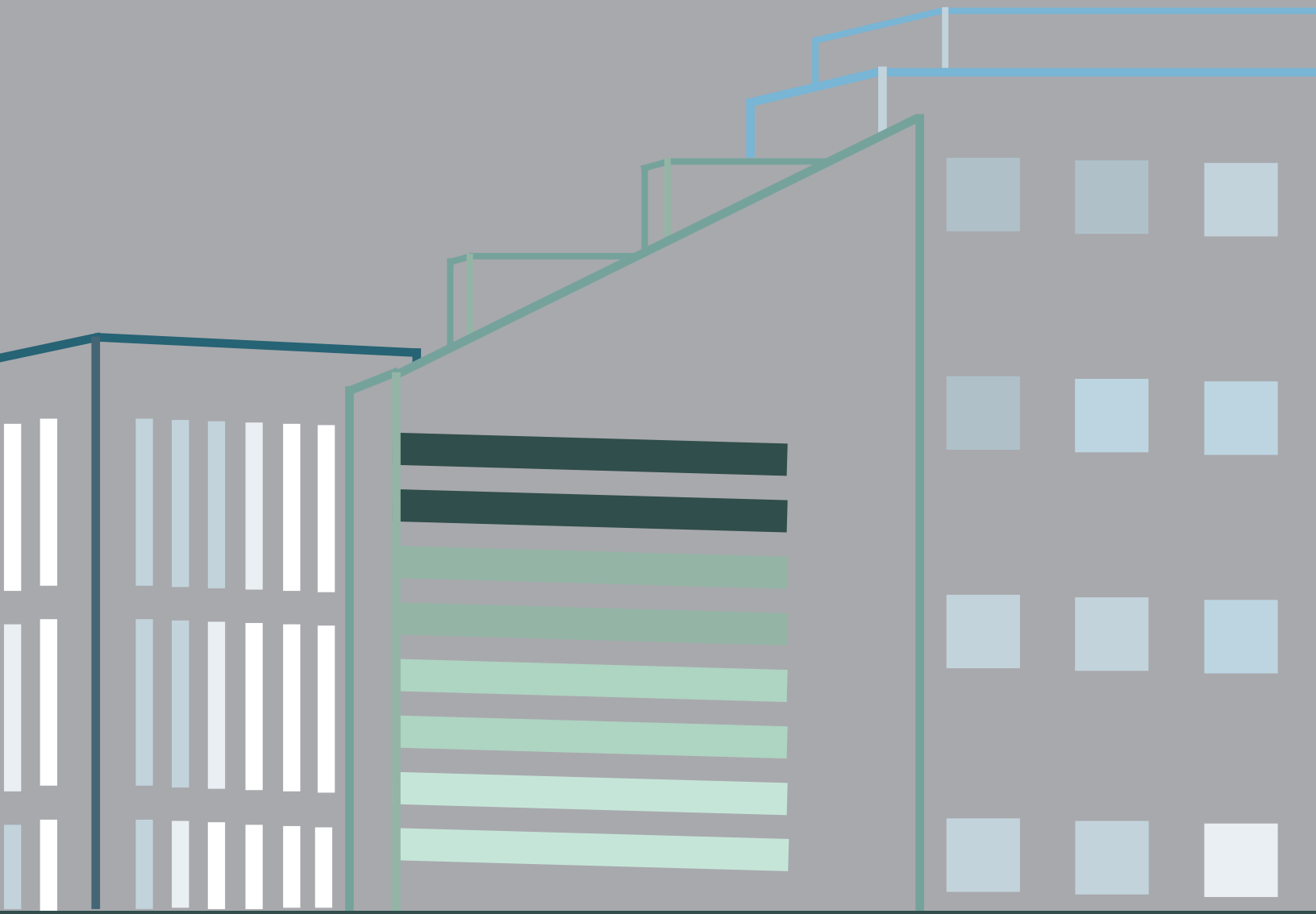
Pathways for Lifecycle Building Practices: Material Reuse in Tiny Home Construction

Nathaniel Hooper
Michael Moreno-Beals



Michigan State University
EDA University Center for
Regional Economic Innovation

2019 Co-Learning
Plan Series

MICHIGAN STATE
UNIVERSITY

Center for Community
and Economic Development
University Center for Regional Economic Innovation

E·D·A
U.S. ECONOMIC DEVELOPMENT ADMINISTRATION

Tiny Houses, Big Potential

Affordable and Sustainable Housing Solutions for Michigan Communities

---

EDA University Center for Regional Economic Innovation

Center for Community and Economic Development

Michigan State University

Nathaniel Hooper, MSW
Michael Moreno-Beals
Dustin Altschul, AIA, LEED® AP
Kim Buchholz

This project is supported in part pursuant to the receipt of financial assistance from the United States Department of Commerce – Economic Development Administration. The statements, findings, conclusions, and recommendations are solely those of the authors and do not necessarily reflect the view of any federal agency or Michigan State University.

CONTENTS

Domicology: Project Roots 3
Introduction 5
Abstract 7
Section 1: Tiny Houses as an Affordable Housing Solution 8
Rethinking Affordable Housing 9
Targeted Supportive Housing Case Study: Quixote Village, Olympia, WA 10
Targeted Supportive Housing Case Study: Cass Community Tiny Homes, Detroit, MI 12
Rental Development Case Study: Tiny Houses as Urban Infill 13
Homeownership Case Study: The Shire at Mountaintown, Ellijay, GA 14
Addressing Barriers to Tiny Home Development 16
Housing Choice Voucher (HCV) and Tiny Houses 16
Child Welfare and Tiny Houses 17
Building Codes and Tiny Houses 18
Zoning Ordinances and Tiny Houses 20
Section 2: Material Reuse and Innovation in Tiny House Design 22
Engagement 23
Our Process 24
Co-Learning Residence: A Closer Look 24
Scenario 1: Code Compliant Design 26
Scenario 2: Alternate Design 28
Design Comparison and Findings 30
Discussion of Findings 33
References 34

ACKNOWLEDGEMENTS

We would like to thank the faculty and student staff at the Michigan State University Center for Community and Economic Development: Rex LaMore, John Schweitzer, Jennifer Bruen, John Melcher, Anita Hernandez, Heather Mahoney, Jonathan Walkotten, Madison Nacker, Jeffrey Franklin, Rachel Mcilvaine, Ethan Jodoin, and many others for their support and assistance in completing this Co-Learning Plan.

Paul Malham for his visionary work with Eagle Ridge Buildings, and for taking the time to share his expertise, all the way from Georgia.

Amanda Eichelberger for her empowering work with the Quixote Village and her willingness to help us learn from the story of Quixote Village.

Ron Fors for sharing his decades of development experience to help educate us on the reality of building codes and zoning ordinances.

Rev. Faith Fowler for her work with Cass Community Social Services and her vision of using tiny houses as a means to empower individuals to re-enter the economic system.

Denise Paquette for her longtime role as a mentor, in this venture and many others.

Mandi Peterson for her patience and kindness throughout.

And a special thanks to Dustin Altschul and Kim Buchholz for jumping head first into this project at such a crucial moment. This project would not have become what it did were it not for the two of you.

DOMICOLOGY: PROJECT ROOTS

The primary driver for this project is traced back to an elective class I (Nathaniel) took during the first year of my master's program at Michigan State University: Special Topics in Domicology. Domicology is a new field of study that Michigan State University is pioneering, it examines the social, environmental, and economic characteristics of the lifecycle of the built environment. The practitioners of which—called Domicologists—explore innovative models, designs, practices, and policies to that have a positive impact in social, economic, and environmental domains across a structures lifecycle. Whereas, current development practices completely ignore these sorts of considerations, Domicology creates the imperative for a new development paradigm that places the economic, social, and environmental impacts of a structure as a primary point of emphasis. This new way of approaching the built environment fundamentally challenges the common tendency of relevant knowledge, skillsets and expertise to remain siloed from one another, and instead necessitates a collaborative and dynamic process of continual investigation and reflection. It is under these circumstances that our project team, consisting of a social worker, physicist, architects, and interior designers would come together.

Domicology is the overarching framework which has served to contextualize and guide the process of investigating and completing each of the components of this Co-Learning Plan. Each of the topical areas included in this Co-Learning Plan tie back to the examination of potential social, environmental, or economic impacts of utilizing tiny houses as an alternative to conventional homes.

INTRODUCTION

More than just a passing fad or trend, tiny homes are rising as a part of a movement to live more simply, more affordably, and with a smaller impact on the environment. Though individuals have 'lived tiny' for ages, a fervor of intrigue has arisen within the last couple of years around tiny homes and those who dwell in them. This interest is galvanized by the popularity of shows such as *Tiny House, Big Living, Tiny House Hunter, and Tiny House World*; which often showcase boutiquey tiny house designs and the freedom that the dwellers experience within. As much as this growing awareness has spurred growth in industries related to tiny house design--some tiny house organizations have reported up to a 900% increase in inquiries from 2014-2018--this newfound attention has also potentially contributed to a great deal of misunderstanding regarding tiny houses, those who live tiny, and the degree to which these structures meet a wide variety of housing needs (tinyhousebuild.com, 2019). This Co-Learning Plan is intended to examine the multiplicity of ways these structures to aid in sustainable community development, and expand the understanding of tiny houses to accurately reflect the utility and efficiency that they can offer homeowners.

Tiny houses can either be built on a foundation (THOF), on a trailer, or on another set of wheels (THOW). Much of the increasing awareness surrounding tiny houses in pop culture has been focused on THOW. These designs are often much smaller than their THOF counterparts, and are usually favored by individuals who wish to maintain a lifestyle with a high degree of mobility. Similar to RVs, THOW can be towed across the country and relocated. The high mobility allowed by these structures lend themselves to meeting certain housing needs. Many individuals who dwell in THOW do so because their work necessitates a more migratory lifestyle, such as ranch hands, farm labor, traveling artisans and craftsmen, etc. THOF, on the other hand, offer no physical mobility. They do, however, allow for a substantially higher degree of utility in design and function than do THOW, and can offer many of the benefits of traditional residential structures with a fraction of the burden. Additionally, THOF can be designed in a multitude of ways as to readily integrate into existing housing stock without disturbing the fabric or character of a neighborhood, something that THOW cannot as easily boast. Because of these factors, a substantial focus of this Co-Learning Plan will focus more heavily on THOF than on THOW.

There is no universally agreed upon square footage threshold to officially designate a structure as a tiny home, however most tiny house organizations define them as a home anywhere from 250sf - 600sf. For context, consider that the average American single wide trailer is typically 600-1330sf, while the average American home is 2600sf. (Yes Communities, 2014; The Tiny life, 2019). As such, an average tiny house is roughly 1/10 the size of a newly constructed residential home. Though space is undeniably at a premium when it comes to designing and living in a tiny house; many tiny house designs feature multiple bedrooms, shared spaces, and even outdoor patio / balcony areas. These design features are significant, as they indicate that these structures can serve as suitable and functional dwellings for more than just single adults or couples, but perhaps even families with children.

The Tiny house movement is largely based on the benefits that come from living in a small structure. The cost of a Tiny house can vary greatly, but typically they range from $10,000 to $100,000; whereas, the average house costs in the U.S. was $226,800 nationwide, and $191,000 in the state of Michigan (Hoffower, 2019). In many cities across the United States, and in certain places in the state of Michigan, the cost of a new Tiny house can potentially be less than a years' worth of rent at market rates. Proponents of 'tiny living' assert that these lowered costs can allow for individuals and families to enjoy financial independence, mobility, and a more accessible path to wealth accumulation than may be expected with conventional housing options. In addition to this, tiny houses offer an inherently lower environmental

footprint when compared to conventional residential structures; both because of the lessened resource burden as well as the energy efficiency that comes from having to maintain such a smaller space. According to a report from the Oregon Department of Environmental Quality, “reducing home size by 50% results in a 36% decrease in lifecycle greenhouse gas emissions from materials on the house and the emissions produced by actions of the inhabitants” (Carlin, 2014). When it comes to electricity, natural gas, and water, tiny homes provide a substantial decrease in monthly bills. Several sources estimate that average utility bills for tiny homes range between $10-$30 per month, depending on the owner's needs and access to sources of renewable energy (Colestock, 2018; Pino, 2016). These benefits come with real implications for overall cost relating to the creation and maintenance of these structures.

Despite the economic and environmental benefits that many tiny house dwellers enjoy, the vast majority of cities across the nation (and especially in the state of Michigan) have been hesitant to allow the integration of tiny houses into their communities. In fact, many communities in Michigan are prohibitive of tiny houses, and utilizing zoning ordinances and code enforcement processes to keep these structures away. It is the belief of the authors that this represents a fundamental missed opportunity for innovative and sustainable development in Michigan; and that there is ample room for investigation and inquiry into the potential benefits that these structures can bring to communities across the state.

ABSTRACT

This Co-Learning Plan will investigate two fundamental aspects of the tiny house movement as it relates to community and economic development practitioners across the state of Michigan. The first will be an investigation into the proposed efficacy of using tiny houses to meet affordable housing needs in the state of Michigan. This will center on the current barriers that impede the development of such structures, and will highlight the multiplicity of ways that tiny houses have been used as a viable affordable housing strategy by other communities across the nation. The barriers cited throughout this section have been identified either through a comprehensive literature review conducted by the authors, or through any of multiple key informant interviews conducted throughout the project period. The second will focus on the environmental implications of tiny house construction, and will provide an environmental and cost impact analysis of building tiny houses with reused and salvaged materials, along with an overview of design practices that can promote equity and access. Together, these two sections can meaningfully inform communities across the state as to the social, economic, and environmental realities of the tiny house movement; and will hopefully demonstrate that such structures can serve as a powerful tool to foster equitable, accessible, and environmentally sustainable community development.

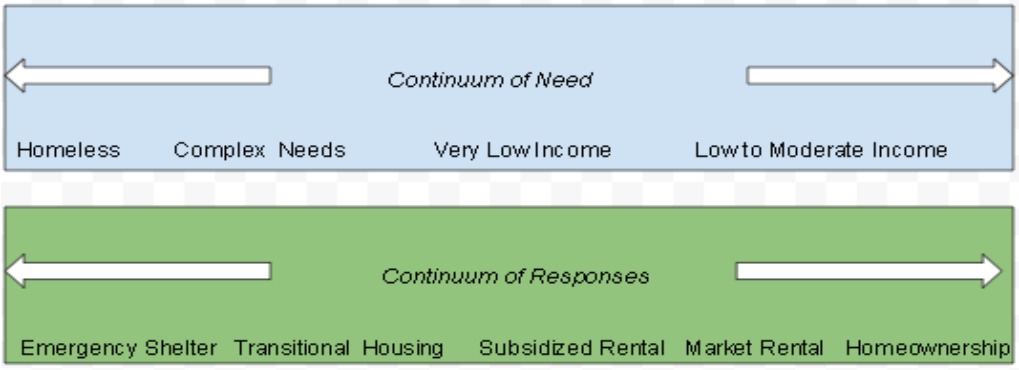
Section 1: Tiny Houses as an Affordable Housing Solution

Nathaniel Hooper, MSW

RETHINKING AFFORDABLE HOUSING

This Co-Learning Plan utilizes a hybridized definition of affordable housing combine traditional measures with a more rights-oriented framework that emphasizes the ability of all individuals to access and maintain safe and affordable housing. This philosophy is informed by the housing first movement that has arisen within human services professions that work predominantly with homelessness. As a movement within these fields, housing first emphasizes the right of all individuals to have access to stable and secure housing as inalienable; and advocates for interventions and programming which utilize stable housing as a platform for additional programming intended to meet higher order needs. Not only do such approaches recognize access to shelter as a human right, they are effective in reducing overall recidivism, especially in working with populations with complex needs. It is the belief of the authors of this Co-Learning Plan that the housing first movement can help inform discussions around affordable housing by broadening the definition to include discussions regarding access and equity in addition to traditional metrics such as fair market rent (FMR) and area median income (AMI). The below figure illustrates a continuum of housing needs and corresponding responses.

Figure 1: Continuum of Affordable Housing Needs and Responses



In acknowledging a continuum of affordable housing needs, we can characterize the array of potential housing responses in terms *development goals,* or specific function that proposed tiny house development will serve in relation to the target population. The needs of the target population should be a primary consideration for any tiny house development project. For example, a developer looking to create affordable senior housing would need to incorporate barrier-free design techniques, such as walk in showers or ADA accessibility. Whereas someone looking to build for individuals in the labor force might prioritize maximizing the number of separate bedrooms (to make the structure more conducive to family living). These sorts of considerations are important for community and economic development professionals, as this determination will characterize both opportunities for funding and strategic partnerships, but will also determine the overall steps necessary to make a tiny house development adequately meet a community's varying needs. Based on an analysis of the continuum of housing needs and responses, as well as an overview of existing tiny house communities across the country, the following three tiny house development classifications have been determined:

1. *Targeted Supportive Housing* - intended to fulfill development goals such as providing emergency shelter or short-term shelter, transitional living services or programs, or otherwise designed to target populations with specific needs.

2. *Rental Developments* - developed with the intention of entering into the housing market to be rented to tenants according to the 30% AMI rule, with potential application for subsidized rental programs.

3. *Homeownership Developments* - developed with the intention of being placed on the market to be sold to prospective homeowners.

The delineation between these different tiny house development types allows for a more thorough examination into the ways in which these structures may be used to meet the differing affordable housing needs of communities across the state of Michigan.

Tiny Houses as Affordable Housing

One of the most commonly cited barriers regarding the use of tiny houses in the state of Michigan lies in a negative perception regarding the utility that tiny houses may offer. Many key stakeholders who were interviewed for this project cited varying concerns regarding the overall ability of these structures to meet community needs. Others voiced concerns regarding the lack of a market for such structures (rental or otherwise) and an assumption that traditional home construction could better address the needs of communities than tiny houses. It is the opinion of the authors that these noted perceptions are based largely inaccurate or misinformed notions regarding the types of structures that can fall under the tiny house umbrella. Many stakeholders interviewed were under the assumption that tiny houses were bound to be either a 0 or 1-bedroom structure; and were surprised to learn some designs featured 2 or 3 bedrooms. Others interviewees were surprised to learn that tiny houses could be built on foundations, indicating that their previous understanding of these structures was restricted to THOW designs. As such, the following section is intended to demonstrate the true utility and variety of tiny houses by providing an overview of successful tiny house development projects across the nation. The case studies below have been organized according to three development classifications; as a means to highlight the wide array of housing needs that numerous communities have been able to effectively address using tiny houses.

Targeted Supportive Housing Case Study: Quixote Village, Olympia, WA

Quixote Village was established in 2007 as a self-governing tent city in the city of Olympia, WA. The 'brainchild' of roughly 30 homeless adults, the first residents of Quixote Village gathered together in a parking lot in downtown Olympia and established their camp as a form of protest. The residents were angered by the city adopting an ordinance that forbade sitting or lying on sidewalks, essentially criminalizing homelessness. They aspired to establish a community in which residents were able to share resources and have access to basic sanitation necessities that were currently unavailable to homeless and unsheltered populations in the city. Though the city police were quick to evict the villagers from their occupied parking lot downtown, a number of faith-based communities stepped in to offer their grounds as a sanctuary for the growing community. The city worked with this coalition of activists and faith-based groups over the course of 7 years to develop rules that would allow such a camp to exist. The community was shuttled back and forth between various faith groups in the area under an ordinance requiring the tent community to relocate every 3 months. During this period, leadership structures began to formalize within Camp Quixote. Camp residents shared resources, and utilized democratic processes to pass and enforce rules within the camp, and even evict problematic residents when necessary.

Over time, a coalition of community organizations formed around the village and began to activate various resources to make the vision of a permanent village a reality. Advocates worked with local units of government, eventually securing a plot of land for the development to be located. Even more importantly,

these advocates worked with the local code enforcement body, and were able to amend building codes in order to create a designation of 'single room occupancy' that would encapsulate the tiny houses being designed for the village. This was a crucially important step, as this allowed for the project to receive public funding because the tiny house structures now legally qualified as permanent housing. The project was then able to utilize state housing trust funds and CDBG funds (for community spaces and infrastructure). Other donations and grants from various sources paid the remaining project costs.

Today, Quixote Village features 30 single occupancy tiny houses, each 144sf with a half bath. Residents have full time access to community showers and bathtubs and a large community kitchen with locking dry and cold storage. Each structure is fully furnished, heated, and air conditioned; the cabins feature a front porch, and a small garden area. At the core of the Quixote Village model is an emphasis on demonstrating the dignity and worth of the person, harkening back to the principles of self-governance and self-determination upon which the village was founded. A non-profit organization (Panza) was formed to provide two paid staff members to manage the property and provide case management services to the residents. Community members pay 30% of their incomes, and agree to volunteer to clean and maintain the community spaces. A very active resident council still functions as a representative body for the residents, with each resident being able to elect representatives to act on their behalf. While the Village Life Committee can no longer evict residents, they act as leaders in the community that liaise between the residents, Quixote Staff, and the Panza board.

Whereas other similar villages in the region were able to use barebones structures to provide inexpensive shelter (sometimes less than $5,000 per unit), Quixote Village elected to incur much higher development costs in exchange for higher quality housing. The overall cost of each unit was estimated to be approximately $102,000 including land and donated materials. Compared to the estimated $239,396 that a single subsidized apartment unit costs to develop in the same county; this village still proves to be an economically viable permanent supportive housing option.

TARGETED SUPPORTIVE HOUSING CASE STUDY: CASS COMMUNITY TINY HOMES, DETROIT, MI

The Cass Community Tiny House project is the brainchild of Reverend Faith Fowler, a Methodist minister and director of the nonprofit organization Cass Community Social Services. The organization as a whole is responsible for providing a wide array of services including: a free medical clinic, workforce development and employment training, job opportunities in green industries, community meals, food support, and free transportation. The organization also offers a wide array of housing specific services such as: emergency shelters and warming centers, rotating community shelters, short-term shelters for families with children, and a number of permanent supportive housing options. The true scope and scale of the services provided by Cass Community Social Services is hard to grasp. Suffice to say that this organization lives up to its person-centered mission of providing a comprehensive continuum of services.

The Tiny Home Project was born out of the desire to better serve the homeless population that was utilizing services by providing a tangible pathway for reintegration into the economic system. Whereas many other tiny house projects utilize a housing-first model in which the primary function of the development is to stably house individuals as quickly as possible. The Cass tiny home project is more similar to a transitional housing program intended to build the capacity of individuals by integrating various services alongside housing. The Cass tiny home project is unique in that it goes far beyond the typical client permanency planning associated with transitional housing programs. It features a rent-to-own model in which residents can own their tiny home, and the property that it stands on after a period of about 7 years. Rent is determined based on the size of the tiny home, with residents paying $1/sf. Residents who are accepted into the tiny house program are expected to complete a variety of training and educational components, participate in a neighborhood watch group, and perform a variety of volunteer tasks depending on the ability of the person. The 'homeownership 101' teaches: cleaning processes and products, maintaining a toolbox and/or borrowing tools, preventative maintenance, basic handyperson skills, security systems and crime prevention, pest control, household emergencies, utilizing independent contractors, landscaping and lawn maintenance, trash and recycling, understanding property taxes, homeowner's insurance, and recordkeeping.

In the words of Rev. Fowler, "[The tiny house] project is intended for people who are ready to move out of shelters or residential programs… [the program is designed so that] beds will be freed up for people still living outside, and to assist those who have aspirations of acquiring wealth." (Fowler, 2018). She goes on to emphasize that the intention of the tiny house homeownership program is to foster wealth accumulation (as a means to reintegrate with the economic system) and to integrate these tiny houses and their owners back into an existing neighborhood, as a community building and neighborhood revitalization tool. Prospective applicants were evaluated on a number of factors, and went through extensive an interview process. Factors that disqualified a person from acceptance into the program included:

incomplete applications, currently residing outside of Michigan, violent criminal history within the last 10 years, any conviction of a sexual offense, or a conviction of selling drugs in the last 5 years. Rev. Fowlers explains that though the philosophy of Cass is that people are capable of great change and redemption, the presence of so many highly vulnerable persons in the community necessitated filtering for these qualities. Applicants were then reviewed based on their criminal histories, indicators of housing stability readiness, indicators of financial readiness, and based on feedback from independent references.

In 2019, the Cass Community tiny house project has constructed 12 tiny homes, and is planning to construct 13 more within the next year. The structures range in size from 250sf - 400sf, and are designed to be unique (both inside and outside) from one another. Ultimately, Cass purchased unique plans for each structure to emulate different architectural styles that can be seen throughout the city of Detroit. These designs include: Tudor, Craftsman, Queen Anne, Cape Cod, Victorian, and even a Tower style studio apartment. Though this choice ultimately added additional cost to the project, Rev. Fowler defends the decision arguing that the uniqueness of the structures serve as a point of pride and dignity for the residents, and will contribute to the overall character and the continual development of social capital within the neighborhood.

Cass Community Social Services use many volunteer crews and donated materials to offset some of the costs of building these homes; depending on the home size the construction costs ranged from $45,000 - $65,000. Rev. Fowler cites data in her book *Tiny Homes in a Big City* stating that the cost of an average 'Habitat house' in Michigan is between $80,000 - $155,000, and that a subsidized 1br apartment is between $150,000 - $300,000.

Rental Development Case Study: Tiny Houses as Urban Infill

In addition to clustered tiny house developments, communities across the nation find tiny houses to be a mechanism for affordable and sustainable urban infill. These sorts of developments are commonly seen in large cities that feature very high property values and rental rates, such as: San Francisco, Boston, Portland, Los Angeles, Austin, etc. These developments are typically enabled by the existence of an Accessory Dwelling Unit (ADU) ordinance, that allows for an additional residential structure to be constructed in an area zoned for detached single-family residence. These structures can be used to meet a wide variety of housing needs. Many who have built accessory tiny house units use them as a source of additional income either through a conventional lease or through lodging apps such as Airbnb. Others use these structures to take advantage of affordable incentives offered by local housing authorities or local governments. The following section provides a brief overview of a number of different programs that support Tiny Houses.

The city of Boston has been utilizing ADU's to help meet the ever-growing demand for affordable housing in the city. The Mayor's office first announced plans to pilot the ADU infill program in early 2017, arguing that the use of ADUs would "increase the amount of naturally-occurring affordable housing options in the city, and help prevent the possibility of displacement caused by increasing rents and property values" (Boston.gov). This pilot program was designed to spur the creation of ADUs that are created within the existing structures envelope; other ventures have built upon this initiative to demonstrate the efficacy of using modular tiny homes as detached ADUs in the city. One such example of this is the Plugin House, designed by James Shen, co-founder of the Peoples Architecture firm in Beijing, and a guest lecturer at the Harvard Graduate School of Design. The Plugin House is made out of prefabricated and insulated polyurethane panels, and can be constructed completely by hand in hours using only a hex wrench. The structure is 360sf, and costs an estimated $50,000 to build. The Plugin House is an extremely low-cost

solution for affordable housing and a way to increase the value of property, adding income via the collection of rent.

Individuals in the city of Portland, OR, have been using tiny house ADU structures as a means to respond to the city's population boom of the last decade. Many of these structures are free standing 'stick built' tiny homes, while others are built into detached garages or other existing structures on the property. While some homeowners have taken advantage of these ordinances, many who are interested are unable to due to the costs associated with constructing an ADU on site. In response to this, a start-up called Dweller offers interested homeowners a variety of different financing incentives to offset the cost for construction. Individuals who work with Dweller can choose to outright purchase a prefabricated tiny house for $118,000 (while the estimated cost of building a comparable structure is around $150,000) and retain full ownership to the property. Dweller also offers a number of other financing mechanisms in which the homeowner can elect to either take responsibility for the maintenance and management of the structure, or allow Dweller to take full responsibility for these responsibilities, effectively 'leasing' a portion of the homeowners' lot to the organization.

Perhaps the most ambitious Tiny House ADU Initiative comes out of the city of Los Angeles, where the mayor's office is providing homeowners $75,000 loans to build ADU structures in their backyard, on the condition that these structures be rented out to low-income individuals or families. Tenants are not to pay more than 30% of their income to maintain the house, and the remainder is subsidized by state and federal housing assistance funds. After 10 years, the mayor's office forgives the loans, and they are free to continue to list the property.

Overall, tiny houses of varying designs have shown to function well as an affordable and sustainable infill mechanism, especially in communities where property values and rental prices are substantially high. The overall success of such development projects hinges on the presence of zoning ordinances that allow for ADU structures.

HOMEOWNERSHIP CASE STUDY: THE SHIRE AT MOUNTAINTOWN, ELLIJAY, GA

Eagle Ridge Buildings is a development and construction group based out of Ellijay, GA, owned by founder (and tiny house visionary) Paul Malham. Eagle Ridge Buildings offers 16 highly customizable tiny house designs built in using a wide array of construction techniques, including traditional stick built, structural insulated panels (SIP), tongue and groove panelized construction, and structural steel framed. Though the wide array of tiny house designs and construction techniques is impressive; Eagle Ridge Buildings is also responsible for implementing innovative development models that utilize tiny houses as a pathway for homeownership, mobility, and sustainability. The authors of this Co-Learning Plan were able to speak with Malham a number of times; as he was extremely supportive of the project. The following is a brief overview of a successful homeowner oriented tiny house development pioneered by Malham and Eagle Ridge Buildings.

The Shire at Mountaintown is a tiny house community located in the remnants of a failed subdivision in the North Georgia region of the Blue Ridge Mountains. This failed subdivision resulted in a network of roads and utility services in an otherwise undeveloped remote area featuring access to a small private lake and widespread untouched woods. Having had years of experience in building tiny houses for individuals across the southeast, Malham was familiar with many of the barriers that sometimes arise in the development of these structures. In an interview, Malham explained that perhaps the most prominent development barrier that he and his group encountered came from the much higher proportion of overall project cost that site preparation and utilities comprise with a tiny house project, as compared to a

conventional construction project. He further elaborated that many project shareholders expressed concerns regarding balancing the fixed cost of site preparation compared to the perceived lower value (and return on investment) of tiny houses. By acquiring a failed subdivision with road infrastructure, utilities prepped, and septic systems, this group was able to overcome many of these barriers. In addition to this opportunity, the unique landscape and access to natural features that this failed development offered would in-turn become the primary selling point for this new tiny house development. Having known the typical market for his other tiny house projects, this community was marketed primarily to younger individuals and families, first time homeowners, those desiring to live more connected to nature, and those looking for a vacation home.

Starting at $99,000 interested parties can own a tiny house, one acre of land, and have access to a private lake as a part of the newly developing Shire at Mountaintown. This package features one of the more modest tiny house designs offered by Eagle Ridge Buildings; however, individuals are able to customize any of the 16 tiny house designs offered by Eagle Ridge Buildings, or even work to develop their own design to best meet their needs. Eagle Ridge tiny homes tend to be slightly larger than other tiny homes examined in this report, typically falling between the 400-600sf range. Even with highly customized designs, many of the homes closed at around the $160,000 range (including an acre of land each). In discussing the shire, Malham emphasized that many individuals that he works with at the shire elect to pay higher up-front costs in order to have rooftop solar panels installed on their homes. Though this raises the up-front cost, Malham says that many who choose to go with rooftop solar recuperate the cost within a few years, effectively eliminating operating cost of the structures over the lifetime of the solar array. Though Malham concedes that individuals may need to make certain lifestyle changes or employ additional strategies to accommodate tiny living (such as building additional storage buildings on-site), he argues that the benefits of substantially reduced cost of living often outweighs these concerns.

ADDRESSING BARRIERS TO TINY HOME DEVELOPMENT

The following section is intended to address perceived development barriers that were identified through interviews with key stakeholders, and through an extensive review of relevant literature. Based on this study, three primary types of barriers were identified: misinformation or misconceptions regarding the utility of tiny houses (negative tiny house perception), building code challenges, and zoning ordinance challenges. The first barrier (tiny house perceptions) entails a variety of misinformation regarding the variety and utility of structures that fall under the tiny house umbrella, as well as concerns regarding the ability of tiny houses to meet differing community needs. In order to address these concerns, the authors of this Co-Learning Plan included a number of relevant case studies and address three commonly cited concerns in the section below. To address the second and third barriers, the Co-Learning Plan authors have conducted an in-depth analysis into building codes and zoning ordinances as they potentially apply to tiny houses in the state of Michigan. Included in these two sections is an overview of major challenges that prospective tiny house developers may face, and a brief discussion of strategies that could be used to overcome these challenges. In addition, the section will briefly highlight a number of critical resources that were instrumental in allowing the authors to address these concerns.

HOUSING CHOICE VOUCHER AND TINY HOUSES

Many stakeholders interviewed for this project, expressed concerns with whether or not tiny house rentals would qualify for the housing choice voucher program (formerly section 8). To investigate this claim, the authors contacted the Housing Choice Voucher (HCV) office at the Michigan State Housing Development Authority (MSHDA) to inquire whether or not the HCV program prohibits the use of a voucher with a tiny house rental. Though the MSHDA representative that was interviewed was quick to note that they had not heard of any such application of the HCV program in the state, they also expressed a high degree of optimism that a tiny house could qualify for such an application. According to this representative, any rental property must be inspected according to HUD's Housing Quality Standards Index (HQS) in order to qualify for a tenant to use a voucher. The HQS form that stipulates these standards is available from HUD.gov. An individual or group who wishes to build tiny houses with the intention of using the HCV program should incorporate HQS standards into the design process of their tiny homes, ensuring that these structures would easily pass inspection.

The MSHDA representative expressed optimism regarding the potential application of tiny houses as an affordable housing option in the state. They were also asked to cite any concerns that they thought MSHDA would have regarding the use of tiny homes in this way, they responded with a number of potential concerns. They clarified that these concerns are not necessarily intended to advocate for or against the application of tiny houses, but instead were provided to help better understand the factors that MSHDA interprets as pertinent to fulfilling the intended outcomes of the HCV program. These concerns are listed below:

1. How many bedrooms would the structure feature?

2. Would this prohibit the tenant from having family / friends visit?

3. Could living in a tiny house potentially pose a barrier in the event that tenant experiences a change in household size?

4. How suitable would these structures be in housing children and family units?

5. Would the space constraints of living in a tiny house potentially inhibit the tenant's path towards reintegration into the community and economic system?

6. Would living in a tiny house potentially deprive the tenant from community / neighborhood functioning and growth?

The short answer to many of these questions is that it will depend based on the nature of the development, the size and design of the structure, and the preferences of the tenant. Based on the above case studies detailing the variety of ways that tiny houses have been used as affordable housing, it is the opinion of the authors that many applications of these structures could prevent against many of the cited concerns regarding integration into the broader community and economic system. Additionally, as the tiny house design featured in the second portion of this project reveals, many tiny houses can be designed to feature multiple bedrooms without sacrificing conventional features such as a living room. Though the size constraints could certainly pose challenges for household size changes, the degree to which this would be effectively any different from an individual living in a one or two-bedroom apartment deserves critical consideration.

Child Welfare and Tiny Houses

A second major concern that was voiced by stakeholders (and that was encountered on a number of tiny house forums) are the potential challenges related to legally dwelling in tiny houses with children. These concerns were broken down into two major areas: concerns regarding foster care, adoption, and family reunification; and concerns regarding the involvement of Child Protective Services (CPS) because of challenges inherent to dwelling in tiny houses. It is a common misconception that the foster care system and CPS are synonymous; when in fact, both of these systems operate independently from one another. In practice this means that each of these systems are bound to different requirements as laid out in the respective policies, and as such, conclusions drawn regarding one of these systems may not necessarily be transferable to another. In order to investigate these concerns further, multiple individuals from Michigan Department of Health and Human Services (MDHHS) and the Michigan Adoption Resource Exchange were interviewed.

Tiny house dwellers who wish to apply to be a foster home, or to work with a child welfare to pursue adoption could potentially face challenges in successfully having their homes licensed. All child welfare agencies in the state of Michigan are mandated to adhere to the same licensing requirements to certify both potential adoptive and foster homes. These requirements feature a wide array of stipulations that are intended to ensure the wellbeing of the child is maintained; but potentially come into conflict with some features commonly encountered in tiny house designs including: lofted living spaces, living spaces sharing utilities such as water heaters, and proper egress. The specific licensing requirements that impact both adoption and foster care are available through the MDHHS website.[1] Though the process is not commonly used, this policy does allow for prospective foster homes and adoptive parents to apply for a variance to any of these rules as long as the "health, care, safety, and supervision [of the child]" can be guaranteed (MDHHS, 2015). Though this policy does not outright prohibit the use of tiny houses for adoption or foster care; individuals or families living in tiny houses wishing to participate in these systems will likely have to make special accommodations.

Another concern that was encountered numerous times on various tiny house living forums was the concern that Child Protective Services can remove children from families that are living in tiny houses.

[1] https://www.michigan.gov/documents/mdhhs/CWL-PUB-10_502652_7.pdf

To investigate this claim, a CPS policy analyst from MDHHS was contacted with this inquiry. After reviewing CPS policy, the analyst clarified that it was very unlikely that a family would ever be investigated due to the size of a structure alone, provided that the structure itself was in such a condition that it did not present any undue risk of harm to the child's wellbeing, and that the structure allowed for the family to carry out "normal day-to-day functioning" (Personal Communication, 2019). They went on to clarify that in many cases with individuals and families living in non-conventional settings (such as living in a very remote setting) families can utilize features such as multiple food coolers or detached bathhouses to ensure that the family unit is able to function in a way that does not compromise the safety and wellbeing of the child. In this same way, families dwelling in tiny houses could conceivably pursue solutions such as these to ensure that the safety and wellbeing of their children is not compromised by living in a tiny house. As such, the requirements that a structure needs to meet in order to qualify for use in foster care or adoption can be understood to be much more stringent than those necessary to protect against the involvement of CPS, given that the safety and wellbeing of the child is not being compromised.

Building Codes and Tiny Houses

It is an open secret within the tiny house community, that many individuals living within Tiny Homes intentionally skirt local zoning and code enforcement barriers. Often individuals choose to build their homes on trailers (THOW) as a means to escape some of the challenges that building such a structure to code can produce, while others find success in building slightly larger (above 400sf) structures on foundation (THOF). Whether a Tiny House is located on a trailer or on foundation will have substantial implications for what code requirements its design will have to meet, and whether or not it will be able to be legally occupied. In general, all tiny houses build on a foundation are subject to residential building code for a *single-family dwelling*, while those built on trailers are subject to either *manufactured housing* or *recreational vehicle codes*. Most commonly, local units of government will elect to adopt the body of codes called the International Residential Code (IRC) which are maintained and altered by the International Code Council (ICC), Though some jurisdictions will attach additional requirements for new construction. Prospective developers are encouraged to query their local code enforcement body to inquire about any other code requirements that may supersede the IRC baseline.

Tiny Houses may encounter challenges meeting building codes. This analysis is based on a review of multiple relevant publications and draws heavily from a 2017 guide published by the National Fire Protection Association (NFPA)(See references) Codes referenced in this section come from the International Residential Code 2018. The information presented below is solely this author's interpretation, and does not necessarily represent the NFPA, MSU, or any other organization. This author is not a licensed builder or fire inspector, and the information herein is to be strictly for conceptual purposes.

Please see appendix for specific IRC codes relevant to the areas identified below.

Minimum Floor Area and Dimensions

One of the most commonly cited concerns regarding Tiny Houses and code compliance is the challenge of meeting minimum area, and minimum dimension requirements. Due to the compact nature of Tiny Homes, and the tendency for spaces in these structures to serve multiple purposes, it is possible that certain design practices common to Tiny Houses could inadvertently cause the structure to not have enough qualifying habitable floor space. Habitable floor space is commonly defined as spaces such as: foyers, hallways, bedrooms, bathrooms, etc. Similarly, the tendency for Tiny Homes to feature elevated loft style sleeping areas could prove problematic, as it would be possible for these sleeping areas to not count as eligible habitable floor space.

Overall, minimum room size and dimension stipulations may pose a challenge in certain aspects of Tiny House Design, but overall these regulations are not outright prohibitive of Tiny House development. The International Residential Code (IRC) does not stipulate that a dwelling must have multiple rooms, which means that in certain circumstances Tiny Houses can be treated as studio units. It is worth considering, however, that the square footage necessary for additional occupants past the first could result in certain Tiny Homes being licensed for single occupancy, depending on the rental code stipulations.

Egress and Means of Escape

Most Tiny Houses are single story dwelling units, the means of egress is often considered to be the door used for entry into the structure. In the event that a Tiny House design creates a separate sleeping area, a secondary means of escape will be necessary. This is often a window to the exterior of the structure, with no less than 5.7sf of window space and a minimum height of 24", and minimum width of 20" (R310.2.1). The IRC does also stipulate that the primary means of escape must be a side hinged door.

Mezzanines / Lofts

Many Tiny Homes have lofted areas for storage, sleeping, or leisure space. Though the use of this space for sleeping would in theory designate this area as habitable, there is no distinct provision within the codes that designates a separate classification for lofted sleeping areas. As such, elevated areas built with the intention of being habitable space must be built to the requirements of a mezzanine, with allowable headroom and egress. Building a lofted area in accordance to mezzanine requirements can prove to be quite challenging, as the small square footage typically seen in Tiny Houses could make the requirements for minimum space above/below mezzanine construction, and the area limitations difficult to meet.

OVERCOMING BUILDING CODE CHALLENGES

In 2018, the IRC released a new appendix section specifically for the classification of Tiny Houses, as a freestanding single residential unit that is smaller than 400sf. This addition to the IRC helps address many of the potential code related challenges that have been outlined above. Currently the states of Idaho, Oregon, Georgia, and Maine have adopted IRC Appendix Q, although other states such as Colorado are expected to adopt this change soon. Smaller jurisdictions with code enforcement authority also have the option to adopt Appendix Q, even if this is not currently adopted statewide. Public Act 230 of 1972 sets the standard and precedent for enforcement of building codes in the state of Michigan and includes language that enables code enforcement agencies across the state to consider the inclusion of changes that have been adopted during interim publications of the IRC and other codes. Individuals who may encounter building code related challenges are encouraged to cite an excerpt from section 125.1504 (8) of Public Act 230 that clarifies the ability of code enforcement jurisdictions to honor interim code changes. In short, this language does not mandate that code enforcement jurisdictions honor interim code changes, but instead specifies that IRC code changes that occur within the interim of a code cycle are authorized to be upheld by code enforcement jurisdictions, even if those specific changes have not yet been adopted by the state.

In addition to the option for individuals to appeal their code enforcement jurisdictions to recognize IRC Appendix Q, individuals can also contest specific code challenges by citing the following section from the 2018 IRC code:

a. ***R104.11 Alternative materials, design and methods of construction and equipment:*** *The provisions of the code are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by the code, if the alternative has been approved. An alternative material, design, or method of construction shall be approved where the building official*

finds that the proposed design is satisfactory and complies with the intent of the provisions of the code, and that the material, method, or work offered is, for the purpose intended, at least the equivalent of that prescribed in the code.

Zoning Ordinances and Tiny Houses

Individuals who are trying to integrate Tiny Houses and smaller homes into urban areas often face significant challenges in land use policy, as dictated by their local zoning ordinances. By permitting and prohibiting certain uses of land in certain areas, zoning ordinances are intended to protect the collective interests of an area's population (Evans, 2018). Though the stipulations are often crafted with quality of life, economic factors, neighborhood character, and other factors in mind; many activists and scholars are growing increasingly critical of certain zoning practices. Research conducted by a number of scholars has been used to claim that zoning ordinances can in effect outright prohibit the integration of low-middle income families into certain neighborhoods, and certain zoning practices have even been cited as "the go-to tool for NIMBY (not in my back yard) groups, to exclude groups such as young adults, families with children, and lower classes (Evans, 2018; Talen 2012; Ross 2014; Silver 2015; Fischel 2015; Pfeiffer 2015). The degree to which this rings true will vary across Michigan communities; yet the point that these scholars make regarding zoning ordinances as a tool for the maintenance of the status quo is worth consideration.

Zoning ordinances are subject to change by a municipality. Though there are certainly commonalities in the form and substance of these policies across the state of Michigan, that go well beyond the scope of this Co-Learning Plan to adequately represent the status of these ordinances across the state. Instead, this section is intended to serve as a guide to highlight some ordinances that could prove problematic for the integration of tiny houses into urban and suburban areas. Individuals who are interested in pursuing a Tiny House development are encouraged to contact their local code enforcement office, and query using the terms discussed below.

Minimum Structure Size

In addition to the potential that a locality's building codes may stipulate a minimum habitable dwelling size, it is possible (and perhaps even likely) that an areas zoning ordinances may feature minimum structure size ordinances. Some ordinances may be written so that they apply to all residential zoned areas in a locality; while others may be written that allows for differing residential structure sizes in designated residential zoned areas. For example, in the city of Lansing, the minimum structure size is written such that it links minimum structure size to the size of the lot in question. Quoted below is the ordinance that was conveyed to this author directly from the city planning office. The ordinance in question was so recently adopted, that it does not appear yet in the cities publicly available zoning books. Though this ordinance would certainly prohibit many Tiny House designs from being built in the city, it does not outright prevent such a development.

For lots under 40' in width, the minimum allowable structure size will be 400sf. For lots over 40' in width, the minimum allowable structure size will be 576sf.

Allowable Structures Per Lot

Though on the surface such an ordinance may not seem outright prohibitive of Tiny House development, many cities stipulate that only one habitable structure be allowed per lot. Such an ordinance could be detrimental to the completion of a Tiny House project not because of any direct prohibition of such structures, but instead because of financier fears regarding potential return on investment. This sentiment was echoed in multiple conversations with different stakeholders, including individuals from the City

Planning office, and a local builder with over 40 years of residential construction experience. Individuals expressed concerns regarding both the depreciation of a Tiny House's value and the lack of a sustainable rental or homeownership market. The following quote from a local builder perfectly sums up these concerns:

"If I have a piece of land that I can only build one structure on, I am inclined to build the most versatile structure that I can. To me, this means a 3-4br house 1500sf house that can either be attractive for sale to a homeowner, or a landlord who can collect rent based on a 4br pricing" (Personal Communication, Residential Construction Professional, 2019).

As indicated by the quote above, such an ordinance may not be outright directly prohibitive of tiny houses, but instead create a situation in which the likelihood of attracting a developer to build a tiny house in place of a larger structure is low.

Minimum Lot Size

Many municipalities have minimum lot size ordinances that are subject to change depending on the local zoning designation. Similar to the discussion above regarding allowable structures per lot, ordinances of this kind can have a detrimental impact on Tiny House developments. When queried about the role of such an ordinance, key informants expressed a similar line of thinking as highlighted above--the higher relative cost incurred that results from larger lot sizes could potentially prevent prospective developers from electing to develop a Tiny House, or even a smaller home. Similar themes to those cited in the above section emerged in this conversation: uncertainty regarding the presence of an adequate market for Tiny Houses or small homes, concerns regarding ROI in consideration of project costs, as well as a general sentiment that the placement of a Tiny House on a large lot would be "a missed opportunity for a more lucrative development" (Personal Communication, 2019).

A minimum lot size ordinance greatly decreases the likelihood of a prospective developer subdividing a parcel of land into smaller lots. In theory, a developer could overcome an ordinance by subdividing a section of land into smaller lots to make the development of Tiny Houses move feasible. With the presence of a minimum lot size ordinance, such a process would likely not be possible. In the city of Lansing, there are three single family detached residential designations each with differing minimum lot sizes ranging from 6000' - 4000'.

Section 2: Material Reuse and Innovation in Tiny House Design

Dustin Altschul & Kim Buchholz
Hungry Architecture

ENGAGEMENT

As a spatial design practice, Hungry Architecture operates under the philosophy that environmentalism, artistry, technology, and activism have the potential to deeply impact human health and wellbeing when applied to the design process. The challenge to explore new and innovative methods for habitation while simultaneously evolving social welfare is one that resonates with our architectural practice. While it is unusual for social workers and architects to work in deep collaboration, this alliance exemplifies what we believe must be done to produce unprecedented design outcomes: to create new architectures, we must work in new ways.

In the pursuance of aesthetics in architecture without considering performance-based qualities, design misses out on the opportunity for critical synthesis. Our method of design involves using performative indicators, created through both embodied and operational energy simulations, to inform structural, visual, and experiential design considerations. Connecting these simulated analyses with research rooted in social activism pushes society and policy one step closer towards acceptance of tiny homes.

This project presents Hungry Architecture with the opportunity to continue leveraging technical expertise and resources in partnership with specialists in organizational and community leadership. As a team, we created an innovative design process to test new materials and integrate considered architecture. This project became a living dialogue of something much larger than itself: the importance of creating a knowledge community within a world demanding evolved habitation for environmental, economic, and social sustainability.

OUR PROCESS

The current condition of tiny home research and implementation presented challenges including, but not limited to, social acceptance, obstacles in public policy and other regulatory bodies, architecture and quality of life, as well as accessibility. While the practice of architecture brings together many diverse aspects within project research and development, socially-based architectural contributions within academic, co-learning frameworks in research are largely unengaged. Our goal in this project was – and is - to provide value, uniquely reflective of our discipline, including identifying innovative research and design processes that allow for optimum investigation of model scenarios, while also supporting the advancing study of Domicology.

This research argues that tiny homes can and should be used for meaningful, residential living that can meet a wide variety of housing needs. For that reason, it is important to design a 'standard plan' that goes beyond standard – a spatial arrangement that is reminiscent of 'home,' uniquely named Co-Learning Residence. The Co-Learning Residence includes a kitchen, dining, living, and work area, as well as a bedroom and a full bath – all of which are balanced around a central Colonial-style entry and total approximately 400 square feet.

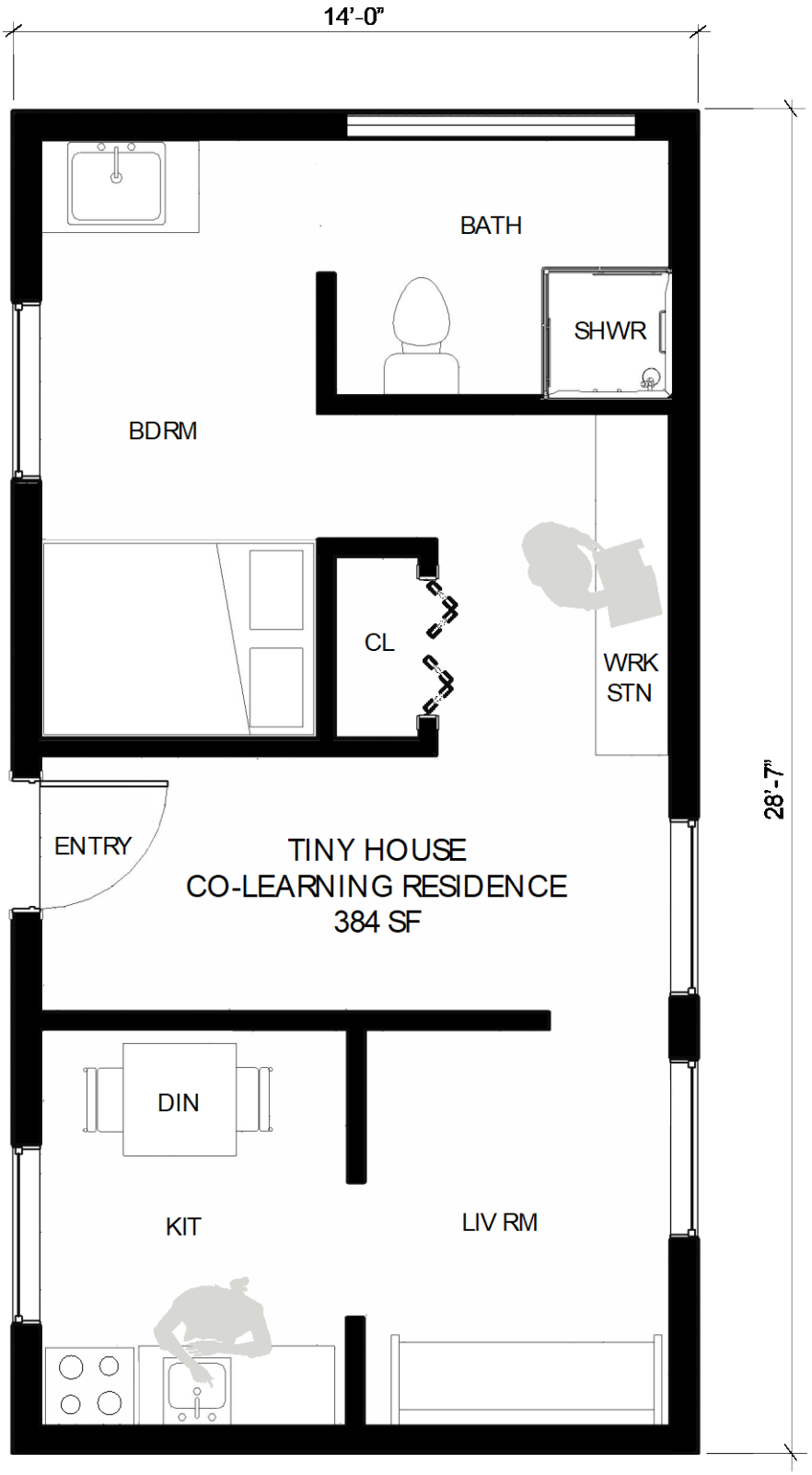
Once the Co-Learning Residence floor plan design was completed, the first step involved using the International Residential Code (IRC) to prescriptively materialize a full structure. Using building information management (BIM) modeling to design a digital model of this structure, it was possible to perform real-time energy modeling and life cycle analysis (LCA) reports based on the quantifiable materials and material systems identified through IRC. Advanced material simulations isolated individual materials, allowing for a detailed material inventory and specifications. By employing architectural data-base management strategies to this project, we introduced material baselines with socially-based research; an inventive way of considering otherwise differing data. In doing so, environmental opportunities were identified.

Returning to the Co-Learning Residence to envision a second scenario, we created an alternate design leveraging unconventional and repurposed materials, directly contrasting IRC regulations. Again, a digital model of this structure was created and a second round of energy modeling, material simulations and LCA was conducted. The resulting data allowed for us to cross compare the LCA and energy analysis with the design based on IRC. While there is much research supporting the social benefit of tiny homes, we have exposed evidence that supports significant environmental and economic benefits to tiny homes, as well as applied Domicology.

CO-LEARNING RESIDENCE: A CLOSER LOOK

Every residence has functions that satisfy basic human needs, however it is in the best-designed homes that these needs are elevated in a way that evokes a sense of sanctuary. We created a spatial arrangement that is reflective of daily living rituals – cooking, cleaning, sleeping, and lounging. For us, the design of the standard floor plan was not about creating a basic enclosure, but rather about creating a unique tiny home architecture. Figure 2 below illustrates a spatial arrangement for Co-Learning Residence tiny home architecture.

Figure 2: Spatial Arrangement for Co-Learning Residence



SCENARIO 1: CODE COMPLIANT DESIGN

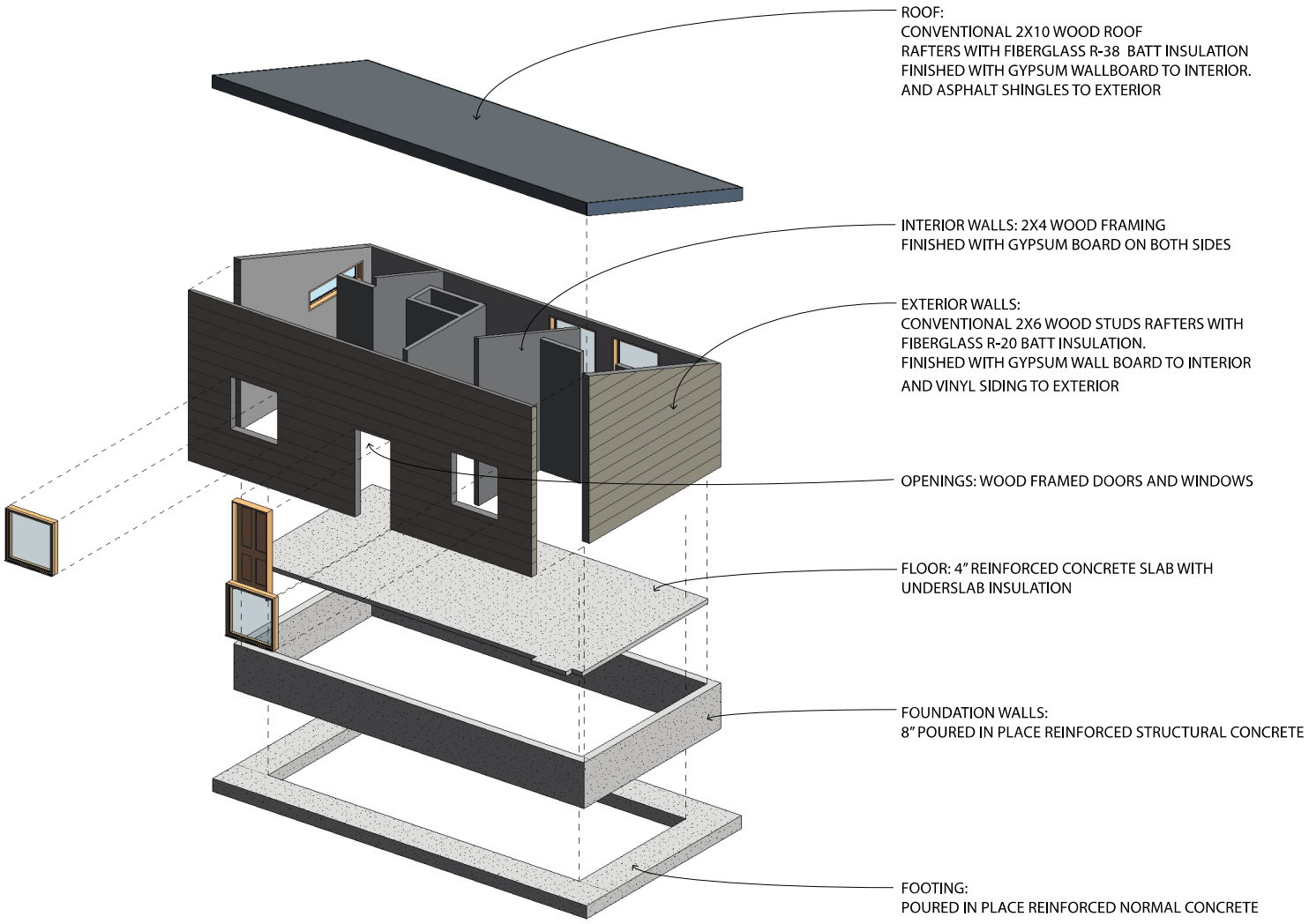
Using IRC as a guide to develop the Co-Learning Residence to a minimal, code compliant design for mid-Michigan geography and climate zone, we based our architectural decisions on traditional/conventional construction and building techniques.

This scenario specifies a poured-in-place reinforced concrete footing and 8" foundation walls with 4" reinforced concrete slab. Conventional 2"x 6" wood studs at 24" O.C. are used for exterior walls, filled with resistance value 20 batt insulation and finished with gypsum wallboard on the interior and vinyl siding to the exterior. Interior walls use conventional 2" x 4" wood framing, finished with gypsum wallboard on both sides. The shed roof is designed with traditional 2" x 10" wood roof rafters with resistance value 28 batt insulation, finished with gypsum wallboard to the interior and asphalt shingles to exterior.

Traditional and/or conventional building strategies benefit from rule-of-thumb estimation and common know-how in architecture and construction, lowering costs of design that can be easily repeated. While these benefits streamline the construction process, they also have historical and/or practical justifications. For example, reinforced poured-in-place concrete foundation walls are commonly used for the construction of finished basements in cold climates. Another example focuses on how traditional batt insulation is designed to be the same incremental thickness that satisfies minimal insulation requirements per IRC code, and being in-filled between wood studs results in thermal bridging due to non-continuous insulation, directly causing energy loss. Wood studs, batt insulation, gypsum wallboard, vinyl siding and asphalt shingles also provide a readily available inventory and stock, as well as being "just used," therefore the socially accepted norm.

Figure 3 on the next page shows this Co-Learning Residence using conventional construction methods and materials.

Figure 3: Co-Learning Residence base on IRC Compliant minimal requirements



SCENARIO 2: ALTERNATE DESIGN

An additional simulation of the Co-Learning Residence was developed using alternative materials and construction assemblies, including applying reclaimed materials for structure and finish surfaces.

Stepping away from minimal IRC regulations traditionally used in housing construction pushed us to challenge the status quo in terms of what materials can be repurposed for the greatest use. We utilized reclaimed concrete masonry unit (CMU) blocks for foundation walls, sourced all wood framing from reclaimed wood studs, as well as integrated structure and insulation seamlessly using strawbale, finished with earthen plaster on the interior walls, and reclaimed wood planks on the exterior walls. The roof and interior walls were designed using CLT constructed from reclaimed wood framing and finished with natural stucco, with the ceiling also integrating strawbale for insulation.

Generally, the use of CMU blocks is not desired due to the lack of uniformity of their finished face, even though the reclaimed blocks do not compromise structural integrity and other material qualities. It is difficult to use conventional materials, such as gypsum board, to finish the uneven surface of reclaimed CMU blocks. By using natural stucco, it is possible to properly conceal the blocks in a manner that is both sustainable and visually pleasing. Another reason why poured-in-placed reinforced concrete is used for conventional foundation walls is its lack of mortar joints. Mortar joints allow for a greater possibility of shifting as the earth settles. In the application of a tiny home, however, the small footprint eliminates this issue and in fact, the earth pressure keeps the CMU in place. The CMU foundation walls are then doubled in depth to support the thickness of the strawbale walls.

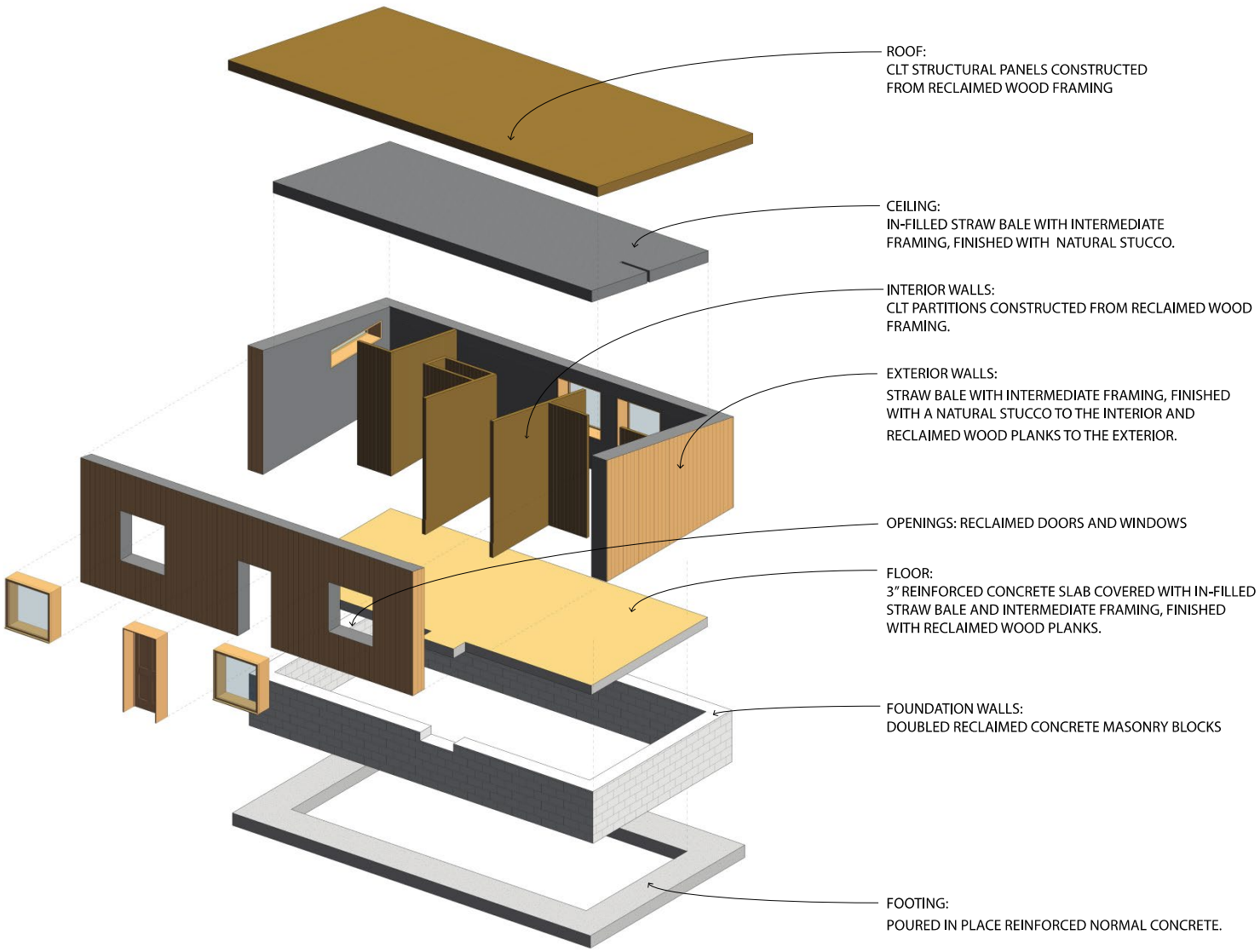
We identified two uses for reclaimed wood planks: in the framing of the floor and ceiling, as well as constructed into CLT panels to create the roof and interior walls. In addition to CLT having a high thermal mass, it also provides a higher acoustical performance than typical interior walls (i.e. minimal requirements per IRC) and is widely accessible in the Midwestern region. Interior CLT walls also do not need to be finished, as the reclaimed wood creates a unique and appealing aesthetic – one that many designers try to replicate through finish materials applied to the surface of typical walls.

Also, highly prevalent and accessible in the Midwest, though underutilized in building construction, is strawbale. Providing a resistance value 30-35+, almost double that of conventional IRC insulation requirements, the strawbale walls in the alternative Co-Learning Residence design provide a feeling of quality and security, while also affording window seats/window boxes in areas of fenestration due to the 18” thickness of the walls. Strawbale walls are also more flame retardant than conventional construction and can easily be reused or recycled.

Earthen plaster and natural stucco are aesthetic and textural materials that provide protection to the surface layer of strawbale walls and reclaimed CMU foundation walls while also being highly practical, sustainable and accessible. The alternative design also includes all reclaimed doors and windows, allowing for each home to be individually unique from one another.

Figure 4 on the next page shows the Co-Learning Plan residence using alternative materials and construction techniques.

Figure 4: Co-Learning Residence base on alternative design and reclaimed materials



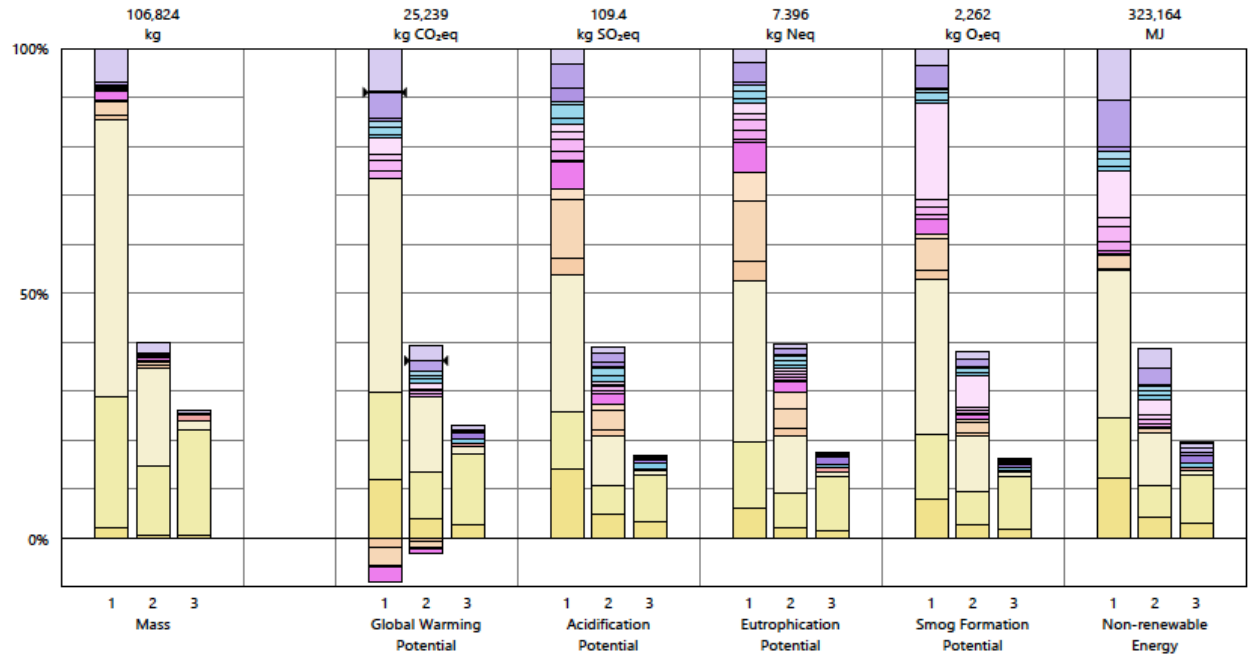
Design Comparison and Findings

With both conventional and alternative design scenarios defined and designed, a cross-comparison analysis was performed. First, we applied each scenario for the Co-Learning Residence through various energy simulations to determine energy consumption for operation, environmental impacts and occupant health aftereffects of each. Our research finds that the Code Compliant Design scenario results in an operational energy cost of $2.74 per square foot per year, whereas the Alternative Design costs $.55 per square foot per year.

The above values for operational consumption of energy were simulated for each tiny home scenario using Insight, a cloud-based, energy modeling software presenting EnergyPlus functionality through an accessible interface. We utilized processes and data from DOE-2-based Building Energy Use and Cost Analysis Software from EnergyPlus because it provides sophisticated building energy-use simulation techniques, allowing for careful studies of detailed building physics with energy data. EnergyPlus is supported by the U.S. Department of Energy and, for the purposes of this research, connects the quantity of energy used within each of the Co-Learning Residence scenarios with current, local utility rates from Lansing, MI.

Because this means that a conventional, IRC-based home costs nearly five times as much for the occupant to operate as the designed alternative model, we conducted a life cycle analysis of each material component to isolate exactly how and where the energy consumption and negative environmental impacts occurred. Figure 4 illustrates how each material category was organized and analyzed. To fully understand the impact of tiny homes, we included a 1,600 square foot standard, freestanding, single family home as a third scenario. Our findings provide evidence that concrete has the largest and most detrimental environmental impact, as exhibited in Figures 5 and 6, closely followed by wood/plastics/composites and thermal and moisture protections. These material components are directly confronted through the alternative tiny home design.

Figure 5: Lifecycle Analysis per Material Category and Specifications



Legend

Net value (impacts + credits)

Design Options

Option 1 - 1,600 Sq.Ft

Option 2 - Conventional Design (primary)

Option 3 - Revised Tiny Home

03 - Concrete

- Steel, reinforcing rod
- Structural concrete, 0-2500 psi, 0-19% fly ash and/or slag
- Structural concrete, 2501-3000 psi, 0-19% fly ash and/or slag

04 - Masonry

- Concrete masonry unit (CMU), solid
- Mortar type N
- Steel, reinforcing rod

06 - Wood/Plastics/Composites

- Ash lumber, 1 inch
- Ash lumber, 2 inch
- Ash lumber, 4 inch
- Cherry lumber, 4 inch
- Domestic softwood, US, AWC - EPD
- Exterior grade plywood, US
- Parallel strand lumber (PSL)
- Wood stain, water based

07 - Thermal and Moisture Protection

- Domestic softwood, US, AWC - EPD
- Fasteners, stainless steel
- Fiberglass blanket insulation, paper faced
- Fiberglass blanket insulation, unfaced
- Paint, exterior acrylic latex
- Self adhering flashing membrane, 40 mil

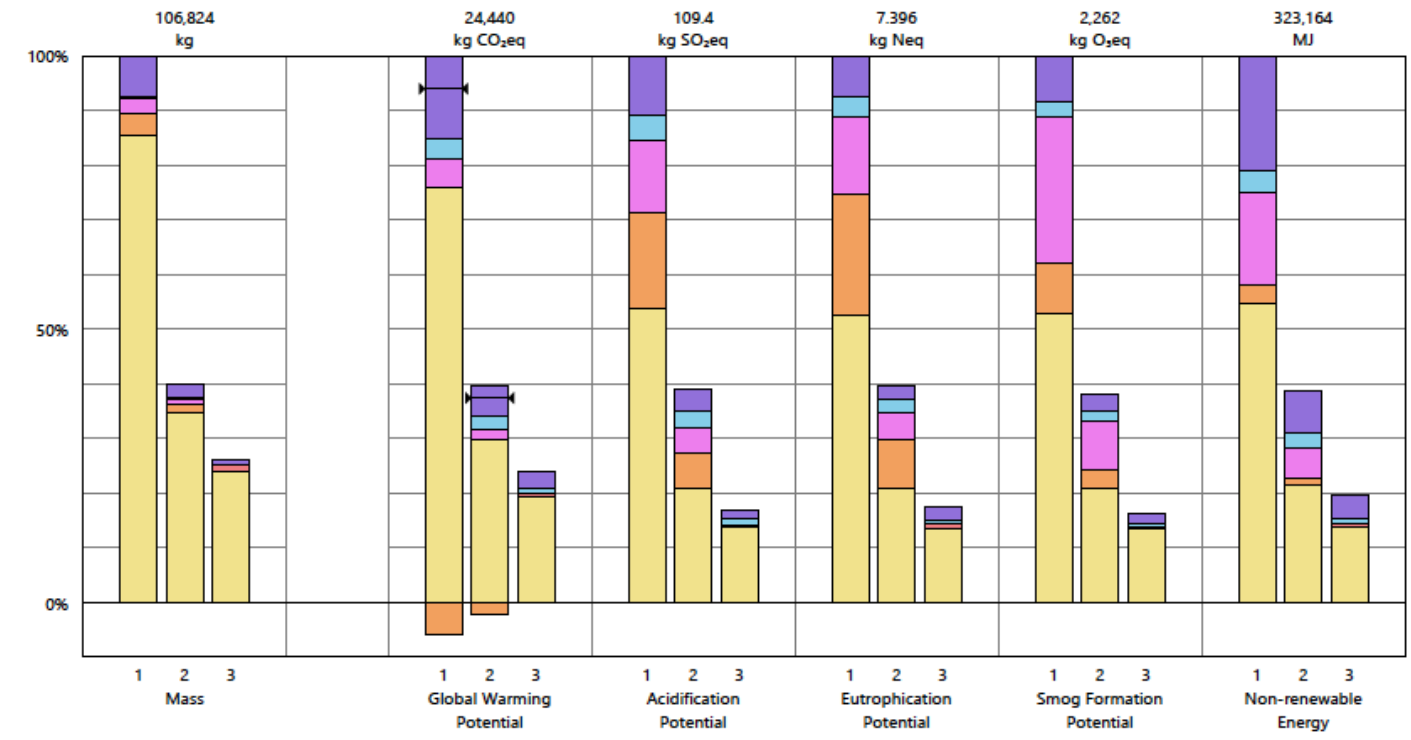
08 - Openings and Glazing

- Curtain wall system, Kawneer, 1600 Wall System - EPD
- Glazing, double, insulated (air)
- Window frame, vinyl, operable
- Window frame, wood, divided operable
- Window frame, wood, operable

09 - Finishes

- Domestic softwood, US, AWC - EPD
- Floor and wall adhesive, urethane
- Paint, Brillux, Arylic facade paint - EPD
- Paint, interior acrylic latex
- Stucco, synthetic
- Wall board, gypsum, natural
- Wood sealer, water-based, for flooring

Figure 6: Lifecycle Analysis per Overarching Material Category



Legend

Net value (impacts + credits)

Design Options

Option 1 - 1,600 Sq.Ft

Option 2 - Conventional Design (primary)

Option 3 - Revised Tiny Home

Divisions

- 03 - Concrete
- 04 - Masonry
- 06 - Wood/Plastics/Composites
- 07 - Thermal and Moisture Protection
- 08 - Openings and Glazing
- 09 - Finishes

Discussion of Findings

Many of the standard and conventional materials, methods, and social norms are causing negative environmental impacts throughout their life cycle and causing considerably more expensive operational costs for occupants. But what do conventional materials contribute towards quality of life and human wellbeing? Aside from satisfying basic shelter needs, conventional architecture and construction does little to support the local economy, reduce waste, and empower residents. Overtime, the durability of traditional materials will decrease and need to be replaced or further maintained. These scenarios are not setting residents up for future success.

Until recently, tiny home living has been associated with intentionally, minimalist and/or nomadic lifestyles. The Co-Learning Residence was designed to be a permanent structure in order to break through these preconceived notions of tiny living. In fact, the use of local, reclaimed and alternate materials makes tiny home living site-specific and influenced by local, architectural vernacular. Each home can be hand-crafted and highly designed – qualities in architecture normally associated with higher socio-economic classes. Decreasing the footprint of a home greatly increases the ultimate value – from conception to construction to occupancy, the end user can be involved in the process of designing and building their own home.

The unique aesthetic need not be limited to any specific designed appearance; each home can fully embody different architectural styles not unlike a conventional 1,600 square foot single family home. As architects, we are deeply invested in environmental psychology and the great influence that materiality has on human wellbeing. By straying from the conventional norm, we focus on materiality as a driving force behind the home design. Using Domicology to achieve architectural material poetics offered us a way to further develop our own disciplinary, practice-based knowledge. The amount of material required to construct a tiny home is small, but the capability of constructing the entire structure from reused materials is profound.

Figure 7: Rendering of Alternative Tiny House Design

,

REFERENCES

Carlin, Timothy Michael. (2014). "Tiny homes: Improving carbon footprint and the American lifestyle on a large scale". Celebrating Scholarship & Creativity Day. Paper 35. http://digitalcommons.csbsju.edu/elce_cscday/35

Colestock, S. (2018, May 18). How Much Does a Tiny House Cost? Retrieved from https://www.doughroller.net/money-life/how-much-does-a-tiny-house-cost/

Community Frameworks (2015) *Tiny Houses: A permanent supportive housing model*. Retrieved from: http://www.quixotecommunities.org/uploads/1/2/1/6/121607421/final_tiny_homes_white_paper_march_2015.pdf

Evans, K. (2018) *Integrating tiny and small homes into the urban landscape: History, land use barriers and potential solutions*. Retrieved from: https://pdfs.semanticscholar.org/624c/9b0400a0a997d459f71f40d846a88b2af256.pdf

Evans, K. (2018). Overcoming Barriers to Tiny and Small Home Urban Integration: A Comparative Case Study in the Carolinas. Journal of Planning Education and Research. https://doi.org/10.1177/0739456X18788938

Fowler, F. (2018) *Tiny Homes in a Big City*. Detroit, Michigan: Cass Community Publishing House

Hoffower, H. (2019, July 05). The most expensive and affordable states to buy a house, ranked. Retrieved from https://www.businessinsider.com/cost-to-buy-a-house-in-every-state-ranked-2018-8#46-michigan-6

Howard, M. (2018) *You Can't Just Put Homeless People in Tiny Houses.* Retrieved from: https://theoutline.com/post/4639/tiny-house-affordable-housing-adu-boston-portland?zd=3&zi=nnmme6of

HUD User. (2019) *Featured Article: Rethinking Affordability Measures*. Retrieved from: https://www.huduser.gov/portal/pdredge/pdr_edge_featd_article_092214.html

Michigan Adoption Resource Exchange (2019) *Adoption Navigators for Families*. Retrieved from: https://mare.org/For-Families/Adoption-Navigators

Michigan Department of Health and Human Services (2015) *Licensing Rules For Foster Family Homes and Foster Family Group Homes For Children.* Retrieved from: https://www.michigan.gov/documents/mdhhs/CWL-PUB-10_502652_7.pdf

Mitchel, R. (2013) *Cracking the Code: Tiny Houses and Building Codes*. Retrieved from: https://thetinylife.com/cracking-the-code-tiny-houses-and-building-codes/

Morrison, A. & Morrison, G. (2019) *The Tiny House Movement*. Retrieved From: https://tinyhousebuild.com/

Myers, M. (2008) *Understanding Affordable Housing*. Retrieved From: https://web.archive.org/web/20120426044456/http://www.qahc.asn.au/images2/website/affordabilitychart.pdf

National Fire Prevention Association (2017) *Applying Building Codes to Tiny Homes*. Retrieved from: https://www.nfpa.org/-/media/Files/Codes-and-standards/Building-Code-Development-Committee/BCDC_WhitePaper_TinyHome_5_12_17.ashx?la=en

National Low Income Housing Coalition. (2018) *Affordable Housing State Profile: Michigan*. Retrieved Online: https://nlihc.org/sites/default/files/SHP_MI.pdf

National Low Income Housing Coalition. (2018) *Out of Reach: Michigan.* Retrieved from: https://reports.nlihc.org/sites/default/files/oor/files/reports/state/OOR_2018_MI.pdf

Pino, A. (2016, December 04). 13 Ways a Tiny House Can Save You $378 a Month or More. Retrieved from https://www.tumbleweedhouses.com/tiny-house-lifestyle/13-ways-a-tiny-house-can-save-you-378-a-month-or-more/

The Tiny Life. (2019). What Is The Tiny House Movement? Why Tiny Houses? Retrieved from https://thetinylife.com/what-is-the-tiny-house-movement/

Yes Communities. (2014). Retrieved from https://www.yescommunities.com/news/what-difference-between-singlewide-and-doublewide-home

APPENDIX

Establishing a Habitable Dwelling

A fundamental challenge in a successful Tiny Home development comes from meeting the necessary requirements to be designated as a *Habitable Dwelling*. Each municipality will have its own definition of what qualifies as a *Habitable Dwelling* that are commonly defined based on the code requirements from the IRC. The following section features a sample ordinance has been sourced from The Tiny Life, an organization devoted to empowering individuals to build and live in their own Tiny Homes. This sample ordinance represents an archetypal *Habitable Dwelling* ordinance.

Archetypal Habitable Dwelling Ordinance (Thetinylife.com / Ryan Mitchel)

Minimum Floor Area for Sleeping Purposes

Every dwelling unit shall contain at least one hundred and fifty (150) square feet of habitable floor area for the first occupant, at least one hundred (100) square feet of additional habitable area for each of the next three occupants, and at least seventy-five (75) square feet of additional habitable floor area for each additional occupant.

Every room occupied for sleeping purposes by one (1) occupant shall contain at least seventy (70) square feet of floor area, and every room occupied for sleeping purposes by more than one (1) occupant shall contain at least fifty (50) square feet of floor area for each occupant twelve (12) years of age and over and at least thirty-five (35) square feet of floor area for each occupant under twelve (12) years of age.

(a) Plumbing System.

> *(1) Each dwelling unit shall be connected to a potable water supply and to the public sewer or other approved sewage disposal system.*
> *(2) Each dwelling unit shall contain not less than a kitchen sink, lavatory, tub or shower, water closet, and adequate supply of both cold and hot water. All water shall be supplied through an approved pipe distribution system connected to an approved potable water supply.*
> *(3) All plumbing fixtures shall be maintained in a state of good repair and in good working order.*
> *(4) All required plumbing fixtures shall be located within the dwelling unit and be accessible to the occupants of same. The water closet and tub or shower shall be located in a room or rooms affording privacy to the user.*

(b) Heating System. Every dwelling and dwelling unit shall have either (1) or (2)

> *(1) Central and electric heating systems. Every central or electric heating system shall be of sufficient capacity so as to heat all habitable rooms, bathrooms and water closet compartments in every dwelling unit to which it is connected with a minimum temperature of sixty-eight (68) degrees*
>
> *(2) Fahrenheit measured at a point three feet (3') above the floor and two feet (2') from exterior walls during ordinary winter conditions*

Other Heating facilities.
Where a central or electric heating system is not provided, each dwelling and dwelling unit shall be provided with sufficient fireplaces, chimneys, flues or gas vents whereby heating appliances may be connected so as to heat all habitable rooms with a minimum temperature of 68 degrees Fahrenheit measured three feet (3') above the floor and two feet (2') from exterior walls during ordinary winter conditions.

(c) Electrical System.

(1) Every dwelling and dwelling unit shall be wired for electric lights and convenience receptacles. Every habitable room shall contain at least two floor or wall-type electric convenience receptacles, connected in such manner as determined by the National Electric Code. There shall be installed in every bathroom, water closet room, laundry room and furnace room at least one supplied ceiling, or wall-type electric light fixture. In the event wall or ceiling light fixtures are not provided in any habitable room,then each such habitable room shall contain at least three floor or wall-type electric convenience receptacles

(2) Every public hall and stairway in every multiple dwelling shall be adequately lighted by electric lights at all times when natural daylight is not sufficient.
(3) All fixtures, receptacles, equipment and wiring shall be maintained in a state of good repair, safe, capable of being used, without hazard to property or person.

Selected IRC Code Sections

The following is a selection of building codes from the 2018 IRC that have been referenced as being potentially problematic for tiny house construction.

Minimum Floor Area and Dimension

R304.1 Minimum area
Habitable rooms shall have a floor area of not less than 70 square feet (6.5 m^2).
Exception: *Kitchens.*

R304.2 Minimum dimensions
Habitable rooms shall be not less than 7 feet (2134 mm) in any horizontal dimension.
Exception: *Kitchens.*

R304.3 Height effect on room area *Portions of a room with a sloping ceiling measuring less than 5 feet (1524 mm) or a furred ceiling measuring less than 7 feet (2134 mm) from the finished floor to the finished ceiling shall not be considered as contributing to the minimum required habitable area for that room.*

Means of Egress

R311.1 Means of egress
Dwellings shall be provided with a means of egress in accordance with this section. The means of egress shall provide a continuous and unobstructed path of vertical and horizontal egress travel from all portions of the dwelling to the required egress door without requiring travel through a garage. The required egress door shall open directly into a public way or to a yard or court that opens to a public way.

Mezzanines and Lofts

R325.2 Mezzanines
The clear height above and below mezzanine floor construction shall be not less than 7 feet (2134 mm).

R325.3 Area limitation
The aggregate area of a mezzanine or mezzanines shall be not greater than one-third of the floor area of the room or space in which they are located. The enclosed portion of a room shall not be included in the determination of the floor area of the room in which the mezzanine is located.

R325.4 Means of egress
The means of egress for mezzanines shall comply with the applicable provisions of Section R311. (See Above Section Titled 'Egress')

R325.5 Openness
Mezzanines shall be open and unobstructed to the room in which they are located except for walls not more than 36 inches (1067 mm) in height, columns and posts

2018 Appendix Q

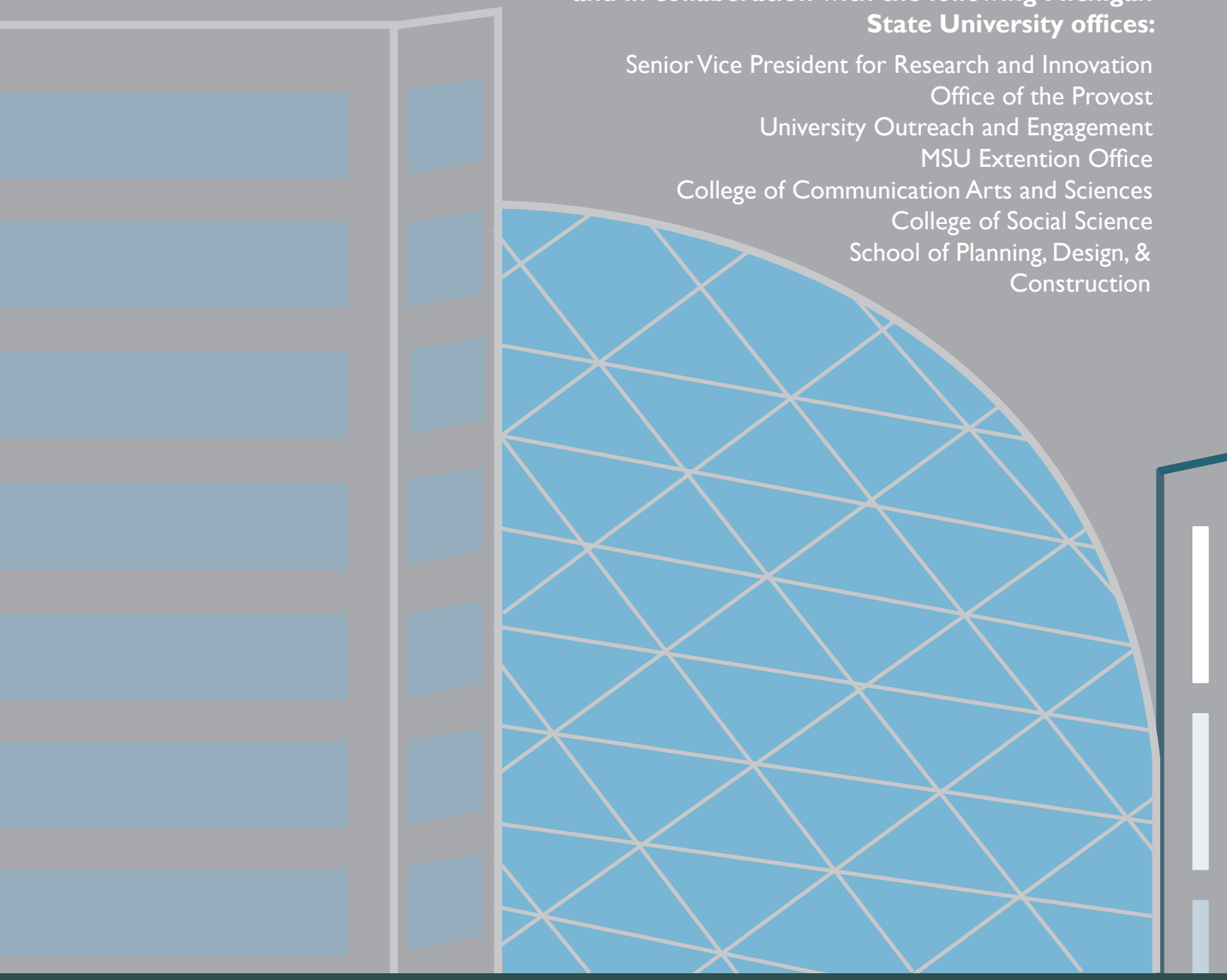
AQ102 Definitions
***LOFT**. A floor level located more than 30 inches (762 mm) above the main floor and open to it on at least one side with a ceiling height of less than 6 feet 8 inches (2032 mm), used as a living or sleeping space.*
***TINY HOUSE**. A dwelling that is 400 square feet (37 m) or less in floor area excluding lofts.*

***AV104.2.2** Ladders.*
*Ladders accessing lofts shall comply with Sections **AV104.2.1** and **AV104.2.2.***
AV104.2.2.1 Size and capacity.
Ladders accessing lofts shall have a rung width of not less than 12 inches (305 mm) and 10 inches (254 mm) to 14 inches (356 mm) spacing between rungs. Ladders shall be capable of supporting a 200 pound (75 kg) load on any rung. Rung spacing shall be uniform within 3/8-inch (9.5 mm).
***AV104.2.2.2** Incline.*
Ladders shall be installed at 70 to 80 degrees from horizontal.

The MSU EDA University Center for Regional Economic Innovation (REI) seeks to identify and develop new economic development tools, models, policies and practices to support innovative economic development high-growth enterprises and job creation in distressed regions across the state. REI has established a new economic development ecosystem to cope with the ever-changing global and regional dynamic(s). Through this ecosystem, we engage innovative and creative minds which result in new economic development practices.

The REI University Center was Established in 2011 with support from the U.S. Department of Commerce, Economic Development Administration (EDA), and in collaberation with the following Michigan State University offices:

Senior Vice President for Research and Innovation
Office of the Provost
University Outreach and Engagement
MSU Extention Office
College of Communication Arts and Sciences
College of Social Science
School of Planning, Design, & Construction



Michigan State University
EDA University Center for Regional Economic Innovation

2019 Co-Learning Plan Series

MICHIGAN STATE UNIVERSITY
Center for Community and Economic Development
University Center for Regional Economic Innovation

E·D·A
U.S. ECONOMIC DEVELOPMENT ADMINISTRATION