

Smaller, Faster, and Creative: Innovations in Affordable Single-Family Home Construction

Sam LaTronica

Edward M. Gramlich Fellow in Housing and Community Development

November, 2016

A paper submitted to Harvard's Joint Center for Housing Studies
and NeighborWorks America



Acknowledgements:

I would like to thank the following people for their continued support and assistance in completing this project:

Chris Herbert, Joint Center for Housing Studies
Jennifer Molinsky, Joint Center for Housing Studies
John Santner, NeighborWorks America
Tom Rice, NeighborWorks America
Heather Starzynski, NeighborWorks America
Marcea Barringer, NeighborWorks America
Kirsten Johnson-Obey, NeighborWorks America
Pamela Baldwin, Harvard Graduate School of Design

I would also like to thank the following housing and community development professionals who provided me with their time, insight, and resources:

James Arenston, Southwest Minnesota Housing Partnership
Brennan Crawford, Community Housing of Wyandotte County
Stacey Epperson, Next Step
William Farnsel, Neighborhood Housing Services of Toledo, Inc.
Seila Mosquera, NeighborWorks New Horizons
Carla Potts, North East Community Action Corporation
Julie Savin, NeighborWorks New Horizons
Eli Spevak, Orange Splot LLC

Last but not least I would like to thank NeighborWorks America and the Harvard Joint Center for Housing Studies for their continued financial and institutional support of the Edward M. Gramlich Fellowship in Community and Economic Development.

Introduction

Innovations in single-family home construction are badly needed. Studies show that every county in the U.S. is facing an affordable housing shortage.¹ Homeownership is increasingly out of reach for many would-be first-time homebuyers, and if younger couples and families can afford to purchase their own home, they increasingly have to wait longer to buy or lower their expectations.² Many homebuilders are emerging from the housing bust by building fewer but larger and more expensive houses for wealthier homebuyers, underscoring the lack of opportunities for low-income buyers.³ The excess of single-family homes built before the recession also gives pause to younger buyers that are wary of procuring a mortgage. For these reasons, community development corporations (CDCs) must explore a range of techniques to develop single-family housing that is affordable to first-time homebuyers. This paper examines current innovations in affordable single-family home construction and their associated opportunities and challenges. This paper includes lessons learned by CDCs that have experimented with these innovations and recommendations to CDCs that are interested in doing the same.

The primary goals of this undertaking, as envisioned by Midwest Regional Office of NeighborWorks America, is to explore the potential for new construction techniques to:

1. Provide affordable single-family homes for lower-income potential homebuyers. This affordability would be present both in the upfront costs and the long-term maintenance costs. Ideally, this affordability would not be contingent upon subsidies on the development side. Given the current state of limited subsidies, finding a way to construct homes without subsidy could increase the total amount of affordable homes constructed.
2. Create single-family homes that are environmentally sustainable. This includes incorporating green and recycled materials and energy efficient appliances and building techniques/materials. These features would also benefit the occupying tenants by contributing to the long-term affordability of the home.
3. Provide single-family homes that foster a healthy atmosphere for its occupants. This includes homes that are built with materials and ventilation systems that are not detrimental to the occupants' physical health, as well as homes that are designed in ways that are not detrimental to their mental health.

Study Focus

This paper explores three distinct innovations in single-family home construction:

1. "Small" housing
2. Factory-built housing
3. Creatively designed housing

¹ Capps, "Every Single County in America Is Facing an Affordable Housing Crisis."

² Badger

³ Aschbrenner

This paper will examine the opportunities and challenges presented by each of these three elements of innovation on its own, and also in conjunction with each other. Combining these three elements can potentially assist CDCs in creating levels of affordability or environmental sustainability that are unachievable by an individual element on its own.

Focus on Midwestern Market

This paper was sponsored by the Midwest regional office and as such there is a clear focus on Midwestern markets and developers, with projects in both urban and rural areas. However, examples from outside the Midwest are incorporated to provide additional insight into best practices and possible pitfalls. The lessons learned throughout this research can be particularly impactful in rural areas, as the affordable housing crisis in rural areas can be easily overlooked within the national dialogue around affordable housing (given there is a perceived “lower prioritization of rural issues overall” at the federal level).⁴ While rural areas often have lower costs of living, incomes are also lower (rural poverty rates in 2012 were 17.2% compared to 14.9% nationwide) and the existing housing stock is in poor condition. According to Sheila Crowley, president of the National low-Income Housing Coalition, “Much of the affordable-housing stock in rural housing areas is old and in need of repair. Many of the people who live there don’t have the resources that they need in order to keep the houses in good repair.”⁵ It is not uncommon for rural housing to exist in unhealthy or dangerous conditions.

Developers of affordable housing in more rural areas sometimes also face unique challenges that developers in urban areas largely avoid, such as the absence of water, sewer, and road infrastructure. According to David Dangler, the Director of Rural Initiatives at NeighborWorks America, “rural areas have been traditionally more dependent upon public subsidies and publicly-funded programs than their urban counterparts. There can be a disproportionate pain in rural areas as we attempt to right our financial books by cutting back on federal-housing programs.” The existing subsidies that serve rural communities (mostly administered by the U.S. Department of Agriculture) “tend to be much smaller in scale in terms of the amount of money than the HUD programs,” according to Crowley. “They also tend to be lost in the bureaucracy.”

Given the current climate of scarce funds for rural affordable housing, any innovations that can reduce costs are in dire need. This project offers potential solutions to some of the distinct problems facing these rural communities. Section 2 of the paper describes three approaches and their associated benefits and challenges in detail. Section 3 offers examples of organizations that have used these approaches and the lessons they have learned in doing so. Section 4 concludes and offers recommendations to CDCs interested in pursuing these approaches.

⁴ White

⁵ White

Innovative Approaches

Small Housing

The first innovation discussed in this paper is small housing. In order to examine the potential that smaller housing presents for affordability, we must first define what we mean to be “small” single-family homes. These definitions vary, and are often relative to their respective markets. This paper uses the U.S. Census single-family home size brackets when analyzing data on current trends in single-family home sizes. However, for most Midwestern Community Development Corporations (CDCs), the smallest single family homes that they produce range from approximately 900 ft² to 1,100 ft². Sizes smaller than this range typically yield a much lower sales price in relation to the overhead and construction costs required to develop the house. This is the range to be kept in mind when discussing “small” housing throughout the remainder of the paper.

Opportunities Presented by Building Small Fewer Materials. Building smaller houses requires a smaller amount of resources for production, and can yield lower development costs and greater construction efficiency. Simply put, “every additional foot of space in every room takes more labor and more material. More space adds more foundation and roof, and... more structural materials to build, more interior finish products (cabinets, flooring, drywall, paint, windows, doors), larger systems for heating and cooling and more furnishings.”⁶ Because some larger items such as the kitchen and water heater have fixed costs, the cost per square foot of smaller houses usually exceeds the cost per square foot of larger homes, but the overall cost of smaller homes can be lower. Some experts encourage builders to focus on the total development cost or the per unit cost, rather than the cost per square foot, as this change in thinking will help them to better quantify the cost savings of constructing smaller homes.

Long-term Savings. Lower square footage of homes can provide occupants with significant ongoing savings on both utilities and maintenance. Less space means that less energy is required to heat, cool, and illuminate that space. Despite advancements in energy efficiency in recent decades, the overall energy expended per household has actually increased since the early 1980s, due in large part to increasing house sizes.⁷ Living in smaller homes, coupled with these advancements in energy efficiency, would require less energy and be more cost effective for the inhabitant. This energy efficiency on the part of the occupant is desirable in part because these efficiencies “require neither enforcement nor a personal commitment to cutting back,” they

⁶ Cook and Garrett, 31.

⁷ Marshall

will simply be consistent throughout the life of the house.⁸ Additionally, standard maintenance and replacements can be easier, less frequent, and require fewer materials, resulting in lower recurring costs.⁹ Lastly, smaller homes will generally result in lower annual property tax payments made by the occupant.¹⁰

Land Considerations. Smaller footprints also mean that developers can utilize smaller and irregular lots and save on land acquisition costs. Even if land is being donated to CDCs and acquisition costs are not as relevant, it is possible that smaller footprints will widen the range of potential buildable parcels by enabling homes to be constructed on parcels that are too small or irregularly shaped for larger houses. This means that there is a greater potential for infill development in higher-density residential neighborhoods. Building small could also increase the number of units that can be built on larger subdivided plots or could allow for detached accessory dwelling unit construction on single plots (pending compliance with local zoning requirements).

Growing Interest. There is a recent growing interest in smaller housing among potential homeowners.¹¹ This increased desire to downsize is the result of newfound consciousness around environmental sustainability, financial sustainability and reducing housing costs, and a desire to live more simplistically.¹² While “tiny homes” are beyond the scope of this paper, the current momentum they are gathering embodies this mentality and has brought attention to downsizing in general.¹³

Challenges Presented by Building Small/No Guaranteed Savings. Despite the theoretical savings that could be achieved by building small, there is no guarantee that building small will yield any savings in practice. If contractors are accustomed to building a certain type/size of house, building a smaller house could be a change that reduces efficiency and thus does not reduce costs. Additionally, a smaller house will generate a lower sales price, a tradeoff that will result in a lower developer’s fee and might reduce the ability of the CDC to produce housing without development subsidies.

Stigma. An unfortunate reality is that smaller housing is often seen as less desirable. If affordable housing becomes increasingly smaller while market-rate housing sizes stay the same

⁸ Owen, “Greenest Place in the U.S.? It’s Not Where You Think.”

⁹ Cook and Garrett, 36.

¹⁰ Cook and Garrett, 32.

¹¹ Gallagher, 136.

¹² Milkman

¹³ The Tiny Life

or grow, it could stigmatize affordable housing or at the least create a visible distinction between the income levels of residents. In larger markets such as New York City, affordable units created through inclusionary zoning must be indistinguishable from market-rate units, and many Midwestern CDCs are also committed to making their homes indistinguishable from market-rate housing. These CDCs are concerned that a noticeable difference will stigmatize residents of affordable housing (they have described instances in which market-rate tenants have belittled or derided nearby affordable developments and residents). This stigmatization can have harmful psychological effects on residents and should be taken into careful consideration.

Building Too Small Can Be Detrimental. With recent attention being given to “tiny houses” and micro units, it is important for CDCs to study the potential drawbacks of building housing that is too small. Tiny homes (approximately 100 - 400 ft²)¹⁴ can potentially exclude larger family sizes or persons uncomfortable with living in smaller spaces, and some households that were once excited by the prospects of living minimally have since returned to larger living arrangements.¹⁵ The smaller units are typically designed with younger couples or single occupants in mind, and the designs can be unwelcoming to others. Indeed, a common critique of tiny houses and micro units is that their “focus on independent adults means they miss many parts of the population that experience homelessness or acute housing insecurity, including families and youth.”¹⁶ And when tiny homes are designed specifically as a means of providing shelter for homeless individuals, these homes are prohibited and often confiscated by city governments that argue that the structures pose public health and safety risks.¹⁷ Recent research conducted around these smaller living situations indicates that, “for some residents, the potential health risks and crowding challenges might outweigh the benefits of affordable housing.”¹⁸ This is important to remember when designing homes that are intended to be healthy for their occupants.

Current Trends. Recent data from the U.S. Census indicates that, despite a recent growing interest in smaller housing, most markets are not producing smaller single-family homes. While many economists and professional organizations predicted a nationwide decline in home sizes after the recession,¹⁹ it now appears that they did so prematurely. While the housing collapse and ensuing economic downturn did result in temporarily lower average sizes of newly constructed homes, development has bounced back and average home sizes have surpassed

¹⁴ The Tiny Life

¹⁵ Willett

¹⁶ Milkman

¹⁷ Holland

¹⁸ Urist

¹⁹ Gallagher, 136.

pre-recession sizes and continue to grow.²⁰ As long as increasingly large houses continue to be the norm, CDCs will have a harder time developing smaller housing that realizes actual cost savings and does not stigmatize residents.

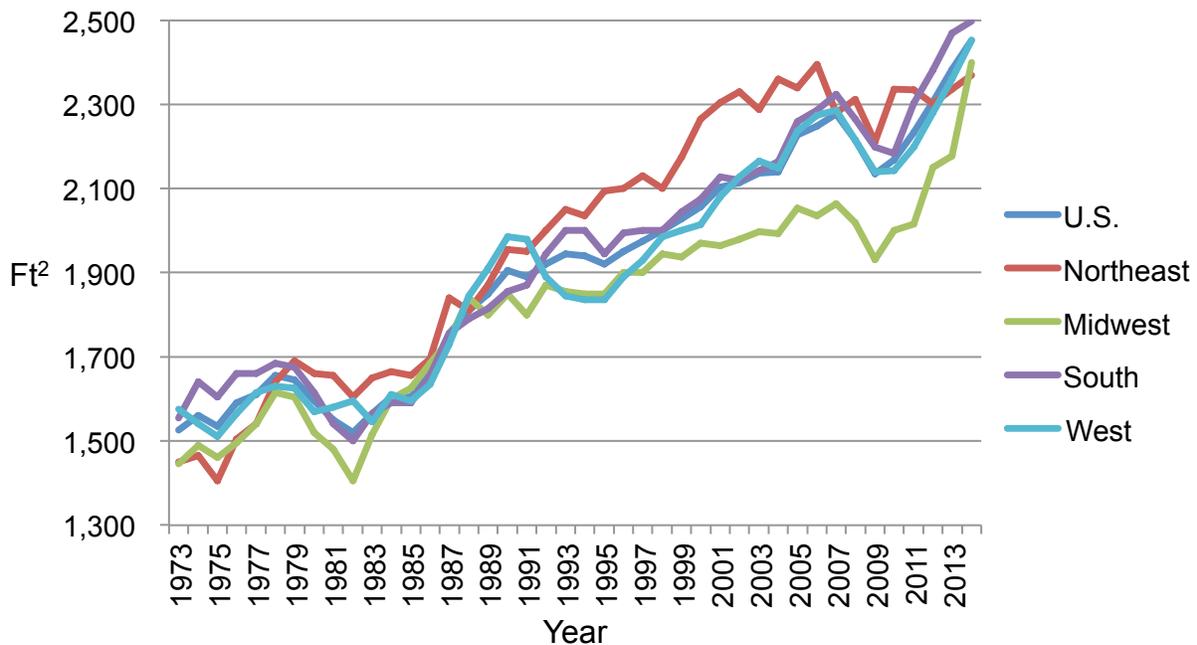
Current Nationwide Trends in Small Single-Family Home Construction

Despite the downturn in single-family home construction that resulted from the recession, median sizes of newly constructed homes have been steadily increasing throughout the recovery, eclipsing the pre-recession sizes.²¹ The median size of houses built pre-recession peaked at around 2,277 ft² in 2007 and dropped to 2,135 ft² in 2009. It has been increasing steadily since then, reaching 2,453 ft² in 2014, the highest recorded median new home size. Since the mid-1990s the Midwest has exhibited the lowest median single-family home sizes by a significant margin. However, in recent years the Midwest has seen the fastest increase in home sizes and in 2014 the region surpassed the Northeast for the first time since the late 1980s (Figure 1). This upward trend in home sizes also pertains to factory-built homes, resulting in higher costs for smaller homes that require shifts in the production process.

²⁰ Capps, "The Recovery Is Super-Sizing Houses."

²¹ U.S. Census

Figure 1



Source: U.S. Census Bureau

There are multiple possible explanations for this trend. Selma Hebb, chief economist at Trulia argues: “Coming out of the recession, a lot of builders were stuck with a lot of developable lots that they were going to develop as the housing construction was booming... After the recession, instead of building what they were building up to that point, they started building larger homes to capitalize on those developable lots.”²² It is also argued that a scarcity of developable lots in urban areas is incentivizing developers to build larger in order to get the most out of the lots on which they are able to build. Additionally, the market for luxury homes was the only market strong enough to weather the recession and lead construction during the recovery. “Wealthy or international buyers who could still acquire mortgages or pay with cash in the aftermath of the credit collapse may have spurred builders to make larger houses.” However, Hebb argues that the issue of land scarcity is likely the largest factor: “Today, we have such a scarcity of lots, [builders] are trying to maximize their profits on the lots that they have available,” especially in urban areas and inner-ring suburbs, where the market for new construction is stronger.

Many developers have also turned their attention to producing larger homes in order to accommodate “multigenerational” households, or households that have “doubled up” by including “at least one other adult who is not the homeowner, spouse, or cohabitating partner of the homeowner.”²³ The increase in these arrangements is the result of a larger number of recent

²² Capps, “The Recovery Is Super-Sizing Houses.”

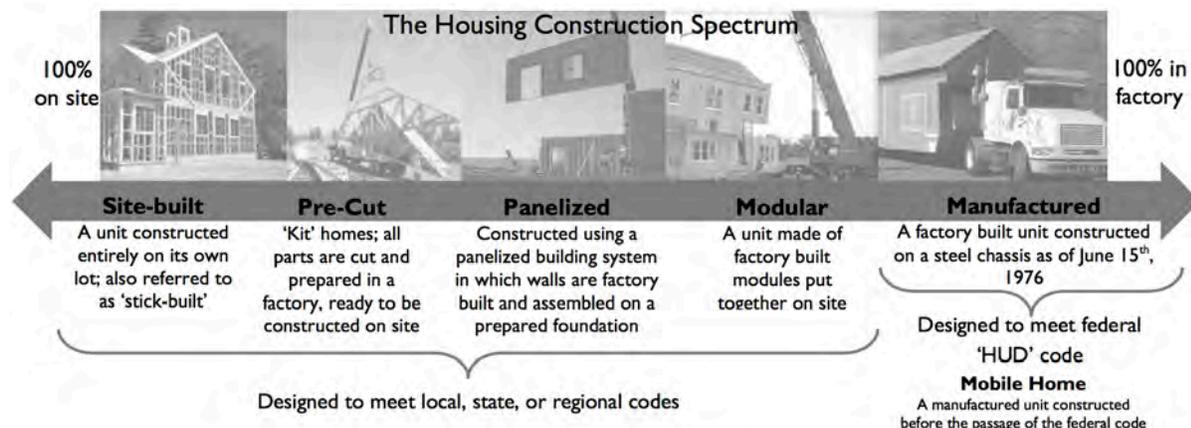
²³ Gallagher, 155.

college graduates returning to their parents' homes, and increase in the number of retired and "aging seniors moving in with their adult children," and the proliferation of ethnically diverse populations "with many families for whom living together is part of the culture."²⁴ Ultimately for one reason or another large houses are simply still more appealing to American homebuyers. Eli Spevak, the founder of development and general contractor company Orange Splot, LLC describes preferences for larger houses as such: "In some ways it's kind of become cool again, to downsize, and people do lot's of things because it's cool, that's not to be underestimated... and that's frankly why people buy big homes, because since the 1950's big homes were cool." Despite some growing interest in smaller homes, these homes still only represent a small share of the market (8% of newly constructed homes in 2014), limiting the viability of smaller homes as an affordable homeownership solution.

Factory-Built Housing

The second innovation is "factory-built" housing. Factory-built housing can take numerous forms and can range from having only certain elements constructed in a factory to the entire home constructed in a factory. See Figure 2 for the NeighborWorks Rural Initiative guide to the housing construction spectrum.

Figure 2



Source: NeighborWorks Rural Initiative

This paper will focus primarily on modular and panelized (specifically structural insulated panels, or SIPs) construction typologies, as these are the two innovations currently being explored and employed by numerous NeighborWorks affiliate CDCs.

²⁴ Gallagher, 155.

Modular

According to the Modular Building Institute, a non-profit modular trade association representing modular producers and contractors, “Modular construction is a process in which a building is constructed off-site, under controlled plant conditions, using the same materials and designing to the same codes and standards as conventionally built facilities – but in about half the time. Buildings are produced in “modules” that when put together on site, reflect the identical design intent and specifications of the most sophisticated site-built facility – without compromise.”²⁵

Single-family homes can be produced in modules that have both interiors and exteriors that are nearly finished. Once the modules arrive onsite, they are placed together using a crane, plumbing/heating/electrical connections are made, and the contractors seal the house. Once the home is sealed it is often indistinguishable from site built homes.

Structural Insulated Panels (SIPs)

According to the Structural Insulated Panel Association a non-profit trade association representing SIPs manufacturers and contractors, SIPs are wall and roof panels that create “a high performance building system for residential and light commercial construction. The panels consist of an insulating foam core sandwiched between two structural facings, typically oriented strand board (OSB). SIPs are manufactured under factory-controlled conditions and can be fabricated to fit nearly any building design. The result is a building system that is extremely strong, energy efficient and cost effective. Building with SIPs will save you time, money and labor.”²⁶ Like modules, SIPs are shipped to the project site where they are assembled to form the structure of the house. After the walls and roof are put up using SIPs, the onsite contractors make the necessary connections and complete the finishing work. Once they are completed they are also indistinguishable from traditional stick-built housing.

Manufactured Homes

Manufactured homes, commonly referred to as “mobile homes” or “trailer homes,” are factory-built homes that are usually (but not always) placed upon a permanent chassis rather than a traditional foundation.²⁷ These homes are built according to the Manufactured Home Construction and Safety Standards (HUD Code), rather than to the applicable local, regional, or state building codes. These homes require the least amount of on-site installation. These elements make manufactured housing cheaper than modular or panelized housing of the same quality, but also less appealing for many buyers due to the simpler design and stigma associated with “trailer parks.” Additionally, manufactured homes can provide less housing stability if the land upon which they are placed is not owned by the tenants. Manufactured

²⁵ Modular Building Institute, “Why Build Modular?”

²⁶ Structural Insulated Panel Association

²⁷ U.S. Department of Housing and Urban Development, “General Program Information.”

homes will not be as explored in as much depth as modular or panelized housing in this paper, but their inclusion is important for comparison with the case studies.

Opportunities Presented by Factory-Built Housing Efficiency. The conditions under which factory-built housing is produced provide for increased efficiency relative to site-built housing. The assembly line processes and controlled environment allow modular producers to construct housing at a much faster rate than would be manageable for traditional builders, yielding potential cost savings.

Shortened Onsite Construction Period. Because most of the home construction occurs in a factory setting, modular and panelized construction typologies allow for shorter periods of work on the actual site. This can reduce the labor cost, as well as the potential for delays and subsequent increased costs caused by inclement weather and vandalism/theft. This is where the bulk of potential savings offered by modular production occurs.

Stability. Factory-built housing offers CDCs the potential to stabilize their production cycle. As housing is produced with more consistency, CDCs can not only produce more units per year but also have a better sense of the duration of construction for each project and thus better manage their annual operations.

Greater Structural Integrity. Both modular and panelized housing typologies exhibit greater structural integrity than traditional site-built housing. Because modular housing is transported to the site mostly intact, each module must be constructed to withstand the shipping process and as such must be more structurally sound than traditional housing. SIPs also have greater structural integrity than traditional wood frame construction by virtue of their design. Both sheets of plywood and the foam core insulation provide for a strong structure in addition to a better-insulated one.

Efficient Use of Materials. Factory-built housing is touted as being “the benchmark of efficiency, cost savings, and waste reduction,”²⁸ by making more efficient use of materials and reducing waste and costs. According to proponents, “every cut is planned, with every scrap either used on the next widget coming down the line.” This is especially true for onsite waste, as materials arrive to the site pre-cut and ready to assemble.

²⁸ Cook and Garrett, 166.

Tighter Building Envelopes. SIPs specifically create a much tighter building envelope and as such provide for a much more energy-efficient and affordable home. The greater insulation provided by SIPs can provide cost savings to homeowners in the form of lower utility bills.

Challenges Presented by Factory-Built Housing Varying Market Potential.

Currently, factory-built housing offers a greater potential for costs savings in higher-cost markets. Labor is more expensive in these markets, and as such the reduced construction time can have a greater effect on reducing costs. Additionally, markets with more factory-built housing producers and more contractors who have experience working with these distinct typologies will enable CDCs to more fully realize potential cost savings than would be possible in markets where this expertise is less abundant.

Unforeseen Complications. Working with factory-build construction typologies often presents on-the-ground complications that are not made aware in the literature on the subject. The literature indicates that the modules arrive at the site practically finished and only need a few days of work to set them in place and connect them. However, in practice this is often far more complicated and requires careful coordination of the general contractor and the subcontractors.

Transportation Issues. Transporting factory-built housing is in itself very expensive and can lead to additional complications. The further away modules are produced, the more expensive they are to ship. As such, if modular home suppliers don't have efficient relationships with local builders and developers, the cost savings can be minimal. According to the Southwest Minnesota Housing Partnership (SWMHP), the transportation process limits the maximum dimensions of a module to:

- Length: 76 ft
- Height: 16 ft
- Width: 18 ft

However, the best/most economical dimensions for shipping are as follows:

- Length: < 68 ft
- Height: 15 ft 6 in (or less)
- Width: 16 ft

Using the maximum dimensions, rather than the most economical dimensions will definitively increase transportation costs. Additionally, narrower urban streets can restrict access to many sites (or may need to be closed off during construction), and smaller infill parcels might not be conducive to setting the modules in place with the necessary equipment.

Volume Limitations. Factory-built housing producers often prefer filling higher-volume orders. Producing and assembling factory-built housing in larger quantities utilizes economies of scale and can realize greater cost savings, but it is less common that CDCs have the capacity to develop a high enough number of projects at the same time to realize these savings. As such, factory-built producers could favor orders from for-profit developers that have a greater capacity. Community Housing of Wyandotte County (CHWC) describes placing an order for SIPs from a local manufacturer and paying a deposit on the order. Some time after the manufacturer had confirmed and agreed to fill the order, they cancelled the order and sent the check back to CHWC because they had received a larger order from a for-profit developer and it was no longer worth their time to fill CHWC's order. This set back CHWC's development timeline significantly as they had to find a new manufacturer and start the ordering process over.

Local Labor Capacity. Many architects, engineers, contractors, and subcontractors are not accustomed to working with panels or modules, and this cumulative lack of experience can lead to extended construction times and significant cost increases that can easily surpass the costs of traditional site-built housing. It is important that every party involved in the supply chain and actual development is familiar with these typologies. Additionally, local labor is not always supportive of factory-built projects. Some local trades unions oppose factory-built projects on the grounds that the shortened construction time reduces the need for union labor and undercuts their livelihood. On the other hand, some unions support these types of projects because there is still some construction/assembly work that needs to be completed onsite and shorter construction periods can lead to a greater number of houses built in a given time period and this increased number of projects will balance out the shorter construction timeframe on each individual job. Additionally, a strong modular market will make homes more affordable and thus within reach of a greater number of potential homebuyers, potentially further increasing the amount of homes that can be built in the market.²⁹

Many Midwestern CDCs, such as SWMHP, are also experiencing general labor shortages that have been driving up construction costs. According to a survey conducted by the Associated General Contractors of America (AGC) in the summer of 2015, 86% of contractors around the country are finding that they are having trouble finding skilled labor in the wake of the construction market rebounding.³⁰ The most severe labor shortage was reported as occurring in the Midwest region. AGC economist Ken Simonson predicts that "as labor shortages worsen, construction wages will spike higher and projects will take longer to complete." This increased timeline would effectively work against the predicted time and cost savings presented by factory-built housing.³¹

²⁹ May 8 Consulting

³⁰ The Associated General Contractors of America

³¹ Hartman

Some CDCs are also trying to promote “sweat-equity,” a mechanism that “calls for community members to actively participate in the manual labor of creating and repairing not only their own homes, but the homes of those who live around them as well – decreasing the financial burden of building while, hopefully, forging strong community ties.”³²

Weather Concerns. Some factory-built housing, specifically SIPs, can be compromised by poor weather conditions. If SIPs get wet they can be ruined and thus unusable, resulting in having to re-order panels and delaying the development timeline. Additionally, once they are ruined they cannot be reused or disposed of in an environmentally sustainable manner. The materials used to produce SIPs are also more expensive than traditional stick-built housing, so if materials are ruined or construction takes too long the costs will likely exceed the costs of building a comparable stick-built house.

Tighter Envelopes. While tighter building envelopes constructed in controlled factory settings can make for better insulated, more energy efficient homes, they also often require improved ventilation systems. These expensive systems add significant costs to the development of housing constructed using SIPs.

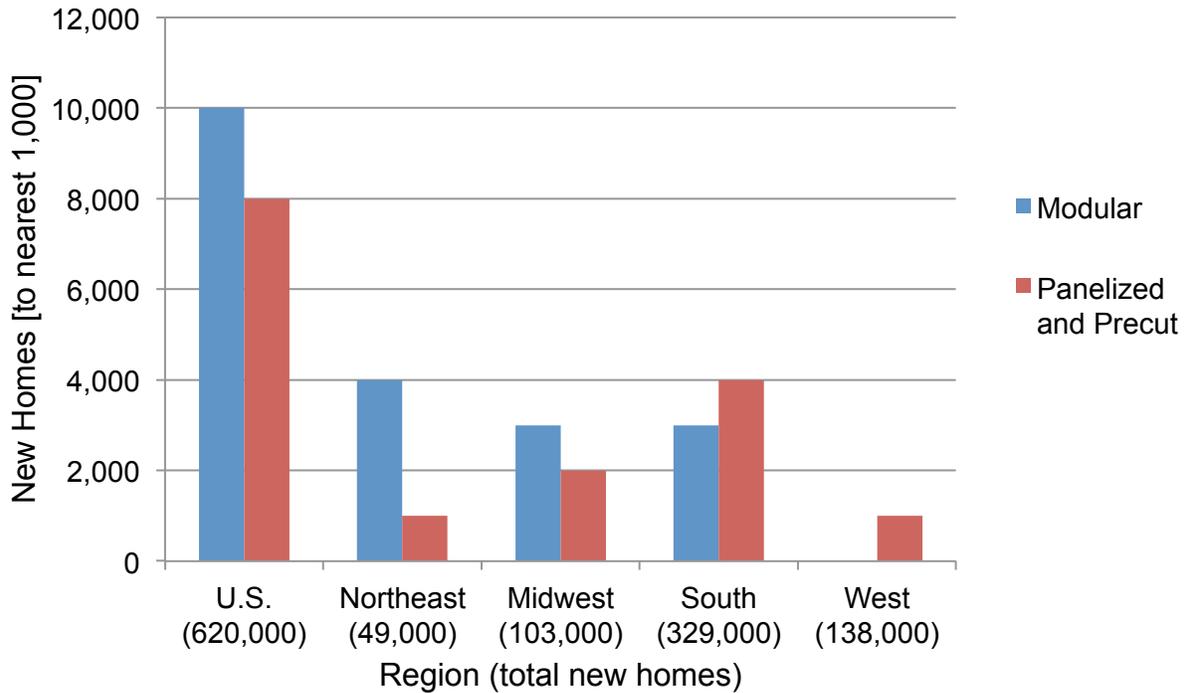
Limited Design. With the efficiency of factory-built housing comes standardization and thus limitations imposed on home design. This can lower costs, but for CDCs that wish to produce more creative, visually diverse and interesting housing this can be a drawback. There is also a certain level of desire among many homeowners to not live in neighborhoods or homes that appear to be too “cookie cutter.” SWMHP has also found that renovations on modular homes can be more difficult and costly due to the enhanced rigidity and sealing techniques.

Current Nationwide Trends in Factory-Built Single-Family Home Construction

Site-built houses are still by far the most commonly built new houses nationwide, comprising 97% of houses completed in 2014. The share of the market that factory-built homes constitute has actually decreased slowly, with some fluctuation, since 1999 when site-built homes made up 94% of new home construction. In 2014, modular housing and panelized/pre-cut houses comprised 2% and 1% of all new homes, respectively. Approximately 10,000 homes were constructed using modular construction, and 8,000 homes were constructed with panels, compared with around 601,000 houses built on site. This highlights the idea that, even though these building techniques have been around for quite some time, they are still relatively uncommon, especially in certain markets (Figure 3).

³² White

Figure 3



Source: U.S. Census Bureau

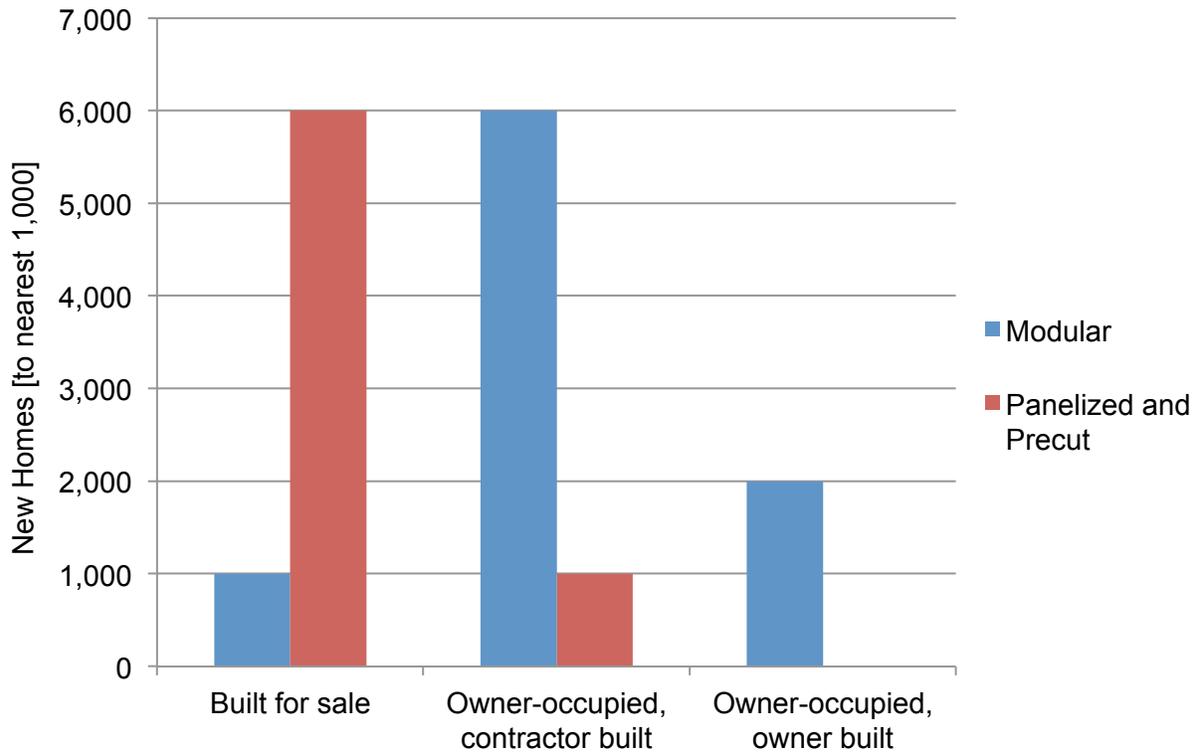
The Northeast had the highest share of houses built utilizing offsite construction techniques in 2014, with 8% of new houses being modular and 3% of new houses being panelized. However, the Northeast had the smallest share of new house construction nationwide, with only approximately 8% of new homes being built within the region. The region with by far the largest share of newly constructed housing in 2014 was the South, which built 53% of the 620,000 homes completed in 2014. In this region, 98% of homes were site built, with modular and panelized homes each making up 1%. Together, these construction typologies accounted for around 7,000 new homes in the South. Again, this demonstrates the lack of experience with and attention paid to these methods, despite them existing for years.³³

New houses built for sale overwhelmingly lean towards site-built homes, with a share of 98% of new home construction, a level that is relatively similar throughout each region. Alternatively, homes built on owner-occupied land, either by owners themselves or by a general contractor hired on behalf of the landowner, were much more likely to pursue modular construction, with modular construction making up 6% of new construction. Panelized housing accounts for less than 1% of new construction on owner-occupied land. Again the Northeast was the region most likely to use modular construction, but made up the smallest fraction of total new construction. While the Northeast only built 17,000 of the 142,000 owner-built homes

³³ U.S. Census Bureau

nationwide, 3,000 of them were built using modular construction, or approximately 18%. The idea that a far greater percentage of owner-built homes utilized modular construction than homes built for sale again suggests that there is an interest on the part of the homeowner in the typology and its associated cost savings (Figure 4).

Figure 4



Source: U.S. Census Bureau

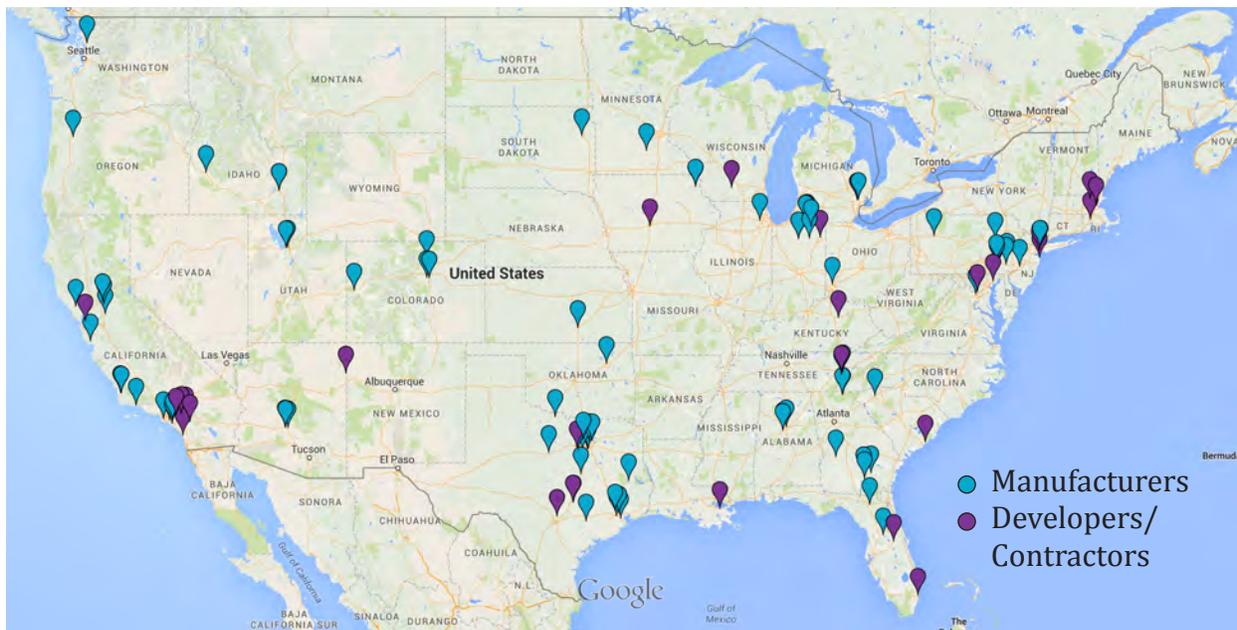
The Census Bureau also reports that 90% of all new houses completed in 2014 were built within a Metropolitan Statistical Area (MSA). This supports Selma Hebb’s analysis that homes are getting bigger because developers are largely building on urban infill parcels that are becoming increasingly scarce, and as such need to build bigger in order to maximize their profit. However, the data also show that homes that were built on owner-occupied lots (which are more likely to be built using modular techniques) were far more likely to be built outside of the MSA. In fact, approximately 28% of new houses constructed on owner-occupied land were built outside the MSA, which challenges the notion that modular construction is better suited for more urban areas that have more expensive labor markets.

Factory-Built Housing Supply Chains

When speaking with Midwestern CDCs, it becomes apparent that the presence of a thorough supply chain is crucial to the success of factory-built projects. In order to achieve the

potential cost reductions, it is important to have access to local manufacturers, dealers, contractors, and subcontractors that are familiar with using factory-built typologies. Figure 5 shows a map of the U.S. with concentrations of modular manufacturers and developers/contractors that have registered with the Modular Building Institute, a trade association that promotes modular construction.³⁴

Figure 5



Source: Modular Building Institute, “Find a Builder.”

Similar maps for SIPs producers and other professionals can be found at <http://www.sips.org/members/sipa-membership-maps>, courtesy of the Structural Insulated Panel Association, a trade association promoting the use of SIPs. The maps of modular and SIPs professionals indicate that there are still large portions of the Midwest where factory-built housing is inaccessible and uncommon.

Creative Design

The third and final innovation is “creative design.” Creative design can take many forms, but can best be defined as non-traditional design techniques that can be used in conjunction with smaller of factory-built housing to reach the most affordable price point. Some examples of creative design are as follows:

³⁴ Modular Building Institute, “Find a Builder.” Full, interactive map is available at https://www.google.com/maps/d/edit?mid=zIuplShsPUbw.k6KV_V2ktWng&usp=sharing

Accessory Dwelling Units (ADUs). ADUs are smaller, secondary units that accompany a larger, primary unit on the same parcel of land. ADUs can be built into an existing structure and utilize a separate entrance, or they can exist as stand-alone structures usually in the backyard of a single-family home. These structures are often also referred to as “granny flats,” “in-law units,” “alley flats,” and “backyard cottages.” ADUs offer an increased range of housing options in residential neighborhoods without disrupting that neighborhood’s fabric. Their smaller size tends to make them more naturally affordable and an attractive option to younger renters entering the market or older renters and “empty-nesters” who desire to downsize from their current housing. Attached ADUs can also yield cost savings from lower energy consumption, as attached units share walls and limit exposure to outside weather conditions.³⁵ Additionally, they can provide a source of rental income to the owners of the primary unit. However, many jurisdictions have zoning requirements that either substantially restrict or flat-out prohibit ADU development.

Cohousing. Cohousing describes an arrangement of smaller single-family homes in a development that shares amenities in order to save costs. The structure is quite similar to that of a multifamily condominium building with shared amenities, except for the fact that each unit is detached. For example, a cohousing development could forego guest rooms and washing machines/dryers in each home, but could provide a community building that included those amenities. This way, everyone in the development would have access to those amenities, but they could get away with providing fewer rooms and appliances and ultimately save costs. Economist Juliet Schor writes that, “...cohousing solve[s] the size dilemma particularly efficiently, by letting residents share spaces that are used only intermittently. Cohousing communities include guest rooms, pools, and other amenities that sit empty much of the time in McMansions. By combining resources, owners can obtain the benefits of large homes, but at a fraction of the cost.”³⁶ Schor also indicates that many larger items traditionally owned on an individual basis can be shared in these situations: “...Under certain conditions, sharing has clear efficiency benefits in comparison with exclusionary private possession. Sharing reduces material throughout, saves money for individuals, and builds community. Its benefits are greatest when individuals don’t need the goods all the time, up-front costs are high, usage does not degrade or personalize the item, and costs of operation or depreciation can be allocated to individuals (as with cars). On the other side of the ledger, shared ownership increases what economists call transaction costs – the time and effort of creating rules, setting up scheduling, and policing problems (although the internet has dramatically reduced these costs).”³⁷

³⁵ U.S. Energy Information Administration.

³⁶ Schor, 136.

³⁷ Schor, 138.

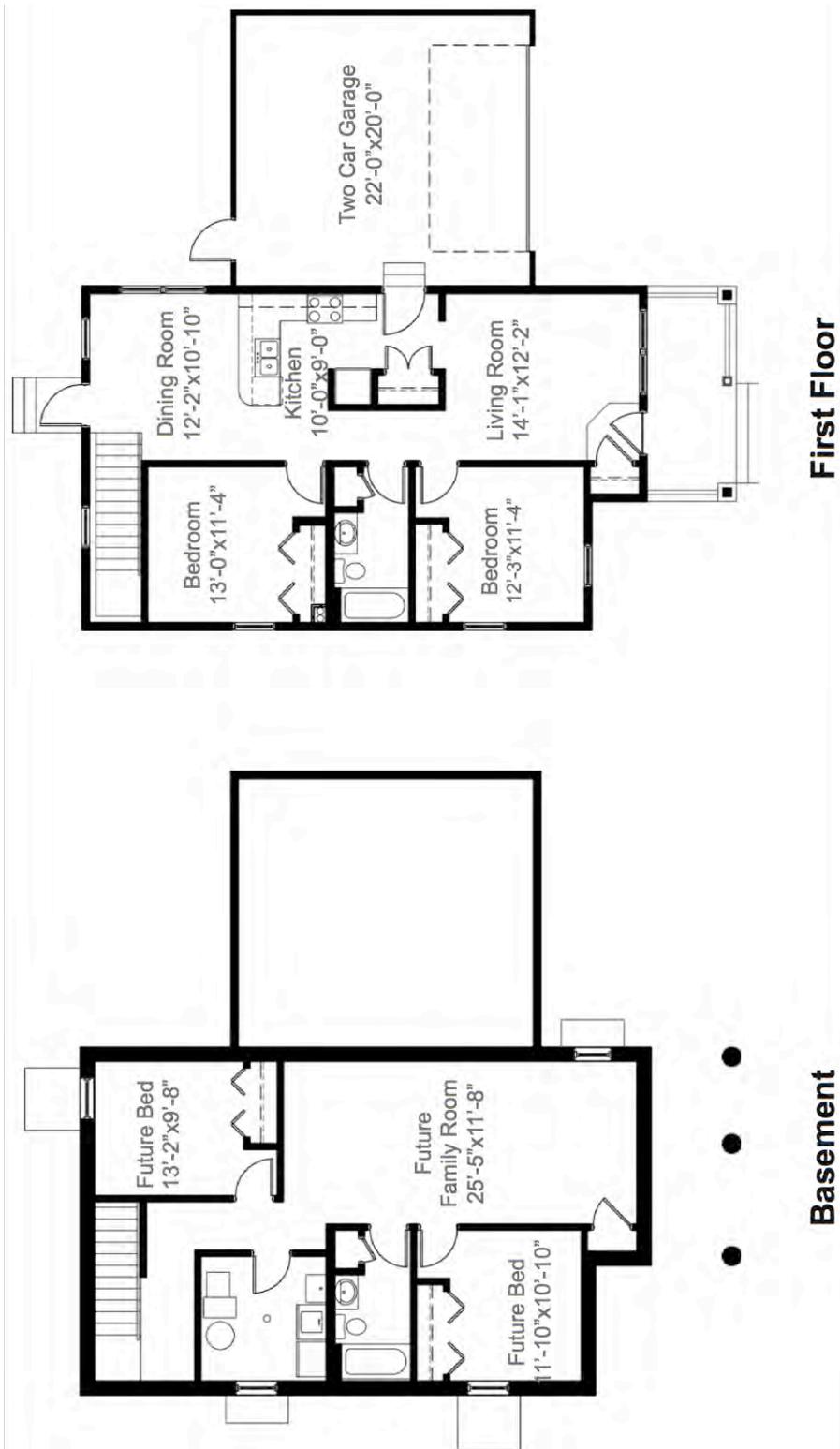
Cohousing can further reduce development costs by making more efficient use of land and utilizing economies of scale when constructing homes. However, it also requires larger parcels of land in order to make full use of these benefits.

While cohousing is a potentially effective way of bringing down costs, the idea of cohousing is somewhat incompatible with the traditionally held views of single-family home ownership. Most people purchase their own houses so that they can have complete autonomy over their homes. The idea of sharing this with others still has to gain traction, and it would be hard to market to many traditional prospective homebuyers.

Unfinished Space. Many CDCs are experimenting with providing housing that includes unfinished spaces, usually in the basement or attic in order to save on development costs. This space does not need to be finished to fully occupy and enjoy the house, but as the households grow in size and/or means, they can finish out the space in a way that most benefits them (extra bedroom, work space, etc.). This was also a technique employed in single-family homes built in Levittowns.³⁸ Figure 6 is a floor plan from SWMHP that exemplifies this principle. Despite seeing success with this practice, SWMHP recently had to start providing fully finished space throughout their houses due to a new Minnesota regulation prohibiting unfinished space.

³⁸ Gallagher, 37.

Figure 6



Source: Southwest Minnesota Housing Partnership

Easy Build-Outs. Some architects and developers are producing homes that are designed to more easily accommodate renovations and buildouts. For example, Bay Area architect Donald MacDonald has designed two-story “cottage” townhomes that locate the bedrooms on the first floor and the kitchen and common spaces on the second floor.³⁹ This way, if a family wants to add an additional bedroom they can do so by expanding the first floor only, rather than needing to expand both the first and second floors in order to support the expansion of bedrooms on the second floor.

Efficient Use of Space. Designing housing with efficient unit plans can allow for more useable square footage and thus make a smaller home feel more spacious and livable. This includes providing open floor plans so that occupants can arrange their spaces as they see fit. And if a design does not include a completely open floor plan, there are still other ways to make space more efficient, such as minimizing hallway space and locating stairs to the basement in the garage rather than using up living space (see Figure 7).

³⁹ U.S. Department of Housing and Urban Development

Figure 7



Source: Southwest Minnesota Housing Partnership

Replicability. Utilizing designs that can be built on parcels of varying shapes and sizes and subject to varying zoning codes can be difficult (if not impossible), but it can bring long-term costs down. Eliminating the need to design new houses for every project will cut out design costs for each development. This can be more easily achieved with smaller designs, as they can be more readily adapted to smaller and irregular parcels. However, community buy-in may be hindered if a house that is designed to fit on diverse lots does not match the existing fabric of different neighborhoods. Some CDCs such as CHWC have been exploring homes that are replicable and have the same internal floor plan while at the same time have a “flexible” exterior that makes it easy to conform to various neighborhoods. Creating home designs that include flexible exteriors can allow CDCs to diversify the appearance of their homes without changing

the structure of floor plans. This can also add curb appeal to developments with minimal cost increases.

Examples

This section of the paper aims to illustrate the experiences of different CDCs in developing small and/or factory-built housing. The first two examples are of CDCs that regularly build small and/or modular. The second two examples highlight newer prototype homes designs that were recently completed by CDCs. Each example offers details on how the production of these designs unfolded on the ground, how these experiences differed from the research around these typologies, and lessons learned throughout the development process.

Next Step US

Innovations: Small, Factory-built

Mission

“Next Step is the first and only national strategy and scalable approach to bring factory built homes to nonprofits nationwide. We aggregate demand for the factory built housing industry by organizing, brokering and training nonprofits on the Next Step System for doing business.”

Background

Next Step is a Kentucky-based organization that connects factory-built home producers with CDCs on a national scale to help those organizations efficiently develop factory-built affordable housing. Next Step works with CDCs to ensure that these homes are of a high quality, are energy efficient with the intention of improving affordability, and are available at wholesale pricing to member CDCs. They also help provide comprehensive homebuyer support so that homebuyers qualify for “the best fixed-rate home financing available.”⁴⁰ Next Step has 48 CDC members from around the country that utilize their network and expertise. Lessons explored in this section have been drawn from Next Step’s overall work, rather than one specific project.

Sample Project: The Brookdale

The Brookdale (Figure 8) is a modular home produced by affiliated builders and made available to network CDCs. The home is the median home size produced for Next Step members at 1,232 ft² and offers slight variation in room configuration. The price for the home varies by State and region due to varying codes and supply chains.

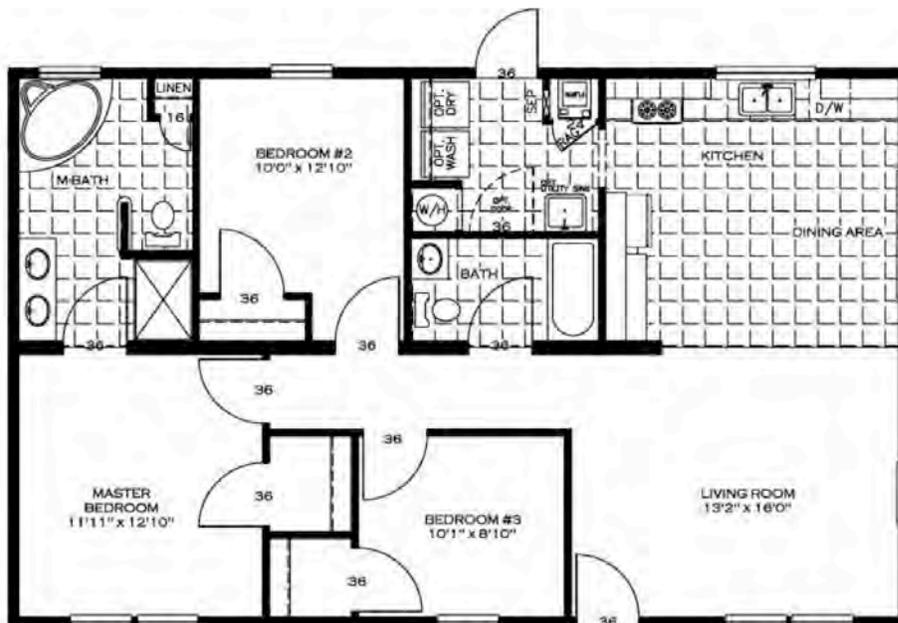
⁴⁰ Next Step

Figure 8



Source: Next Step

Figure 9



Source: Next Step

Bedrooms: 3

Bathrooms: 2

Open floor plan

Eat-in kitchen

Great closet space

ENERGY STAR construction

ENERGY STAR appliances

Manufactured Housing

It has been the experience of Next Step that manufactured housing is key to truly developing affordable housing without a subsidy. If CDCs work with Next Step to procure modular housing, they will ultimately need a subsidy on the development side. It remains true that manufactured homes are “currently – and for many years have been – the only market-produced, low-income housing option in the United States.”⁴¹ To illustrate the cost differences, take the two example homes above: while these two homes provide similar levels of space, functionality, and quality, the manufactured home can be produced for almost \$10,000 less than its modular counterpart. This affordability stems from the simpler design, and approval under a federal HUD code rather than varying local and state regulations.

On average, manufactured housing is also much more energy efficient and than stick built homes due in part to their naturally smaller size (a result of transportation constraints).⁴² Next Step also places their homes on permanent foundations “in order to qualify the home owner for certain government-backed mortgage programs, which are less expensive than a chattel product which is the only financing option if land is not owned along with the home. Next Step estimates it has saved its 173 home buyers approximately \$16.1 million in interest payments.”⁴³

However, negative perceptions around manufactured housing are hugely detrimental to the production of manufactured housing by CDCs. Many low-income potential buyers are reluctant to live in manufactured housing due to the negative perceptions and out of a fear of being stigmatized. Likewise, existing communities are often opposed to new manufactured housing development out of a fear of perceived undesirable elements and decreasing property values.

Modular Housing

Despite the theoretical benefits of smaller housing, Next Step has discovered that simply decreasing the footprint for modular homes doesn’t reduce costs without producing the homes at a much greater volume. In fact, requesting a smaller house size than what is currently being produced by the market for a small number of homes can be more expensive than buying larger homes sized by the market. Because the market is demanding increasingly large houses, the modular housing producers that Next Step works with are producing larger homes to meet that demand. If those modular producers get an order for smaller homes, they will have to significantly alter their assembly procedure to accommodate the new size. When this happens, the variation drives the cost of these homes up, making them more expensive than larger

⁴¹ Milkman

⁴² U.S. Energy Information Administration.

⁴³ Berlin

homes. Smaller homes are only cost effective to produce in these settings if a CDC can place a large enough order (which is unlikely given funding constraints) or if market preference shifts towards smaller houses (which has not been the case since 2010). Next Step finds that in most markets CDCs are not adopting small designs.

Communication

Next Step also stresses the importance of communication between CDCs and modular producers, as well as Next Step's role in fostering that communication. Misconceptions and misunderstandings between these stakeholders can have negative consequences that result in higher costs, so it is important to have an organization like Next Step that is well versed in both industries to mediate and effectively translate the needs of both parties. Next Step provides the knowledge necessary for CDCs to have realistic expectations for modular housing and to build them effectively and efficiently. For example, CDCs often go into the process thinking that they want every green feature possible but they do not have a strong enough sense of the affiliated costs. When Next Step explains that these features are going to be well out of the price range the CDCs usually back down. It is important to have an organization at the table with the experience and expertise to understand these concepts, and their presence can save CDCs substantial time and headaches during the predevelopment phase. Next Step has also experienced supply chain issues and complications with top national modular producers and can help CDCs avoid these pitfalls or notice any red flags.

Southwest Minnesota Housing Partnership (SWMHP)

Innovations: Small, Factory-built, And Creative

Mission

The Southwest Minnesota Housing Partnership is a non-profit community development corporation serving thirty counties in rural Minnesota. We aim to build strong and healthy places to live so that the communities of our region thrive.

Background

The Southwest Minnesota Housing Partnership is a CDC that offers a wide range of housing and community development services in rural Minnesota. SWMHP builds affordable housing, helps to provide low-interest mortgages and closing cost assistance to low-income potential homebuyers, rehabilitates older homes and commercial properties, and provides "development expertise to support local governments, businesses, school districts, community action agencies, and other service providers in their efforts to meet local housing needs."⁴⁴ Since 1992, SWMHP has constructed 271 affordable single-family homes, rehabilitated over 4,000 homes

⁴⁴ Southwest Minnesota Housing Partnership, "What We Do."

and rental housing units for low-income families, provided education, counseling, and financial resources to over 6,000 households, and assisted in the creation and preservation of significant affordable housing developments.⁴⁵ They have experimented with modular and panelized construction typologies and are adept at developing creative and efficient housing designs. They employ in-house architects and an in-house general contractor in order to contain costs and operate as efficiently as possible. Lessons explored in this section have been drawn from SWMHP's overall work, rather than one specific project.

Sample Projects: The Rambler

The Rambler is a single-family home constructed by SWMHP. The home is 1,092 ft² on the main floor and contains another 1,092 ft² of unfinished basement space that can be converted into living space or additional bedrooms at a later date. SWMHP also offers this design with a storage crawlspace and utility room/shelter instead of a basement and space for a patio addition (Figure 7). The home pictured below was constructed in 2014 with an asking price of \$153,900.⁴⁶



Figure 10

Source: Southwest Minnesota Housing Partnership

Bedrooms: 2

Bathrooms: 1

Attached two car garage

Unfinished basement for future expansion of bedrooms or family space

Basement storage space

⁴⁵ Southwest Minnesota Housing Partnership, "How We Help."

⁴⁶ Southwest Minnesota Housing Partnership. "Home for Sale in New Ulm: 612 Pfaender Drive."

Integration

The integration of different disciplines within CDCs is crucial. Employing staff architects and an in-house general contractor will enable CDCs to get to the most affordable price point, especially when working with factory-built housing. Being able to utilize the same professionals on every job who have an intimate knowledge of and familiarity with the relative designs and technology will increase efficiency and dramatically reduce the risk of mistakes and setbacks.

Learning Curve

While modular technology has been around for a long time, the construction industry is always changing and as such presents constant learning curves for CDCs. These learning curves are often steep, but it is important to follow through on innovative ideas. The process will become easier, more efficient, and cheaper with each pass, so it is important to not give up on an innovation if it is not as successful as predicted on the first attempt. These first attempts are investments, and only when CDCs follow-up and continue to work towards the goals will the savings be realized. It is also important to share any informative experiences or best practices with other organizations that are interested in pursuing similar innovations. Providing CDCs with the lessons learned from a project can help others avoid certain mistakes or pitfalls. Open communication is paramount. An important step in developing open communication is establishing concrete definitions around small, factory-built, and creatively designed housing. Speaking a common language will get all parties involved on the same page and help CDCs pursue complex innovations. Addressing misconceptions will also help CDCs find the most appropriate direction forward and avoid unnecessary pitfalls.

Efficient Design

Design that successfully makes efficient use of space is key, especially when designing smaller houses. Many homebuyers still want larger homes, so efficient designs can make smaller houses seem less constricting and more attractive. James Arentson, a staff architect at SWMHP notes that, “You don’t live in a hallway, so take it out of the design.” Eliminating inefficiencies in the floor plans can provide just as much *living* space as a larger home. Other design efficiencies that SWMHP employs include:

- Putting stairs to the basement in the garage rather than in the home itself. This maintains living space that would otherwise be lost.
- Providing a crawlspace instead of a basement. This both saves money during construction and adds living space by eliminating the need for basement stairs altogether.
- Adding a vaulted ceiling to a small house can make the home seem much bigger at a minimal cost increase.

Modular Potential

SWMHP believes that modular housing can be cost effective, but has learned that setting modules in place is highly complicated and there is much more to consider relative to constructing traditional stick-built housing. The primary lessons that SWMHP has learned while working with modular are:

- Building a larger volume of adjacent modular homes (or multifamily properties) will result in cost savings on the construction side. SWMHP has found that their costs decrease when they build more than five homes at a time. However, this can present additional complications, such as making sure there are enough buyers and coordinating with them to make sure that they can all move in around the same time.
- Modular homes delivered to the site can have imperfections, and these imperfections are harder to address than imperfections discovered throughout the process of stick-building a house on site. SWMHP has received modules that have arrived with cracks around the joints, presumably from the transportation process, and it was costly and time consuming to have them repaired, especially given the amount of finishing work that had already been completed. If they are sent back or repaired on site, this takes additional time and cuts into the cost savings associated with a shortened construction period. Additionally, there was a dispute between the manufacturer and SWMHP as to who should be responsible for the repairs. As such, it is paramount to address responsibility and accountability in the earliest stages of working with providers. This way if there are problems with modules when they arrive on site there will be a clear procedure to follow and CDCs can avoid any disputes over accountability.
- Developing ongoing and communicative relationships with modular builders, architects, general contractors, and subcontractors is crucial to realizing cost savings. SWMHP has had numerous experiences in which these groups did not properly communicate, and as a result the project costs exceed their predictions. In one case, the architects and builders of modules had taken into consideration the space required to house the plumbing, heating, and electrical mechanism within the structure of the modules, but had not appropriately taken into consideration the space required for subcontractors to install those mechanisms. It was also unclear in what order these mechanisms were to be installed, requiring subcontractors to return to the site multiple times, slowing down construction and driving up costs. More egregiously, SWMHP has worked with modular providers that were late on building the ordered modules by months, leaving the job site half-completed and exposing it to elements that theoretically should not affect modular construction. SWMHP has since established a strong relationship with a different modular provider, one with open communication and regular meetings throughout the design phase that involve their in-house architect and general contractor. This relationship ensures that major problems or concerns can be addressed before they become too costly.

- If onsite staff is not familiar with modular construction, it is important to find third party firms to act as the “middle man” between the CDC and modular provider throughout the design process. They will have an accurate sense of whether or not the design will work onsite. SWMHP also argues that there is a need to increase the prevalence of regional job training programs in order to address the current labor shortage, and also to improve these job-training programs to include more training with modular construction.

Community Housing of Wyandotte County (CHWC)

Innovations: Small, Factory-built, and Creative

Mission

CHWC’s mission is to revitalize, stabilize and reinvest in Kansas City, Kansas neighborhoods through new and improved housing, homebuyer education and counseling, as well as community building & organizing initiatives; all of which improve the quality of life for the residents of Kansas City, KS.

Background

Community Housing of Wyandotte County is a Kansas City, KS based CDC that builds and preserves affordable single-family homes, provides financial counseling and homebuyer assistance, and supports the creation and maintenance of local parks, community gardens, art programming and community gatherings. CHWC has an in-house general contractor to construct their affordable homes, and recently they have been exploring smaller, factory-built options as a means of lowering development costs. Lessons explored in this section have been drawn from a specific development undertaken by CHWC.

Sample Project: 423 Armstrong St., Kansas City, KS

Architect: Clockwork Architecture + Design

Figure 11



Source: Community Housing of Wyandotte County

Bedrooms: 2

Bathrooms: 2

Square feet: 1,107

Total Development Cost: \$215,607

Sale Price: \$159,900

Development Subsidy: \$65,000 (grant)

Construction Typology: SIPs (first floor), Stick Framing (roof)

Figure 12

2013 ACS 5-Year Estimates				
	State	County	City	Tract
Population	2,868,107	158,348	146,581	788
Median Income	\$51,332	\$39,402	\$38,293	\$9,889
Owner Occupied Housing	67.52%	60.26%	59.50%	3.79%
Detached Single Family Homes	72.66%	70.40%	70.44%	14.85%
Median Owner Occupied House Value	\$128,400	\$93,800	\$90,400	\$101,600
Homeownership Expenses as % of Income	18.20%	22.00%	22.10%	25.80%
Median Gross Rent	\$732	\$740	\$740	\$246
Rent as % of Income	28.10%	31.70%	32.00%	27.20%

Source: American Community Survey

Overview. 423 Armstrong (Figure 11) is the first single-family home constructed using Structural Insulated Panels (SIPs) by Community Housing of Wyandotte County (CHWC). The home was constructed in 2015 on a small infill lot in an urban residential neighborhood (Strawberry Hill) in Kansas City, KS. The project was intended as a means of producing “Sustainable Workforce Housing” and is seen as a starting point for CHWC to pursue SIPs construction in the future. The development costs exceeded predictions, and this house fell short of the goal of being affordable to first-time homebuyers without a subsidy, but CHWC is confident that the lessons they learned from this development can be used to generate these houses at a lower cost in the future.

The house itself consists of a single finished floor with an open-floor style plan. There are two bedrooms and two bathrooms. The second floor is unfinished and as such can eventually be converted into more living space, an office, third bedroom, etc. This also cuts down on development costs and upfront costs to homebuyers.

CHWC decided to use SIPs rather than full-modular construction because they could not find a modular builder close enough to the site to make shipping the modules feasible and affordable. The SIPs were shipped in from Arkansas (there were closer manufacturers, but the contractor already had a relationship with this particular supplier). They believe that “a flat-packed, site assembled housing stock” made the most sense for this project and that using SIPs could also result in lower energy costs for the homebuyer. Stick framing was used for the roof due to the perception by the contractor that the manufacturer would not be able to produce the SIPs for the roof in their given timeframe and that a stick-built roof would be less expensive (this turned out not to be the case).

Goals. One goal of the project was to achieve either better performance at a comparable price, or comparable performance at a lower price (relative to the other homes which they produce). Either way it would result in cost savings for the homebuyers, either up front or over the lifespan of the house. As part of the goal of reducing cost and/or improving performance, CHWC wanted to build a smaller house that would save homeowners money on utility costs throughout the year, and hopefully be less expensive to construct.

CHWC also wanted the design to be adaptable for historic neighborhoods. Much of Kansas City is categorized as historical, and as such the design of homes needs to match the existing neighborhood fabric, regardless of the newer construction typology. In order to make the house fit these parameters, the design of the house needed to be easily manipulated and customized without drastically altering the overall layout or internal features of the home. Doing so would enable the house to be built in varying neighborhoods without substantially increasing costs each time a house is constructed in a new neighborhood. Likewise, the house should also be adaptable to the different types of potential buyers in Kansas City. This could include first time homebuyers, retirees who want to downsize, etc.

Positive Outcomes. The project is generally seen by CHWC as successful for a first pass using SIPs. On average, CHWC can build a traditional stick-built house in six months, and they currently build between six and ten single-family homes every year. This particular house ended up taking only three months to construct (not including pre-construction delays), which leads CHWC to be optimistic that using SIPs as a common construction typology can potentially stabilize their construction cycle. Generally, it is difficult to determine when CHWC will be able to sell their homes in the current market. It is a hope of CHWC that using SIPs as a form of construction will make the process/construction cycle more predictable and manageable. A shorter construction time will let CHWC produce at a higher volume for less while also becoming less susceptible to volatility caused by weather and changing land, labor, and materials costs.

According to Brennan Crawford of CHWC, the building envelope is much tighter than traditional stick-built construction, and the lack of studs interrupting the insulation makes the walls less susceptible to thermal bridging. The R-value for these particular SIPs is 27, compared with the R-value of 13 that is standard for their stick-built homes. The home is also much better insulated with regards to outside noise, though the vaulted ceilings and unfinished second floor do create an echo in the house.

The home, despite having a higher price due to the higher development costs “would be affordable to a family of 3 at 80-100% AMI with typical debt ratios, particularly given the projected lower operating costs.”

Challenges. While SIPs are well-known and common in certain regions, building with them in markets such as Kansas City can prove to be much more difficult. While the existing literature regarding SIPs argues that the decreased construction costs will more than offset the increased materials cost, this has less of an impact in areas where SIPs construction is uncommon. For this development, the construction costs amounted to \$113/square foot, while an identical house built using traditional stick-built framing would cost only \$110/square foot to construct.

Brennan Crawford describes their biggest challenge as being “just simply the supply chain, from the materials perspective to the perspective of finding a contractor that was comfortable and accustomed to installing SIPs. So it was tough to get the bids upfront, because it’s not a system that most residential builders work with. And especially when you’re in a market where you have lots and lots of small builders... the labor savings really didn’t materialize in the way that the literature would predict.” CHWC has an in-house general contractor, but they ended up deciding to hire an outside general contractor that was familiar with SIPs. As previously mentioned, they also had a serious setback when their first SIPs provider reneged on their initial contract.

There were also substantial challenges that resulted from the specific plot used for this development. CHWC estimates that if they were to build this house again on a site without these issues, it would cost them approximately \$25,000 less than the final cost for this project.

Lessons Learned/Future Prospects. While not sure if they will rebuild this particular design, CHWC is positive that they will continue to pursue SIPs as a construction typology for their single-family homes. They have had “quite a bit of interest” in this design, and they are confident they could reproduce it using their in-house builders for a much lower cost than the cost of this prototype. The primary cost savings would come from the fact that they would be reusing the existing design and thus eliminating the design costs associated with this project, and also building the house themselves as opposed to using a local contractor. This would save them approximately \$47,200. Ultimately, CHWC believes that if they were to build this house on the exact same lot a second time, it would cost \$165,665, well below the as-built cost of \$215,607. There were also unusual costs associated with this lot, and CHWC estimates that if they were to build this house on a more traditional lot the cost would be \$140,630. However, this is still more than the estimated \$134,076 it would cost to produce the same house using traditional stick-built framing.

Brennan Crawford also believes that developing new relationships and gaining experience with this construction typology will eventually lower construction costs as builders get more comfortable and efficient with SIPs. “And then the other way that I think that costs could be reduced further would be if we’re building 2 or 3 of these things at a time, we essentially save some of the shipping costs and possibly even some of the production costs from the SIPs themselves...” Says Crawford. “And then finally, again depending upon the scale, if we can actually reduce our construction timeline by a couple months, then we save a couple of months of interest, a couple months of maintenance and mowing, and essentially just accelerate our production schedule, so there’s enough opportunity both to reduce cost and to do more volume in a given time period.”

In the future, CHWC would also stick to SIPs for the roof construction, as mixing construction typologies proved to be more costly than anticipated, but they would consider using a “prefabricated truss system” for the roof. They are also exploring how some of their existing stick-built plans could be modified for SIPs construction.

Crawford also stresses the importance of having an in-house contractor (especially one familiar with using SIPs) when attempting to contain costs. CHWC’s in-house contractor was new to using SIP technology, which meant they needed to hire subcontracts. However, as the market for subcontractor’s familiar with using SIPs is quite thin in the Kansas City area, the bidding process took longer than anticipated and did not result in low enough bids, prompting CHWC to hire an outside general contractor to supplement the work of the in-house general contractor. CHWC also experienced issues with this outside general contractor, including the contractor drastically raising costs on the final invoice (by around \$20,000). CHWC was still contesting these fees as of August 2015.

Through this process, CHWC has determined that strong relationships with all parties involved is one of the biggest requirements for successful modular and panelized construction. CHWC also recommends allocating plentiful time when pursuing new technology or construction

methods to avoid as many costly mistakes as possible. Likewise, they recommend that CDCs pursue experienced SIPs architects and an integrated services package if possible. This will help to reduce the learning curve for CDCs new to these techniques.

NeighborWorks New Horizons (NWNH)

Innovations: Small, Creative

Mission

Through partnership and collaboration, NeighborWorks New Horizons creates homes, builds communities and revitalizes neighborhoods where families and individuals can enjoy a better quality of life.

Background

NeighborWorks New Horizons is a CDC that strives to achieve economic stability for residents in the New Haven CT region. NWNH develops affordable rental properties and affordable homes for purchase. They act as their own property manager and supplement their affordable housing construction with community-wide programs, including first time homebuyer education, budget coaching, renter readiness training and foreclosure prevention tips. NWNH also hosts after school and summer camp programs for their tenants. Lessons explored in this section have been drawn from a specific development undertaken by NeighborWorks New Horizons.

Sample Project: 179 Scranton Street, New Haven, CT

Architect: Yale School of Architecture



Figure 13

Source: Yale School of Architecture/NeighborWorks New Horizons

Primary Unit:

- Bedrooms: 1
- Bathrooms: 2
- 500 ft²

Secondary Unit:

- Bedrooms: Studio
- Bathrooms: 1
- 300 ft²

Construction Hard Costs: \$220,000

Sales Price: \$155,000

Subsidy: Donations (design, materials, and labor)

Construction Typology: Stick-Built

Figure 14

2013 ACS 5-Year Estimates				
	State	County	City	Tract
Population	3,583,561	862,611	130,338	3,986
Median Income	\$69,461	\$61,996	\$37,428	\$30,230
Owner Occupied Housing	67.82%	63.71%	31.07%	20.48%
Detached Single Family Homes	59.32%	53.74%	20.97%	11.85%
Median Owner Occupied House Value	\$278,900	\$256,900	\$209,300	\$114,700
Homeownership Expenses as % of Income	23.80%	24.50%	26.60%	40.40%
Median Gross Rent	\$1,056	\$1,060	\$1,090	\$1,040
Rent as % of Income	31.80%	36.90%	34.20%	41.60%

Source: American Community Survey

Overview. This three-story house (Figure 13) was designed for NeighborWorks New Horizons (NWNH) by first year architecture students at the Yale School of Architecture as part of their coursework. The house makes use of a smaller size and creative design and was constructed on a small infill lot in an urban residential neighborhood in New Haven, CT. The Yale students that designed the home also donated their labor to help construct the home over a summer. This home is most notable for a design that enables multiple configurations of the interior space. The structure contains two units: the primary unit consisting of approximately 500 ft² over the

first and second floors, and the accessory unit on consisting of approximately 300 ft² on the third floor. These two units are separately by wall space that can be converted into a door with relative ease. As such, the two units can remain distinct or be converted into one 800 ft² unit. The intention behind this design was that the house could flex to meet the occupants' changing needs over the life of the house. See Figure 15 for an example of the different possible configurations over time.

Figure 15



Source: Yale School of Architecture/NeighborWorks New Horizons

NeighborWorks New Horizons explored using a modular construction typology for the house using a Massachusetts-based producer, but found that it would be too expensive.

Goals. NeighborWorks New Horizons had a number of different goals for this project. First, they wanted to develop a “microhome” available for a buyer in New Haven. This concept had been gaining traction and they wanted to see if it could be successful in the New Haven market. They wished to attract new and different buyers who might not have access to existing homeownership opportunities. This could include young couples, elderly residents who wished to downsize, environmentally minded residents, or other low-income potential buyers. NWNH wanted the footprint to be small enough that the house be easily replicated on smaller and

irregularly shaped infill lots in New Haven where larger homes would be more difficult to build. And lastly, it was the hope that buyers who moved into the larger unit could use the second unit to provide supplemental rental income.

Positive Outcomes. The design of the house is very popular and has mostly been regarded as a success (though at least one NWNH board member was initially concerned that the house wasn't "micro" enough). The house can be adapted to meet different or fluctuating needs, which is important for the longevity of the house. Additionally, the interior of the house is designed to make as efficient use of the limited space as possible. The interior also offers plenty of light and doors on the first floor that can be opened up onto the patio, giving the space the feel of a larger house.

The small footprint of the house also helped save costs. The lot, which had been purchased by NWNH for \$1,000 from the Livable City Initiative (New Haven's neighborhood anti-blight agency),⁴⁷ previously contained a house on the front of the lot that had been demolished, but the foundation was still mostly intact. Because the footprint of this house was so small, NWNH could locate the house on the back of the lot and avoid a costly excavation of the original foundation. The area of the lot that contained the original house now acts as an extended front yard and garden, complete with low-maintenance native plantings. NWNH has also stated that the general design can be easily modified to fit other irregular parcels. The fact that the square footage of the house was distributed vertically also means that less roof space will reduce sun exposure and the need for cooling in the summer.⁴⁸

The house can provide rental income and alleviate the burden of high homeownership costs. This is crucial in a neighborhood where homeownership costs typically exceed 40% of the owners' income.

Lastly, the neighborhood embraced the design and development of vacant lot. They were excited to see new housing built in their neighborhood and provided input throughout the development process. While the house is taller than some of its neighbors, it does not substantially interfere with sunlight due to its lot placement and smaller footprint. Some other adjacent buildings have similar heights, which helps the house blend into the existing urban fabric.

Challenges. Unfortunately, this house did not meet the level of affordability envisioned by NWNH. The construction hard costs totaled \$220,000, given the inexperience of student builders and higher-quality building materials (a local builder estimated that they could build the same house with more standard materials for \$135,000). The Livable City Initiative (LCI) provided the subsidy that made up the difference between development cost and the sales

⁴⁷ Appel

⁴⁸ Owen, "Green Metropolis," 206.

price.⁴⁹ A young professional purchased the house within a few months of it coming on the market for \$155,000, a price designed to serve residents at 100% of the Area Median Income. The tenant currently uses the accessory unit as a studio where she works as a landscape architect, so the second more affordable unit is not yet available to renters. NWNH acknowledged that renting out space can be costly, time consuming, and stressful, especially for first time homeowners/landlords. There were also potential owners who did not pursue purchasing the home due to its lack of handicap accessibility.⁵⁰

One primary challenge to making this home affordable was the presence of the second kitchen and full bathroom required to allow the third floor to exist as a standalone unit. Kitchens and bathrooms represent high fixed costs, so building two of each drove up the total development cost significantly. The two kitchens, and to a lesser extent the bathrooms, could also be redundant if one family is occupying all three floors simultaneously. Most homes only have one kitchen, so to have two kitchens within 800 ft² does not make for the most efficient use of the space. The presence of the second kitchen could even present safety concerns if the third floor is occupied by or acts as play space for younger children.

Another impediment to affordability was the high construction cost for this house, a cost that would have been even higher if not for the in-kind labor donation from the Yale School of Architecture students. NWNH explored the possibility of employing a modular construction technique, but the price they were quoted by a Massachusetts-based supplier exceeded the stick-built projected cost.

Lessons Learned. The primary lesson that NWNH learned from the experience was that the potential buyers that were interested in the house were by and large not the potential buyers they had been anticipating. Multiple interested buyers did not meet the income restrictions for the home, and NWNH found that local residents that were more interested in the home were existing homeowners looking to downsize rather than first time homebuyers. They are still trying to figure out the market for these homes, but this project has helped them narrow their focus.

They are also smarter about working with students on these types of projects and will pursue working with them again in the future. While the students' donated labor reduced construction costs, their lack of construction experience led to inefficiencies that substantially drove up costs. NWNH is now better equipped to manage a group of students with little experience to produce a final product more efficiently. Similarly, due to Yale's involvement many materials were of a higher quality than NWNH would traditionally use for their homes. In the future the costs could come down by using less expensive materials.

Despite the high construction costs, NWNH is confident that the lessons they have learned will help them move forward in replicating this house or a slightly larger (approximately

⁴⁹ Appel

⁵⁰ Appel

1,000 ft²) Yale-designed house elsewhere in New Haven. They have received a grant that will enable them to build seven more for an estimated total construction cost of \$135,000 each, to be sold to buyers at or below 100% of the Area Median Income.⁵¹ The first of these houses sold in the fall of 2015 for \$155,000.⁵² This lowered cost was achieved by removing the second unit, using less costly materials, and building in greater volume. They have made minor adjustments to the original design to improve efficiency and affordability in the new homes, but the new homes will still be adaptable to smaller and irregular lots. Land for these homes will similarly have been purchased from LCI for \$1,000 or donated by large banks that had held the lots in their portfolios but hadn't been able to sell them. Wells Fargo has donated a number of lots that will be used for these upcoming developments.

Conclusions

Cost Savings Hard to Realize in Practice

The primary takeaway of this project is the idea that these techniques are not (or at least not yet) silver bullets for solving the housing affordability crisis in the Midwest. These techniques can be helpful, either on their own or in conjunction with other techniques, but they do not guarantee lower development costs. While the research on each technique indicates that they can theoretically cut costs, achieving those reductions on the ground is much more complicated than the research indicates. Organizations, architects, and contractors with little to no experience dealing with these construction techniques are susceptible to a significant learning curve, resulting in delays and cost increases. The predicted development cost savings that these techniques would provide are mainly rooted in their shortened construction period, so complications can easily lead to no cost savings or cost overruns. These projects are manageable, but it is necessary for all stakeholders to have experience using these techniques and/or be in constant communication with those that do. It is important for CDCs to be diligent and critical at every step in the process if they wish to realize the desired cost savings, and as they and their partners gain this experience it is possible that these innovations will eventually lead to lower development costs. There is no universal formula for how to make these homes more affordable, so it is crucial that CDCs have a strong sense of the market and supply chain in their region, and are in open communication with organizations that have experimented with these techniques in the past.

Likewise, markets are unique and can necessitate different combinations of techniques and different volumes. A larger volume of production will help CDCs save on development costs, but this is often difficult given the limited scope and resources of non-profit developers. Factory-built houses are not cheaper if only a handful is being produced at a time, especially if they are not identical to the homes producers construct for for-profit developers. Similarly, if the

⁵¹ NeighborWorks New Horizons

⁵² Stannard

scale stays small local contractors will not develop the experience with these techniques necessary to effectively realize cost savings. Smaller and more creatively designed homes present similar problems if contractors and architects are not used to working with these typologies. Ideally, as CDCs and their partners gain experience, their development costs will decrease, potentially allowing them to increase the volume of their production.

Communication

Building strong, positive, communicative relationships with different organizations and stakeholders at every step of the process is absolutely paramount to successfully containing costs in affordable home production. CDCs need to be in constant contact with modular providers, architects, general contractors, subcontractors, planners, potential homebuyers, and any and all other stakeholders. Without these communicative relationships, it is highly unlikely that any innovations we yield substantial cost savings, and it is much more likely that non-communicative experimentation with new techniques and typologies will actually result in much higher costs than traditional construction techniques. Furthermore, CDCs should be in contact with one another to avoid any potential pitfalls that some organizations may have already experienced. CDCs are invested in learning; mistakes are made while building prototypes, but these mistakes can inform others who are exploring new techniques. It is crucial to learn from each other and share best practices so that the knowledge obtained from making mistakes does not go to waste. This could come in the form of a network, publication, membership organization, etc. In 2015 the Midwest NeighborWorks office held a convening of CDCs that have experimented with these techniques (or are considering exploring them) in order to share lessons and best practices, ask questions, and build relationships. This should be a recurring event. They are also implementing an annual award program for successful projects that utilize these innovations, which could be a useful way for industry professionals to learn about best practices. There are steep learning curves associated with these innovations, but it is important for CDCs to work together and be persistent if they are to realize the potential cost savings.

Changing Perceptions

For each of the three categories explored in this paper, changing the perceptions of potential homebuyers could lead to increased affordability. While a shift in perceptions leading to more accepted forms of affordability is mostly speculative, developers constantly indicated that current perceptions can still hinder the proliferation of these construction techniques, even if all the aforementioned construction issues are addressed. Studies indicate that smaller housing is significantly under supplied,⁵³ but if the broader housing market doesn't adopt these techniques, it will be much harder for the non-profit sector to get to scale or develop the experience necessary to realize cost savings. Trends leading toward decreased home sizes in the general

⁵³ Ziegler

market could make smaller, more affordable homes more logistically and financially feasible for production by CDCs. It could also make these homes more acceptable from the perspective of potential buyers who are worried about sticking out in their neighborhood and being stigmatized due to their residence in affordable housing. Similarly, manufactured housing is much more cost effective than other types of modular and stick-built housing without lowering the quality, but negative perceptions of this style of housing can stigmatize residents, deter potential buyers, and provoke opposition from neighbors. Local residents may see manufactured homes as a problem and worry about their own property values. Reducing the stigma of these homes could increase affordable solutions for developers that want to build without a development subsidy. Shifting notions of homeownership can make non-traditional housing arrangements, such as cohousing and ADUs more palatable to a wider audience. Similarly, as potential homeowners warm to non-traditional housing design, unfinished space, or other innovations, these cost saving options will have the chance to grow more prevalent. However, these perceptions have long been ingrained in the culture of homeownership in the United States, and will be incredibly difficult to influence. Changing perceptions will take time but could ultimately allow for forms of affordability that today already exist, if only primarily toward the margins of housing development.

Bibliography

Aschbrenner, Joel. "This chart explains Des Moines' housing recovery." *The Des Moines Register*, May 20, 2016.

<http://www.desmoinesregister.com/story/money/business/development/2016/05/20/chart-explains-des-moines-housing-recovery/84326016/> (accessed November 13, 2016).

Appel, Allan. "McMansion of Micro-Houses' Debuts." *New Haven Independent*, October 3, 2014.

http://www.newhavenindependent.org/index.php/archives/entry/micro_mcmansion_debuts/ (accessed November 13, 2016).

The Associated General Contractors of America. "2015 Worker Shortage Survey Analysis."

https://www.agc.org/sites/default/files/Files/Communications/2015_Worker_Shortage_Survey_Analysis.pdf (accessed November 13, 2016).

Badger, Emily. "Why it seems impossible to buy your first home." *Washington Post*, March 22, 2016. <https://www.washingtonpost.com/news/wonk/wp/2016/03/22/why-it-seems-impossible-to-buy-your-first-home/> (accessed November 13, 2016).

Berlin, Loren. "From Stigma to Housing Fix: The Evolution of Manufactured Homes." *Lincoln Institute of Land Policy*, July 2015. <https://www.lincolninst.edu/publications/articles/stigma-housing-fix> (accessed November 13, 2016).

Capps, Kriston. "Every Single County in America Is Facing an Affordable Housing Crisis." *CityLab*, June 18, 2015. <http://www.citylab.com/housing/2015/06/every-single-county-in-america-is-facing-an-affordable-housing-crisis/396284/> (accessed November 13, 2016).

Capps, Kriston. "The Recovery Is Super-Sizing Houses." *CityLab*, August 3, 2015.

<http://www.citylab.com/housing/2015/08/the-recovery-is-super-sizing-houses/400094/> (accessed November 13, 2016).

Cook, Miki, and Doug Garrett. "Green Home Building." (2015).

Gallagher, Leigh. *The end of the suburbs: Where the American dream is moving*. Penguin, 2014.

Hartman, Mitchell. "Construction workers needed as building industry booms." *Marketplace*, June 1, 2016. <http://www.marketplace.org/2016/05/31/world/construction-workers-needed-building-industry-booms> (accessed November 13, 2016).

Holland, Gale. "L.A. is seizing tiny homes from the homeless." *Los Angeles Times*, February 25, 2016. <http://www.latimes.com/local/lanow/la-me-ln-tiny-houses-seized-20160224-story.html> (accessed November 13, 2016).

Marshall, Aarian. "America's Increasingly Large Homes Are Making Us Less Energy Efficient." *CityLab*, November 16, 2015. <http://www.citylab.com/housing/2015/11/americas-increasingly-gigantic-homes-are-making-us-less-energy-efficient/416139/> (accessed November 13, 2016).

May 8 Consulting. "Going Mod: Reducing Housing Costs in Philadelphia with Modular Construction." http://www.may8consulting.com/publications/Going_Mod.pdf (accessed November 13, 2016).

Milkman, Arielle. "The Tiny House Fantasy." *Jacobin*, January 19, 2016.

<https://www.jacobinmag.com/2016/01/tiny-house-movement-nation-tumbleweed-environment-consumerism/> (accessed November 13, 2016).

Modular Building Institute. "Find a Builder." <http://www.modular.org/Finder/Default.aspx> (accessed November 13, 2016).

Modular Building Institute. "Why Build Modular?" http://www.modular.org/HtmlPage.aspx?name=why_modular (accessed November 13, 2016).

NeighborWorks New Horizons. "News." <http://www.nwnh.net/index.php/what-s-up/> (accessed November 13, 2016).

Next Step. "About Next Step." <http://www.nextstepus.org/aboutusoverview.htm> (accessed November 13, 2016).

Owen, David. *Green Metropolis*. EGEA spa, 2014.

Owen, David. "Greenest Place in the U.S.? It's Not Where You Think." *Yale Environment* 360, October 26, 2009. http://e360.yale.edu/feature/greenest_place_in_the_us_its_not_where_you_think/2203 (accessed November 13, 2016).

Schor, Juliet. "Plenitude." *The New Economics of True Wealth*, New York (2010).

Southwest Minnesota Housing Partnership. "Home for Sale in New Ulm: 612 Pfaender Drive." <http://www.swmhp.org/forsale/NewUlm/612%20Listing%20Sheet%2010-2014.pdf> (accessed November 13, 2016).

Southwest Minnesota Housing Partnership. "How We Help." <http://www.swmhp.org/aboutUs/howWeHelp.aspx?sc=2> (accessed November 13, 2016).

Southwest Minnesota Housing Partnership. "What We Do." <http://www.swmhp.org/aboutUs/whatWeDo.aspx?sc=2> (accessed November 13, 2016).

Stannard, Ed. "Yale students build a New Haven house, now it will become a home." *New Haven Register*, October 6, 2015. <http://www.nhregister.com/article/NH/20151006/NEWS/151009649> (accessed November 13, 2016).

Structural Insulated Panel Association. "What Are SIPs?" <http://www.sips.org/about/what-are-sips> (accessed November 13, 2016).

The Tiny Life. "What Is The Tiny House Movement?" <http://thetinylife.com/what-is-the-tiny-house-movement/> (accessed November 13, 2016).

U.S. Census. "Characteristics of New Housing." <https://www.census.gov/construction/chars/completed.html> (accessed November 13, 2016).

U.S. Department of Housing and Urban Development. "Building Innovation in Homeownership." <https://www.huduser.gov/portal/Publications/PDF/bih.pdf> (accessed November 13, 2016).

U.S. Department of Housing and Urban Development. "General Program Information." http://portal.hud.gov/hudportal/HUD?src=/program_offices/housing/rmra/mhs/faq (accessed November 13, 2016).

U.S. Energy Information Administration. "Apartments in buildings with 5 or more units use less energy than other home types." June 18, 2013. <http://www.eia.gov/todayinenergy/detail.cfm?id=11731> (accessed November 13, 2016).

Urist, Jacoba. "The Health Risks of Small Apartments." *The Atlantic*, December 19, 2013. <http://www.theatlantic.com/health/archive/2013/12/the-health-risks-of-small-apartments/282150/> (accessed November 13, 2016).

White, Gillian B. "Rural America's Silent Housing Crisis." *The Atlantic*, January 28, 2015. <http://www.theatlantic.com/business/archive/2015/01/rural-americas-silent-housing-crisis/384885/> (accessed November 13, 2016).

Willett, Megan. "Living in tiny homes was much harder than these people realized." *Business Insider*, July 27, 2015. <http://www.businessinsider.com/five-people-who-abandoned-their-tiny-homes-2015-7> (accessed November 13, 2016).

Ziegler, Edward H. "The case for megapolitan growth management in the 21st century: Regional urban planning and sustainable development in the United States." *The Urban Lawyer* 41, no. 1 (2009): 08-24.