those times.

## Exhibit 15. Summary Total Development Costs vs. Sales Income, 1998

	A	D	E	F
1	<b>KNOX HILL VILLAGE TDC vs Income</b>			<b>1998 COST</b>
2		<b>UNIT COSTS</b>	<b>24 UNITS</b>	<b>2023 COST*</b>
3	<b>BASE PRICE SALES REVENUE</b>	<b>\$130,000</b>	<b>\$3,120,000</b>	<b>\$350,000</b>
4		<b>Unit Costs</b>		
5		<b>2,100 SF Typ. 3BR/2.5B</b>		
6	<b>Land Acquisition Costs</b>	<b>Ave. Unit Size</b>		
7	<b>DC Gov or DHCD Price to Developer</b>	<b>\$7,500</b>	<b>\$180,000</b>	
11	<b>ACQUISITION COSTS TOTALS</b>	<b>\$7,500</b>	<b>\$180,000</b>	<b>\$10,000</b>
13				
14	<b>SOFT COSTS (Fees &amp; Financing)</b>			
15	<b>Civil Eng/Topo/Prmts/AEPMC/Intrst/Other</b>	<b>6,500</b>	<b>156,000</b>	
16	<b>Contingency</b>	<b>2,000</b>	<b>48,000</b>	
17	<b>SOFT COSTS TOTALS</b>	<b>\$8,500</b>	<b>\$204,000</b>	<b>\$20,000</b>
18				
19	<b>Site Work</b>			
20	<b>Ret. Walls/Grading/Drives/Lndscp/Other</b>	<b>7,500</b>	<b>180,000</b>	
21	<b>Site Design Contingency</b>	<b>3,000</b>	<b>72,000</b>	
22	<b>Site Work Totals</b>	<b>10,500</b>	<b>252,000</b>	<b>\$20,000</b>
23				
24				
25				
27				
29	<b>Builder's Field Work &amp; Modular Construction</b>			
30	<b>On-Site Constr. Work</b>	<b>35,000</b>	<b>840,000</b>	<b>\$53,000</b>
31	<b>Mod Unit: On-Site Drop Cost - 1,680 SF Ave. at \$30 PSF</b>	<b>\$49,500</b>	<b>1,188,000</b>	<b>\$200,000</b>
32	<b>Construction Cost Contingencies</b>	<b>5,000</b>	<b>120,000</b>	<b>\$5,000</b>
33	<b>MOD+CONSTRUCTION COSTS At \$43 PSF</b>	<b>\$89,500</b>	<b>\$2,148,000</b>	<b>\$258,000</b>
34	<b>SALES COMMISSION at 5%</b>	<b>\$6,500</b>	<b>\$156,000</b>	<b>\$12,000</b>
35	<b>TOTAL PROJECT COST</b>	<b>\$122,500</b>	<b>\$2,940,000</b>	<b>\$320,000</b>
36	<b>DEVELOPERS PROFIT ON SALES</b>	<b>\$7,500</b>	<b>\$180,000</b>	<b>\$30,000</b>
37	<b>*ASSUMING LOCAL MODULAR FACTORY</b>			

The above spreadsheet is a summarized proforma depiction of how the 2,100 SF new modular homes delivered in the late 1990s period of the Knox Hill Village development for \$130,000 – currently a \$500-\$600,000 3BR/2B garage townhome – could be delivered today at half of the current price. A single centralized modular manufactory in Washington, DC carries an increasingly high probability of making such a price reduction possible through a local modular factory sized for high volume scales of delivery.



## **Case Study #3 - 3305 7<sup>th</sup> Street, NE Shipping Containers Apartments, 2014 4-6BR-6B Units**

### **Historic Overview**

This is a small apartment building completed just over a decade after the 2002 completion of the Knox Hill Case Study #2 residential subdivision. In 2012 local architect and Catholic University professor Travis Price worked with the owners of a lot occupied by a single-family residence near the university. Their shared objective was to demolish the existing structure and replace it with a multifamily structure made up from standard-size cargo shipping containers.

The utilizing of empty steel cargo shipping containers for human occupancy started in London in 2001. By 2010 the use of containers as modules for residential and small commercial projects had morphed into an architecture movement, owing largely to the inherent structural durability of the steel intermodal cargo containers, their wide availability, low cost, and eco-friendliness.

### **Exhibit 16. Case Study #3 Container City 1, Trinity Buoy Wharf, London, 2001**

**Source: Eco Container Home**



In a July 22, 2014, ARCHITECT Magazine author Caroline Massie wrote effusively about the Washington, DC shipping container apartment building project. Massie described the project as “shared housing,” with each floor having a large central common area with a living room and a kitchen, flanked on both sides by three 240-square-foot bedrooms, each with its own bathroom and study area. Six containers constitute a floor of the building, and they are lined up in two rows of three. The inside walls of the containers are cut out to create the open common room; the ends of the containers constitute the bedrooms and bathrooms.” The architect, Price, is also quoted as saying that “sea containers for building construction makes sense, ecologically. There are over 700,000 sea containers sitting foul, going nowhere in the U.S. Remember, we imported all the stuff. All of your iPhones came in those containers, but we’re not sending anything back,”

## **Site Plane, Zoning, and Building Code Regulatory Issues**

### **Zoning:**

#### **Exhibit 17: Case Study #3 Site Plan**



The project is in a residential neighborhood within the Catholic University district in northeast DC. The lot is on a block of large lot single family residences. At the time of the design of the project the zone was Residential Flats-1 (RF-1) that allowed the proposed re-use as “matter of right” and required only minor Board of Zoning Adjustments variances.

### **Building Code:**

By the time this project was undertaken in 2012, the use of modular construction technology that allowed third party factory inspections had been become permissible two decades earlier through the actions delineated in Case Study #2. However, the use of shipping containers as the modules did not preclude conventional DC building department on-site inspections.

## Floor Plans and Graphic Images

### Exhibit 18. Case Study #3 Typical Floor Plan, Shipping Container Modules, and Street Views. Source; Courtesy of Travis Price, FAIA



**Renter/purchaser profiles, summarized project costs, and local/federal subsidies**  
In another CURBED Magazine article dated May 18, 2015, author Michelle Goldchain quotes Travis Price as saying;

“Using shipping containers as a construction material can cut costs significantly. One single shipping container costs between \$2,500 and \$4,500.” In typical construction, at least 50 to 60 percent of the building costs can be the outer shell work; in this case, the [shipping container] outer shell is more like 15 percent of the total cost,” said Price, who later added that energy bills for the homebuyer

are also incredibly affordable. "We will be approaching the lowest fuel bills in the city."

DC real estate newsletter CURBED dated September 29, 2014; author Larkin Turner quoted the architect as saying that the project took seven months from design to construction completion. This apartment project is actually occupied by Catholic University students. A student is entitled to the exclusive use of the six bedrooms and full private full size bathrooms on each floor and complete use of the common area containing a living and dining space and full kitchen. Rental amounts are full market rate. The architect posits that the 30% savings achieved in the total development cost of the project were attributable to the use of the shipping container modules. There were no public subsidies used in the project.



## **Case Study #4 - MODO Apartments – 3709 New Hampshire Ave NW 2015-2021 – 17 3BR/3B Units**

### **Historic Overview**

The 4th case study is of immense importance in today's conventional vs offsite construction discussion. The project was completed in 2021 and lauded in a popular local real estate newsletter as being the first ever modular factory-built apartment project in DC. That was not an entirely accurate claim. As our research experience corroborates, shortly after the 1974 conclusion of the HUD Operation Breakthrough, a builder from that program commenced with the construction of a total of just over 1,000 units of offsite constructed hi-rise apartments for seniors at multiple locations in Washington, DC (see Case Study #1).

This case study project was not conceived as a factory-built modular project at its inception. The project began in 2015 as a conventional 24-unit onsite constructed market-rate rental apartment building on a site located directly across the street from the Georgia-New Hampshire Avenue Metro station. The site had been occupied by a two-story structure that housed a popular Caribbean eatery on the ground floor and several residential apartment units above. The property owner was simply seeking to cash in through a sale of the site to a developer. To maximize the sale price, the owner sought and received zoning relief from all required parking based on immediate adjacency to a rapid transit station stop.

The developer had a keen awareness of the immense opportunities made possible by the DC government planning office having rezoned all existing parcels – vacant or occupied by two- and three-story structures - on both sides of the street of the entire four mile long 7<sup>th</sup> Street-Georgia Avenue corridor. The new medium density residential over ground floor commercial rezoning allowed for thousands of new mid-rise high density residential apartments over ground floor retail. Similar zoning changes were made for another dozen major avenue corridors across the city. The Georgia Avenue corridor alone could result in thousands of new residential units over the next decade.

*This planned MODO apartment project was intended as the developer's prototype for*



*hundreds of similar-sized and types of projects along the up-zoned corridors in Washington, DC.*

The critical insight of the MODO Georgia-New Hampshire developers was that the “at scale” constructing of similar mid-rise high density apartment buildings in the rezoned corridors offered the potential for vastly increased production of market-rate and affordable housing. Any hopes of lowering the construction costs required finding a way to substantially reduce construction times and all of the associated high interests carrying cost of the project.

In 2020 the developer revamped the initial marketplace target and began repositioning the project to meet newly emerging demand from young single persons willing to share common areas. The combination of the high cost of the site, rapidly increasing construction costs, and very high interest rates at that time drove the need to reimagine the project. In short, the project as initially conceived was no longer able to “pencil out” (real estate development slang for “financially feasible”). *The near desperate need to cut construction costs and drastically reduce interest carrying charges led the seasoned development team to begin to seriously consider resorting to modular construction.*

Given the developer’s larger game plan of building thousands of units in rezone parts of DC, the need to engage with a large, established and fully integrated modular company was essential. The selected modular company, Philadelphia-based Volumetric Building Companies, was charged by the developer with delivering finished modular units to the Georgia-New Hampshire Avenue site in literally days rather than the months normally required using conventional construction methods.

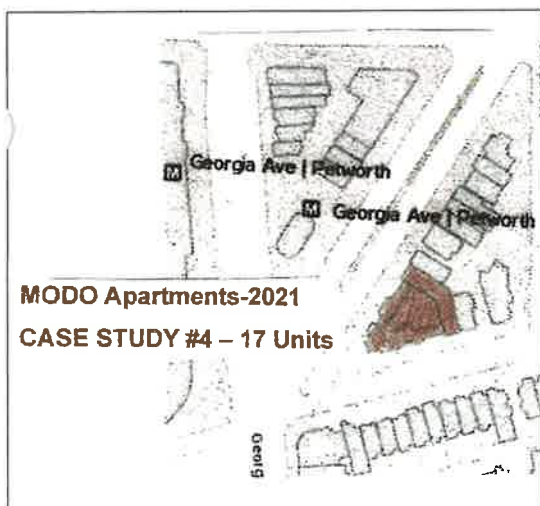
The new medium density DC re-zoning capitalizes upon a 1996 invention by Tim Smith, a west coast architect who uncovered a building code clause that allowed the building of six and seven-story apartments using treated wood as a load-bearing structural system with the five floors resting on a reinforced concrete slab acting as a podium or pedestal. By 2010 this form of apartment construction was ubiquitous across the nation as well as in DC. Previously, a six stories high apartment building was only

possible using heavy steel of reinforced concrete structural slabs at each floor. However, the cost of steel or reinforced concrete systems became prohibitive for anything other than rental or condo prices affordable by the top income strata of the U.S. population. Architect Smith's load bearing, treated wood as a structural system is now fully established as being the only financially feasible way to build most of the millions of units required to meet the need for market-rate and affordable housing.

*The MODO project developers actions may be a good indication of the onset of a paradigm shift to an era where the typical builder/developer's will be unable to make a market-rate or affordable housing projects "pencil out" without the use of offsite modular construction technology.*

## **Site Plan, Zoning, and Building Code Regulatory Issues**

### **Exhibit #19. Case Study 4 Site Plan**



There were no DC zoning code restrictions on the use of modular offsite construction. The determination of allowable building materials and structural systems is relegated to the building construction codes. The building code restrictions that precluded acceptance of third-party review and approval – as allowed by the International Building Code (IBC) – had been lifted in 1993, due largely to the lobbying efforts by the Case

Study #2 development team. Washington, DC zoning and building codes and the bureaucracies that administer the codes, as are most urban municipalities today, are not resistant to offsite construction generally and modular specifically.

## **Project Development Team and Offsite Manufacturing Company**

### ***Principal Developer***

The developer entity was a joint venture of DC-based Community Three, a full services real estate development company, headed by architect-developer Grant Epstein – and

DC-based Rooney Properties – a public-private partnership that was organized by the architect.

### ***Architects***

2015; PGN Architects

2021; Eric Colbert Associates

### ***General Contractor***

2015; Manhattan Construction-a  
Rooney Subsidiary

2021; Philadelphia-based VBC

Construction

### ***Offsite Factory Manufacturer***

Volumetric Building Companies – a  
Philadelphia-based company

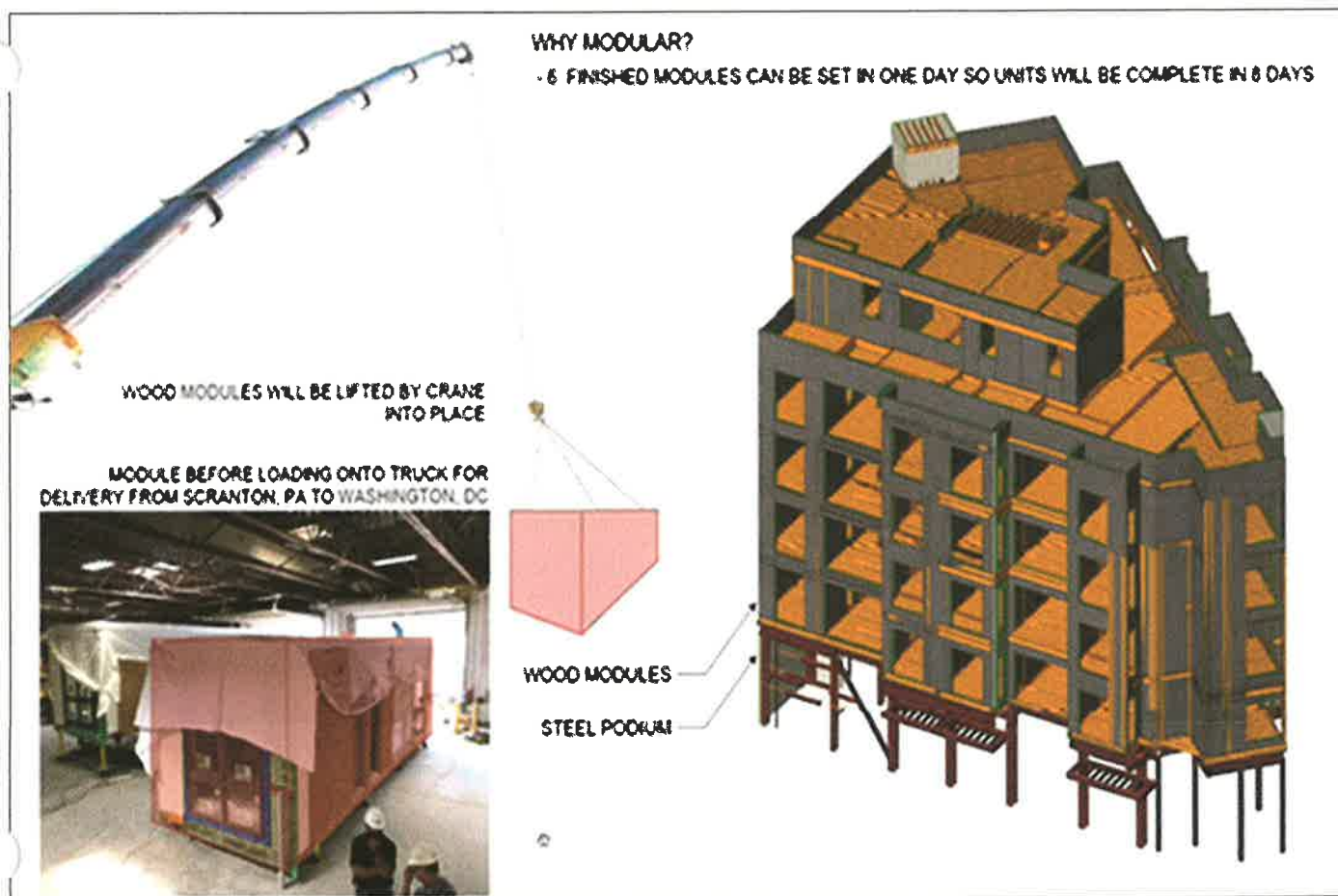
Simplex Homes – a Scranton, PA-based  
company

## **Floor Plan and Graphic Images**

### **Exhibit 20. Case Study #4 3BR-2B-1,000 SF Unit Floor Plans**



## Exhibit 21. Case Study #4 Modular Assembly Process



## Exhibit 22. Under construction Street Views





## **Exhibit 23. Case Study #4 2015 Pre-modular design and 2021 Completion as Modular**



### **Renter/purchaser profiles, summarized project costs, and local/federal subsidies**

The smaller units in the initial 24-unit design were reconfigured as larger 3 bedroom, 2 bath units. The larger unit's strategy was not aimed at large families. The target market is for single persons in need of one bedroom and willing to share the living, dining, and kitchen spaces and possibly a bathroom. For a single apartment unit, the three individuals simply had to be able to equally divide a market-rate rent that approached \$4,000 per month.

Despite the reduction in overall project development costs derived from the use of modular construction and project loan interest savings, the project development costs were still too high to be classified as "affordable." The huge site acquisition costs to the developer cancelled out savings derived from modular construction. There were no federal or DC subsidies involved. However, through zoning variances that eliminated all parking requirements, the developer was able to reduce the rent amount on two of the 17 units (known as "inclusionary zoning").



## Chapter 3: Key Findings From the Case Studies

### Overview

Washington, DC has one of the nation's most aggressive, creative, and financially sophisticated affordable housing programs. The case study projects that occurred over the past 50 years offer clear evidence that there are no remaining major technical barriers to the large-scale use of offsite construction technology to develop affordable, market rate, or emergency housing.

*Resistance is coming virtually exclusively from small, medium, and large builder/developers who have not yet seen satisfactory evidence that the market-rate and affordable housing projects they are building requires the use of offsite construction for their project to “pencil out” (achieve financial feasibility).* The government and quasi-government entities that subsidize the projects of some of those builder/developers will have to arrive at a point of declaring the use of offsite construction as a precondition for receiving such assistance. Matters may be moving towards the formal adoption of such policies but that point has not yet arrived.

Washington, DC is an excellent location for the launch of a major HUD and federal government-supported demonstration offsite housing construction project of sufficient scale to influence a change in the behavior of the builder/developer community. Our team case studies research also support our hypothesis that offsite construction technology can be an important asset in the strategy and goals of achieving the consensus Black socio-economic agenda of sharp increases in homeownership, generational wealth creation, and community business development .

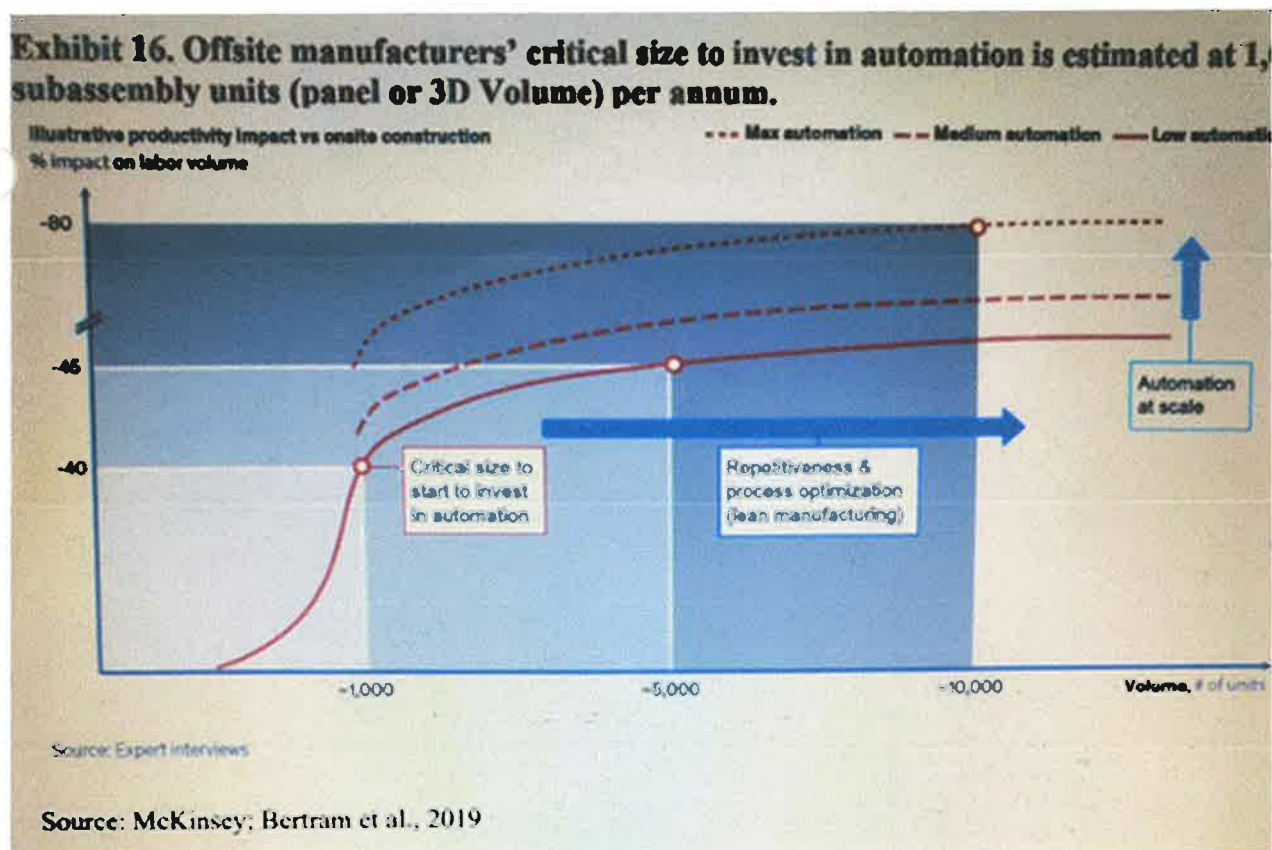
### **Key Finding 1: “Scale” is the Sine Qua Non of Maximum Success in Modular Construction.**

Offsite construction projects must be comprehensive, sufficiently large scale, and fully digitally integrated to achieve the maximum levels of cost savings in materials, labor, and interest charges. The optimal circumstance would favor a local factory that

eliminates the transport cost factor in addition to the other cost reductions. The purchasing of modular units from a distant and independent offsite manufacturing plant by small to medium size local builder/developer teams simply does not provide a large enough cost savings to induce foregoing a “stick-built” approach.

The feasibility bar for the construction of a modular factory is a relatively low number of 1,000 units according to a recent McKinsey study (see exhibit below). That such a locally built factory can offer employment and business opportunities to people and businesses drawn from the same local population of the occupants of the units is an added benefit.

### Exhibit 24: McKinsey Graph of Minimal Units Needed to Justify Modular Factory Investment.



## **Key Finding 2: Case Study #1: A Non-Modular Hybrid of Panelized Wall and Floor System and Modular Kitchen/Bath Cores Did Not Challenge Existing DC Code Issues;**

**Issue 1: Required Interim Local Inspections.** The actual onsite assembly of factory built concrete panels and small kitchen-bath modules was speedier than conventionally onsite poured concrete but still allowed for all important interval inspections by local building code officers.

**Issue 2: Construction Costs:** During the late 1970s-to early 1980s the cost of constructing 1,000 units configured as high-rise concrete structures could not have been cost effective without the use of offsite factory construction.

**Issue 3: Prevailing Architecture Style:** The completed buildings were fully in line with prevailing modernist architecture aesthetics. The structures were largely compatible with the Fort Lincoln New Town architecture style, the emerging new urban design character of 14<sup>th</sup> and U Streets community and the East End Downtown of Washington, DC.

However, by the early 1990s the use of concrete (or steel) as required by building codes to construct hi-rise and mid-rise buildings became prohibitive for any occupants other than those with incomes high enough to afford to luxury class rents. Persons making average incomes were being squeezed out along with those making less than average incomes, due mainly to the escalating costs of labor, building materials, and land. Exacerbating matters was the building code requirements that precluded the construction of even midrise (six to seven floors) apartment buildings without the use of concrete and steel.

### **Key Finding 3: Case Study #2: Met Its Primary Immediate Objective of Increased Black Generational Wealth Creation Through Home Ownership, and Establishing the Feasibility of Greater Cost Savings at Scale**

Over the near decade long period between the DC government issuing of a Request for Proposals to build the 100+homes at Knox Hill in the Congress Heights neighborhood and the delivery and sale of the last Knox Hill Village home in 2002 there were over 2,000 other new homes built in the two easterly wards of DC. With possibly one exception none of the other two dozen builders strayed from the path of using conventional fully onsite construction technology. However, a review of annual appraisals, value appreciations, and sales prices of the other 2,000 homes has shown the Knox Hill homes to be fully comparable in rising value. A casual drive or stroll through the several dozen neighborhoods of the conventionally onsite built developments and the Knox development will also show the same visual compatibility.

Today a coalition of small to medium sized, and properly capitalized local builder/developer entities with immediate and direct access to a locally based modular plant could develop a ten-fold number of similar new homes over a 12 to 24 month period. The achievable level of construction cost savings could eventually exceed 50% of conventional stick-built cost. This, combined with reduced or zero land costs, could push the total development cost of starter homes to sales prices that would qualify as affordable homeownership.

## Exhibit 25. Case Study #2 Knox Hill Village Homes Sales Price Trajectory

2 Knox Circle, SE DC Built in Year 2000

Sales Price: \$140,000

Sales Price: \$510,000 October 2023

Knox Hill Village, October 2023



### Key Finding 4: Cargo Shipping Containers Are Useful *But Not Suitable* For the Objective of Increased Black Generational Wealth Creation Thru Homeownership.

The use of cargo shipping containers in Washington, DC indicates the suitability for a range of uses that include college student housing and similarly transitory uses. The shipping containers appear well suited to small and inconspicuous uses in commercial settings. The same might be said for temporary usage in select educational settings. However, the use of cargo shipping containers in neighbors similar to Case Study #2 would likely fail. Sustaining the required levels of visual compatibility that is essential to increases in property values in an entry middle class neighbor appears highly doubtful.

While this Washington, DC shipping container project and many others like it now have achieved high cache appeal in the U.S. and across the globe, the notion of steel shipping containers for residential usage has been challenged as well as completely



reimagined in a 2021 book *The Future of Modular Architecture*<sup>13</sup> by David Wallance. He puts forth a compelling counter idea about the role of the intermodal shipping container. He argues that it is not the steel cargo container that is important. Wallace argues instead that it is the now global universality of the dimensions of the container – 8' wide by 9'-6" high by length increments of 20', 30', and 40' - that are of utmost importance and that must be adopted. Wallace also contends that the steel containers are ultimately vastly inadequate to the task of being retrofitted as a module for human living on a long term of permanent basis.

### **Exhibit 26. Project Using Modules That Equal Shipping Container Dimensions**



Wallance is convinced that his idea could aid the cause of the long-sought industrialization of the building construction industry. He, *“proposes those dimensions as the new volumetric brick which he labels as the “Volumetric Construction Unit” (VCU) and basis of a mass-customized mid- and high rise modular housing that can be manufactured and distributed on a global*

*scale...”* that can facilitate the building of an entire urban community similar to the one shown in Exhibit 22.

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<sup>13</sup> Wallance, David. *The Future of Modular Architecture*.

## **Key Finding 5: Case Study #4 MODO Apartments Was Phase 1 of a Master Strategy for Building Thousands of Affordable Medium Density Housing in DC**

By the early 1990s the use of concrete and/or steel to construct hi-rise and mid-rise buildings became prohibitive, despite also being a rigid building code requirement. The building of housing in quantities that could began to accommodate affordability by those in the less-than luxury market-rate and affordable housing was no longer achievable. In 1996 west coast-based architect Timothy Smith's proposal to construct mid-rise high density apartment buildings using treated wood in lieu of concrete and steel rapidly became the only acceptable method to get a medium or high density market-rate or affordable housing deal to "pencil out." The housing construction industry is now in the dawn of an era that will require the conjoining of Smith's 1996 insight about treated wood mid-rise construction with factory-built modular construction at scale quantities as the only way to make a market-rate and affordable housing deal to "pencil out." The Case Study #4 developers foresaw this coming paradigm shift and were acting accordingly.

### **Conclusions and Recommended Avenues for Further Study**

HUD research initiatives and financial support over the past three years for an urgent reprisal of the initial Operation Breakthrough could, over the coming five years, result in a dwarfing of the \$72 million (\$420 million in today's dollars)<sup>14</sup> expended over the five year duration of Operation Breakthrough.<sup>15</sup> Most recently, two municipalities stand out as highly representative of what appears destined to become a major initiative in the HUD strategy of a 21<sup>st</sup> century version of Operation Breakthrough. There are indications that an Operation Breakthrough 2.0 may already be in progress. The city of Boston, MASS, (and

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<sup>14</sup> PSAD-76-173-pdf. Operation Breakthrough: Lessons Learned About Demonstrating New Technology. A report to the Congress; By Elmer B. Staats, Controller General. Chapter 1, page 1.

<sup>15</sup> Properly cite Feb. 6-8, 2024 HUD conference on the findings of the entire HUD PRD apparatus of senior PDR leadership and key HUD research partners including federal agencies. EDGE; PD&R online newsletter, 8 page summary published March 5, 2024.

immediately adjacent municipalities) is currently in pursuit of HUD funding support to develop detailed proposals for what may result in the construction of a local modular housing factory dedicated to increasing the city's supply of affordable housing.

Another pertinent local municipal effort to be emulated is the city of Boulder, Colorado that is seeking grant assistance to build an affordable housing focused modular factory. The level of HUD funding for similar local initiatives could begin to increase at an exponential rate. The following two paragraphs were taken directly from the [Boston MAPC online application grant](#). While the HUD Request for Proposals does not list "offsite construction" under the six bulleted criteria, the language of the criteria is broad enough to allow a firm assumption that offsite construction is a desirable strategy.

**October 11, 2023** - The Metropolitan Area Planning Council (MAPC) seeks public input on its grant application to the United States Department of Housing and Urban Development (HUD). MAPC is applying to HUD's PRO Housing grant program to research alternative construction technologies. This grant is aimed to support communities who are actively taking steps to increase housing production and remove barriers to affordable housing. The grant project proposal includes researching regulatory barriers to offsite construction, working with municipalities to identify projects suited for offsite construction and modular/prefabricated housing, working with labor and workforce development partners to inform how new offsite construction facilities and related jobs can complement traditional construction methods and offer different kinds of good jobs for local residents, and explore siting a new manufacturing facility within Greater Boston to lower the cost of modular or prefabricated housing. *The grant project will result in research briefs and an eventual solicitation for development proposals to incentivize and attract a new manufacturing facility to Greater Boston.* (Highlighting and italics by our research team)

The Washington, DC case study projects in this research study appear to indicate that the Boston objectives for pursuing a local offsite construction factory are fully in line with the team research objectives for Washington DC regarding offsite construction.

## Reference Literature

***Operation Breakthrough, 1968-1974.*** Office of Policy Development Research (PD&R). PSAD-76-173-pdf. Operation Breakthrough: Lessons Learned About Demonstrating New Technology. A report to the Congress; By Elmer B. Staats, Controller General is a definitive 97 page report that describes in great detail the OBT program along with an assessment of its successes and failures.

***“Factory Built Housing: A New Age of Experimentation”*** Todd Richardson, HUD OPRD, EDGE, The OPRD On-line Newsletter, March 5, 2024summary of the Feb. 6-8, 2024 HUD conference of OPRD policy leaders and other key HUD research partners.

[https://www.linkedin.com/posts/mod-x\\_hudfactory-built-housinga-new-age-of-experimentation-activity-7171515321147707392-](https://www.linkedin.com/posts/mod-x_hudfactory-built-housinga-new-age-of-experimentation-activity-7171515321147707392-)

**Safdie, Moshe,** 1973. *Beyond Habitat*. Cambridge, Mass: MIT Press.

Tim Smith Architect invents new methodology for building high density apartment buildings.  
<https://en.wikipedia.org/wiki/5-over-1>

***Offsite Construction for Housing: Research Roadmap.*** Prepared for the U.S. Department of Housing and Urban Development, Office of Policy Development and Research. Prepared by **Ryan E. Smith, Ivan Rupnik, Ph.D., Tyler Schmetterer,** and Kyler Barry. July 2022.

***Modularization Precedes Digitalization in Offsite Housing Delivery.*** Prepared for the U.S. Department of Housing and Urban Development, Office of Policy Development and Research. Prepared by **Ryan E. Smith, Ivan Rupnik, Ph.D., Tyler Schmetterer,** and Kyler Barry. November 2022.

***5 In 5 Modular Growth Initiative: Research Roadmap Recommendations.*** Prepared for the Modular Building Institute. Prepared by **Ryan E. Smith and Ivan Rupnik, Ph.D.,** May 2018.

**Wallance, David, FAIA,** Foreword by Szenasy, Susan, 2021. *The Future of Modular Architecture*. New York: Routledge-Taylor & Francis Group.

**Naylor, Sam, D'Orca, Daniel, and Herbert, Chris**, Editors, 2023. *The State of Housing Design*. Cambridge, Mass.: Harvard Joint Center for Housing Studies.

**Smith, Ryan E., Foreword by Timberlake, James, FAIA**, 2010. *Prefab Architecture: A Guide to Modular Design and Construction*. Hoboken, New Jersey: John Wiley & Sons, Inc.

**Kieran, Stephen and Timberlake, James**, 2004. *Refabricating Architecture: How Manufacturing Methodologies Are Poised to Transform Building Construction*. New York: McGraw-Hill Companies.

**HUD Innovation in Affordable Housing Student Design & Planning Competition, 2023 (10<sup>th</sup> Anniversary)**: <https://www.huduser.gov/portal/challenge/home.html>

HUD 2022-2026 Learning Agenda:

<https://www.huduser.gov/portal/sites/default/files/pdf/HUD-Learning-Agenda.pdf>

HUD Equity Agenda Plan:

<https://www.hud.gov/sites/dfiles/PA/documents/HUDEquity508compliant.pdf>

**Elliot, Amy**, April 1997. *Architect Helps City Officials Understand How Modulares Can Speed Up Inner-City Housing Development*. Arlington, VA: Automated Builder.

**Potter, Brian**, 2021. *Operation Breakthrough: America's Failed Government Program to Industrialize Home Production*.

Mod Stack and "Pencil Out" OSC Project

<https://www.modular.org/2024/02/11/the-norwalk-multifamily-modular-project-case-study/>