University of Cincinnati

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I, Michael_A Pasquale, hereby submit this original work as part of the requirements for the degree of Master of Architecture in Architecture (Master of).

It is entitled:
Smarter Single Family

Student's name: Michael A Pasquale

This work and its defense approved by:

Committee chair: Michael McInturf, M.Arch
Committee member: Aarati Kanekar, Ph.D.
Smarter Single Family

A thesis submitted to the Graduate School of the University of Cincinnati
in partial fulfillment of the requirements for the degree of

Masters of Architecture Thesis
In the School of Architecture and Interior Design of the college of
Design, Art, Architecture, & Planning.

April 5th 2013

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Abstract

At the turn of the century, Frank Lloyd Wright set out to change the housing paradigm to meet society’s new needs in housing. He exploded the traditional cut up interiors calling them “boxes beside boxes or inside boxes... cellular sequestration that implied ancestors familiar with penal institutions.” Wright’s introduction of the open plan was able to better meet a family’s program requirements due to the fact that the traditional Victorian style home was designed primarily for a wealthy family with servants, during a time when energy and resources were vastly different. Yet the Victorian design ethos became the paradigm for the American single family home and is largely dominant today. The 2010 census notes 65% of housing units are owner occupied single family homes. However many planning and energy conflicts may be present with these homes. For example most homes built prior to the 1970’s oil crisis are energy inefficient. Further, older homes are designed around the outdated, Victorian family structure.

This thesis takes a design/ build approach to renovation and home planning strategies on some of Cincinnati’s older homes. Habitat for Humanity of Greater Cincinnati has given this thesis a chance to actually implement designs from the studio & research. Energy data and occupancy evaluations will be kept and studied. Ultimately the strategies for better planning and energy savings will be applicable to the vast market of homes throughout the middle of the United States.

In my experience, architecture students spend most of our time on studio work, only engaged in design. This is interesting because the exact opposite occurs while working in an architecture firm. In the professional practice, one spends most of their time producing construction documents. Detailing a building is a totally different kind of design challenge that we hardly experience in school. As one who likes details and admires drawing sheets, I get frustrated when a studio professor says something to the likes of, “you will have your whole life to deal with the code, go crazy and have fun with your studio project” because they are not preparing us to be licensed professionals. Thus to incorporate a design/build project into the thesis in lieu of paper architecture, fellow thesis student Nate Substanley and myself sought the Cincinnati Chapter of Habitat for Humanity to see if we could partner with them on one of their home projects.

Recognizing the potential in existing homes, Cincinnati Habitat has moved into home renovations alongside building their new model homes. They can house five families in renovations to only three families on new builds for the same costs. However the old (renovation) homes are all different with varying existing conditions. Habitat’s designers and construction crews do not have the means and procedures to provide a better build strategy than to simply fix what needs to be fixed in these old homes. This thesis includes ideal renovation strategies for replanning and energy savings in old homes based on studies of the function of the Victorian home. Furthermore the renovation strategies include detail drawings, images, and photographs of how they are assembled and function in a real home in Cincinnati (Millrich Ave). Not only will Habitat homes be better planned and more environmentally friendly from this work, but the ideas can be implemented into almost any old home.

Through this process we have had the additional professional experiences of permitting our designs, managing volunteer crews, planning and budgeting, communicating with inspectors and sub contractors, on-site detailing, working with a real client, and actually building! We expect the home to be completed sometime in early June of 2013. Please check the blog for photos or log in to Habitat for Humanity’s website to volunteer or donate.

http://smartersinglefamily.blogspot.com/
http://www.habitatcincinnati.org/
Acknowledgements

Design Build Symposium

This thesis was sparked by a lecture series hosted by the School of Architecture & Interior Design (SAID) within the College of Design, Art, Architecture, & Planning (DAAP) during the 2011-2012 school year. It was focused around design-build education and service learning projects by Bryan Bell, Dan Rockhill, John Folan, Sergio Paleroni, & John Quale and others. Each presenter had a drive and passion in their built works I found very admirable as an architecture student wanting to do more than paper or digital design.

MetroLab Studio

MetroLab is a graduate studio at the University of Cincinnati instructed by Architect Terry Boling. This preliminary study of a new paradigm in design build education brought us into an old brick building in the Over-The-Rhine neighborhood of Cincinnati. It allowed us to experiment with materials, connections, program and architectural form. We got thrifty by reusing materials and technical by designing for more than the final appearance. It allowed for a start to finish project touching on all parts of the construction process and also inspired me to continue to build in this thesis.

Figure 0.1
Migrant worker housing. Design Corps & Byan Bell
Figure 0.2
House 1. University of Arizona John Folan & Mary Hardin
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The Housing Market
US Census Bureau’s Report on Home Types

65%
Of the US population live in single family homes they own.

80%
Of the US population live in single family homes, including owner occupied units and rental units.

Figure 1.1
Pie charts illustrating the popularity and prevalence of the single family home.
Data collected from US 2010 Census.
The single family home is the most prevalent building type in America. Builders during strong economic periods have produced 20,000 to 40,000 single family homes per year. 65% of Americans live in a home they own and approximately 80% of the population lives in a single family home when rental homes are added to the list. Knowing the prevalence of this building typology, one would think it is at the forefront of most planners, designers, & architect’s consideration. But reality is the work of architects & designers of our built environment, only reaches about 2% of the world’s population.

However this new wave of public interest designers like Bryan Bell, Sergio Paleroni, Maurice Cox are not the first to be concerned with the design, or lack thereof, in housing. Nearly a century ago Frank Lloyd Wright had similar concerns stating, “The small house of moderate cost is not only America’s major architectural problem, but the problem most difficult for her major architects.” Wright’s concern was with the historic, Victorian design of typical 20th century houses. He composed many writings on various parts of the home and how they should be viewed and implemented for people of today’s world.

The Victorian home was one of ornate design and functional consideration. While the woodworking was very detailed and articulate, the proportions and plans encompassed rational thinking. For example old Victorian homes in the french quarter of New Orleans have high ceilings of 12’ and 14’. These walls have tall double hung windows and are surrounded by porches on the exterior. While these items give a nostalgic and appealing presence on newly built homes, they were all part of a passive cooling design for the 19th century. In hot and humid climates, before air conditioning was available, ventilation, shading, & distance were the only ways a person could escape the heat. Since hot air rises, the tall ceilings created more distance between the occupant and the undesirable hot air. True double hung windows that could open at the top and bottom allowed high/ low ventilation. This creating natural air movement through a room, exhausting hot air atop, and pulling cool air in from outside. Porches also shaded the windows from the high summer sun and created a cool buffer zone around the home.

Similarly in winter, the Victorian home relied on simple technologies for heating. Since wood and oil burning fireplaces were the only heating means, rooms were boxes with doors between each other.

This was done to keep the heat in a room while the fire burned. But industrialization and standardization gave way to the passive and simple designed functions of the Victorian home. The passive designs were lost to natural gas and air conditioning. In all it took less man hours and less material to build a simple home with mechanical equipment, and was ultimately cheaper than a proper Victorian home.

**Production Development**

The Post WWII housing shortage put custom built home solutions off the map for the majority of new home owners. Thousands of young families and an industrialized workforce lead perfectly into a plans of mass produced houses and suburban developments. Bill Levitt was one developer who met the demands of the post WWII market. He bought farmland just outside metropolitan areas to convert into residential neighborhoods. He would build a select few models of homes, dropping his labor rates and material waste to a minimum through assembly-line like construction crews. Meanwhile customers were very happy with Levitt homes as they were very affordable with a reputation of solid construction since the build process was so seamless. This production style development appalled may architects as they lost work and communities became less distinguished architecturally. But larger issues like the housing shortage were prevalent and since Levittowns existed on farm land, without all the planning and building commissions, there was little local government or anti development advocates could do to stop production.

This model has persisted since WWII and is deeply dependant on market value. Since customization adds time and money, today’s big home developers will hire some architects for their designs. But that cost for the design is divided among several copies of that home being built so the architect and/or design becomes affordable for the masses. A homeowner of the middle class can quickly put money into their home that won’t translate into added value at the end of a loan period or sale like extra built ins, custom furniture, multiple levels, or high ceilings. A home’s value is always compared against similar houses in the market and the average level of extras. So the jacuzzi tubs, extra garage space, and cedar deck might not be a good investment to the average buyer. Essentially, the biggest statistic in a home’s value in a suburban neighborhood, new or old, is cost per square ft. Its something banks

5 Ibid - Hayden (62)
and appraisers can easily calculate value from and thus a number developers and builders know and can control on a project. Meanwhile designers or architects without much experience in market value, will often find themselves ‘value engineering’ pieces of the project off the paper.

This standardized model has had negative environmental impacts that were hardly considered during this housing shortage. Hayden notes the cookie-cutter practice put the same models in the northeastern states like Massachusetts as the southwestern states like Arizona, two totally different climates. Furthermore the standardized lots left no consideration for solar orientations, and the use of existing farmland for sites left almost no old growth trees for shade and air quality. Consequently these cheap to build homes required much more heating and cooling energy than a uniquely & environmentally designed home.⁷

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⁷ Ibid - Hayden (64)
Another developer/ builder with ideas for the future was Carl Strandlund and his Lustron Home. With a steel stock no longer needed for military purpose and a federal government wishing to sell it cheap and also house GIs, Carl looked toward the porcelain enamel steel. The technology was roughly 20 years old at the time, but was uncharted in the single family home market. He saw it as a means to fast, affordable houses that made Levitt’s system look antique. The Lustron Housing Company produced 2,680 units in two years before bankruptcy in 1950. Since the homes were a factory kit of parts that fit onto one truck trailer, they were shipped all over the continental states as well as Alaska and Venezuela. When the factory got into full operation, it could produce 50 homes per day. While conventional building couldn’t compare to how quickly a Lustron could be built, shipped and assembled, labor and building codes were obstacles for the mass produced unit. While a lustron cost $7,500 at a dealer in 1949, it could be $10,000 by the time it was assembled on site with permits and utilities connected to the house. Meanwhile similar sized stick built buildings could be had for $6,000 to $7,000 in most areas.

While the Lustron seemed like the future’s answer to housing, it suffered with environmental issues and place as well. While its porcelain enameled steel could outlast wood siding in terms of maintenance, the scarcely insulated metal building required much heating and cooling for the seasonal temperature changes of the US. The specially designed trailer that hauled one unit from place to place, needed to be brought back to the factory for reloading, making a Lustron built near the factory nearly $2,500 cheaper than one built across the country due to shipping. Ultimately Strandlund and the Lustron home could not produce enough to pay back their federal loans and were forced into bankruptcy.

It would have been interesting to see where an auto industry home manufacturer would have fit in the single family home market. What would Lustron Corporation have done when the GI housing shortage was meet? Would they have additions and upgrades? Would service and maintenance be streamlined or impossible? In all I believe mass production is not the answer to architecture. Site and place pose far too many challenges as well as inspirations that cannot be answered with one prototype building.
The Single Family Conundrum

While Levitt’s development practice and factory production efforts of the Lustron home meet the housing shortage, they did little for the evolution of the American household. These single families are designed around an ideal American lifestyle of the past. They are ideal for a life where that of work, public and private are separate entities, in separate parts of town. They are also for family structure with a husband and wife housing their school age children. Let us remember that this cultural household is relatively new and mostly pioneered in America. Our first US cities and most of Europe followed a multi generational approach to housing in less metro areas. Fast forwarding through many other cultural changes and scenarios, we now have single working parents, multi generational households, elder or boomerang children, empty nesters, disabilities, aging in place, divorced, and many other kinds of families, all living in the average, post war, 3 bedroom 1.5 bath home.

Frank Lloyd Wright Usonian Homes
Jacobs & Seth Peterson Residences

Top  Figure 2.1 Jacob’s House. Frank Lloyd Wright, Madison WI
Bottom  Figure 2.2 Seth Peterson House. Frank Lloyd Wright Mirror Lake, WI

Chapter 2
Housing Ideals & The Usonian

Frank Lloyd Wright is possibly the greatest and most well known of American architects. He started his own practice by designing & building his own home in 1889 and continually had single family homes on his desk until his death in 1959. While he is most well known for large homes of beauty and drama like Falling Water, the idea of an affordable, economical and desirable single family home was something he continued to design and publish throughout his life. Wright was dissatisfied with the Victorian disguised boxes built by most developers around him. He adamantly wrote about an organic architecture, where rooms could be thought of in ideal circumstances for the building’s users. Where views and light should drive the design of the exterior. Interior space could flow, hold different functions and connect to nature. He saw the site, the horizon, nature, light, air, unity, clerestory, heating, and other components of a home as design opportunities for which he could capture their brilliance and manipulate to an ideal function. He ultimately designed around 140 single family homes under this idea of reasonably sized organic architecture, today known as Wright’s Usonian Homes.

2 Ibid - Maddex (53)
3 Ibid- Maddex (15-16)
Site

Wright is said to have visited every site he designed for. He used site to first determine the ideas that should drive the design of a project. He believed, “A home should appear to grow organically from its site like a tree from the soil, built of the hill, not on it, and giving few hints where the ground leaves off and the building begins.” He also believed a site, or climate should determine the materials the home should be, during a time when national builders would build the same in any climate. Wright’s homes in the hot dry climate of Phoenix, the mild climate of Southern California or the changing humid climates of the middle west would all look different. Thus Wright’s Californian usonian homes are made of concrete block or light wooden structures with window walls, to allow air to vent through the homes in the warm mild climate. In the Southeast he prefers adobe, local sandstone, with large overhangs and many courtyards for shade and ventilation. In the woods of the midwest parts of the home tuck into the ground for warmth, while clerestories bring light deep into the interior and vent on hot days. When compared to the basics, a Wright home is really built the same way a production builder would build. Wright just puts more time into detailing the designs and a little more money is put into finishes. As Wright clearly stated, “Simply selling houses at less cost means nothing to me. To sell beautiful houses at less cost means everything.”

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4 Ibid - Maddex (23)
5 Ibid - Maddex (25-26)
6 Ibid - Maddex (13)
Figure 2.3
Lykes House,
Phoenix, AZ
By Frank Lloyd Wright

Figure 2.4
Seth Peterson House
Mirror Lake, WI
By Frank Lloyd Wright

Figure 2.5
Walker House
Carmel, CA
By Frank Lloyd Wright

Figure 2.6
Lustron Home
near Dayton, OH
By Lustron Homes, MFG
*Estimated build date 1957-1959, this home was shipped all over continental US, Alaska, & to Venezuela.
The Hearth

Wright Recognized the importance of the fireplace in single family homes. In the Victorian home, the fireplace was the evening gathering place, center for cooking, warmth, heating of bath water, light source, etc. He saw the fireplace or hearth as maintaining the idea for gathering, thus making hearths an integral part of the home’s interior and exterior. He tried to design these hearths as focal points of rooms with seating around them and or multiple openings into adjacent rooms. They try to engage space, not sit on the perimeter of it. He used them as center points in the home, defining space in the plan and elevation, and only used on large chimney to puncture the roof. Wright was certainly ahead of his time designing our interiors for what we really want. In his summer retreat and architecture school, Taliesin West, Wright implemented a hearth with a projection screen above it, for evening cinema gatherings. In 1945 this was his flat screen above a fireplace, now a common suburban status symbol for the 2010 housing market.

Glazing

Windows are another important part of the home Wright, thought of as components to enhance the design. He describes glass as a “magic material, there but not seen.” Wright believed windows should be grouped together in rooms to create a connection to the outdoors and vistas through the home. These would include operable windows and/or french doors to further blend the line between inside and outside. He also believed in filtering and controlling light, for the correct ambience of a room. Using clerestory windows, light shelves, and screens to bounce light deep into a room or soften its rays. He also preferred reflecting light off lightly stained wood for a warm interior. Wright’s windows always open to the exterior, to connect with nature and bring in fresh air. Seldom does he treat a window as a puncture through the facade, but rather as an arrangement or window wall. The convention of puncturing window units could never deliver the connection and continuity of a fully glazed wall.

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9 Ibid - Maddex (36)
Top & Middle  Figure 2.7 & 2.8  Zimmerman House. Frank Llyod Wright Architect. Manchester, NH.
Bottom  Figure 2.9 Laurent House. Frank Llyod Wright Architect. Rockford, IL
The Plan

Wright strongly believed in designing the plan. He wrote in a paper to Architectural Record in 1908, “No Man ever built a building worthy the name of architecture who fashioned it in perspective.” The plan is where the logic of a design comes together, it is the surface on which gravity forces us to inhabit. It is where spaces and corridors align and abut and it is the primary document for which the building and site are situated. Wright preferred a building without wasted space, where only the rooms needed were constituted by their functions. In his own home he included a second floor studio to work on projects after hours. As his practice and family grew, the office received an extra partition down the center, creating two children’s bedrooms. In planning single family homes, Wright specifically mentions the living room, dining room and kitchen as the only necessities to the building type, furthermore that their ‘home style’ match their ‘family style’.

In The Robie house of 1906 outside Chicago, IL, Wright used several moves and planning adjacencies to arrange the plan. The two shifted boxes designate public and private space and hinge on the court and front entries. The section shows public and private relations as the plan to organise space. He extends the house to planters and privacy walls that blurred edges of public and private though levels of view and exposure from the street.

In later homes like the Lykes House outside Phoenix, AZ in 1956, the diagram of how one should dwell and how the home and site work together are very much the same. Here two circles of public and private are connected by a series of bedrooms, ideal for a family of three children and guest room for relatives. The home has a great view of the valley, but is twisted, giving its sparsely glazed back to the South West to lessen daytime overheating and hold the warmth through the night in the masonry wall. Again the entry is used as hinge between public and private as the building’s elevation is an extrusion of its idealized floor plans.

12 Ibid - Wright (55)

Chapter 2
Top Figure 2.10 Diagrams of Robie house and Lykes house. By Author
Middle Figure 2.10a Plans of Robie house. http://cristinaolucha.wordpress.com/
Bottom Figure 2.10b Plan of Lykes house. Maddex - Wright Sized Houses
The Usonian & The Victorian & The Production Home

The Victorian home was very divorced of site, but its components shared ideals akin to those of Frank Lloyd Wright where ideas grounded their design. Windows and candles were the only light sources before electricity and the light bulb were mastered so tall windows got light deeper into a room. Also opening the window was the only cooling and ventilation system, so clerestory windows and operable door transoms were used. These also worked with the wrap-a-round porches on southern homes, blurring the boundary between inside and outside like Wright and his courtyards. The porches offered shading to the home from the high summer sun like Wright’s long cantilevering hip roofs. Pre industrialization, fireplaces were the only heating source, so it was desirable and functional to have more. In production building the Victorian style stayed around as cosmetic inspiration. Simply look at the prefab Lustron home. The factory could turn out 50 models in a day, and they could be built by a small team in a week once they arrived on site. But they looked like a stick framed cottage because they couldn’t design something less a little less dramatic then Buckminster Fuller’s Dioxan house. It wasn’t a unique building fit for a client and their site but a non-offensive, politically correct version of a home that didn’t upset anyone but didn’t impress either.

14 Lustron : The House America’s Been Waiting for. Prod. KDN Videoworks. WOSU-TV (Television Station : Columbus, Ohio); Ohio State University, 2002. DVD.

Chapter 2
Figure 2.1
Jacob’s House
Madison, WI
By Frank Lloyd Wright

Figure 2.6
Lustron Home
near Dayton, OH
By Lustron Homes, MFGR
*Estimated build date 1957-1959, this home was a factory kit, shipped all over continental US, Alaska, & to Venezuela.

Figure 2.11
Diamoxin House
By Buckminster Fuller
A Pre-Fab housing prototype of 1929 & 1945.

Figure 2.12
Typical Levitt Home
Levittown, NY
Figure 3.1
Photos by author of Rio Rancho, NM, the largest suburban neighborhood of Albuquerque. They show the dominance of the single family home in the US landscape and developmental sprawl into the open landscape.
Outtakess on Affordable Housing

Housing is the most common form of architecture in the US and quite a popular subject. Most Americans grow up in a single family home, have friends and families with single family homes, and will probably own a single family home at some point in their lives. Meanwhile designers working with single family are a peculiar topic. A select few design ultra-luxurious or modern dwellings for the elite while most designers create faux imitations of European typologies that get stamped onto many markets and locations.

This isn’t to say that designers aren’t interested in the single family market or design for individual clients. Some designers continue to push the home’s function, its design, and its affordability. The subject of affordable housing is a “hazy dream” according to Karrie Jacobs in her book, The Perfect $100,000.00 House, yet she cites several examples in her travels. Yale & Auburn Universities each operate design-build studios that take innovative design thinking into housing. Others such as Brett Zamore, of Brett Zamore Design, have even taken on the challenge of starting from scratch and showing the way to affordable architecture.
The Perfect $100,000 House

Is a book/documentary by Karrie Jacobs and her 14,500 mile summer road trip in search of an affordable dream home. This former editor of Dwell magazine meets with architects, real-estate agents, builders and even spends some time learning construction in her quest for avant-garde architecture that anyone could potentially own. In general, she discovered if someone wants a new home for $100k, they are limited to a commercial home builder or getting something used. In the used market there is a lot of potential. New-urbanist neighborhoods are retaking value in once undesirable older neighborhoods and the financial down turn has made some old homes very affordable for the DIY type. Jacobs found an upkept, original Craftsman home in Yankton, SD she adored for $65k. Seldom can new home builders offer more than 1,000 square feet of faux European styled box for the $100k milestone. With some builders who are completing over 27,000 to 44,000 homes a year, the only customization is in color selection or pre-designed add-ons; nothing truly site or client specific.

On a personal note, Jacobs taste is modern, yet the principles of modern are not something that has come into the single family home market. Stick-built houses are erected quite quickly and efficiently. Few designers or builders have implemented innovation to the industry. One should consider that site built, site specific design is not a bad thing and should not be eliminated. There is a wealth of sustainable and ideological knowledge pertaining to site built architecture that this paper doesn't have time to cover, but will be acknowledged via an excerpt by Francis Ching:

Buildings do not exist in isolation. They are conceived to house, support, and inspire a range of human activities in response to sociocultural, economic, and political needs, and are erected in natural and built environments that constrain as well as offer opportunities for development. We should therefore carefully consider the contextual forces that a site presents in planning the design and construction of buildings.

The simple fact is that the industrial revolution started over 150 years ago. If there was more room for industry and mass production in the single family home, it would be here by now. For example, many

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2 Ibid - (89)
3 Ibid - (57)
designers take the hard approach of reinventing the wheel. Yes, structural insulating panels and pre-fabrication sound like the future in home building, but few companies have the capital investment power of a major automotive maker to deeply invest in these experiments.\(^5\) While starting the experiment is one issue, longevity is another. Lustron homes were only manufactured two years until bankruptcy.\(^6\) Furthermore, modern style, with its sleek lines, minimalist materials and pure geometry is actually more expensive to build than traditional housing because it takes much more time and labor to make sure joints are perfect and clean.

Jacobs finds some more perspective and hope for the dream in her meeting with Architect Adam Kalkin & the Anderson Brothers. She first met Kalkin in Vermont, to see his personal home featuring 3,640 square foot, very high ceilings, and modern aesthetic for approximately $125,000.\(^7\) This $34 per square foot mansion is thanks to a pre-engineered metal building and reused shipping containers. While the style and openness may be welcomed by some (including Jacobs), the masses don’t know what to think. Banks wouldn’t loan Kalkin or his clients any money for the home since they saw no resale value in it if he were to default on the loan.\(^8\) It is hard compare homes, since they can vary so much in terms of style and market value. So, those in the middle of the market sector tend to take the route of paying for size, since it’s a calculated determinate, but often pass on paying for creature comfort or architectural extras. While Jacobs acknowledges the art and ingenuity, the scale and statement of this modern home are too much for her taste. While the budget is right, it’s just too far a stretch from typical single family housing. (Figure- Kalkin houses)

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6 Ibid Jacobs - (48)
7 Ibid Jacobs – (48)
8 Ibid Jacobs - (43)
Anderson & Anderson Architecture, founded by brothers Mark and Peter Anderson, is based out of the San Francisco Area and is the designer of the Kennedy Residence. Jacobs was rather attached to the home prior to her visit since she made it the cover of Dwell magazine, although she had never visited the home in person. Upon meeting the designers and walking the project she had a different sense of modern in the single family home market. Up close, the home shows its imperfections. Built for $86,000 from an original budget of $65,000, the homeowner and family did much of the labor. The homeowner wanted something unique. While Anderson Anderson Architecture worked hard to design a pre-fab structure from mostly off-the-shelf components and inexpensive materials, the fee for their time was eating into the budget. Upon completion everyone was very happy with the home. The firm reported they billed minimally for their time and didn’t make any profit.

They were simply happy they participated because they were able to experiment with the building and construction, and the homeowner got the custom product they desired. As the Andersons concluded, custom design is always a first attempt, and lessons are always learned on the first attempt at anything. To a big general contractor, lessons are mistakes and cost money and time. So the $100,000 mark must be considered with respect to a larger field of variables. If the Kennedy residence were to go into production by some pre-fabrication giant like an automobile producer, the design fee of such a house would be insignificant in the total cost. But there are issues of site that make buildings stand apart from mass produced objects. Mark Anderson explains that natural/secluded lots off the grid could easily take $30,000 in infrastructure to prep for a home. In the end, Jacobs found it takes a close balance of conventionality and design to make an architecturally significant $100k house. Perhaps the most important advice Jacobs would give is, the owner and designer must pair the right personalities and goals to keep the outcome and value at the desired rate. (Figure- Kennedy Residence & Details)
Design Build Architecture Schools:  
Rural Studio and Yale Building Project

Staying true to site designed architecture is a major focal point in the homes built by Yale’s Architecture program in their Vlock studio (formerly called Yale Building Project) and Auburn Architecture’s Rural Studio. Both studios approach the single family home by working with local non-profits in housing a family each year, but their approach and scale are quite different. Yale’s Vlock Studio starts with team designs mostly free of program restrictions and without a client. The teams of students each work on a design, then after a few weeks of designing, they elect to build one of the designs. 13 The projects appear highly design driven and few different from the typical single family home in New Haven, CT. Rural Studio takes an entirely different approach to their single family housing design build program. Their projects begin locally, meeting residents and community leaders, and selecting a family and site which they feel best most comfortable working with and will hopefully accomplishing the most good for the community. 14 (Figure VLock & 20k house).

Rural Studio is perhaps the most well-known service learning, community based design build program in the country; founded at Auburn under the late Sam Mockbee and D.K. Ruth in 1992. 15 They focus their work in the poorest regions of the south, particularly Hale County Alabama (160 miles from Auburn) where the average household income is around $12,000 per year and the unemployment rate averages 13%. The program has built strength and credibility over the years with an annual budget of around $425,000, thanks to Ruth’s solicitation of grants on the campus side. 16 This budget allows for several projects a year and involvement at the graduate and undergraduate levels. The program follows a back to back semester model where students will visit sites, interview clients, and design buildings during the first semester and execute the building during the second semester. 17

A popular Rural Studio project done annually is the $20,000 house (Fig). This target expense allows low income families a path toward home ownership at a monthly payment around $100. 18 Furthermore, the material bill is targeted at $10,000 to $12,000, so these homes can be reproduced as models, allowing

14 Ibid - (36)
15 Ibid - (36-38)
17 Ibid - (85-89)
profit for future builders. There tends to be much similarity in the architecture and small size of the $20k homes, materials are typical but applied with architectural expression, the geometry is functional and rational. These benefits to residents and community are undeniable where 30% or residents live in poverty. Rural Studio supports site built, permanent housing due to the fact that homes tend to increase in value over their life and they have a much longer life expectancy than mobile homes & trailers as would typically be seen at this income level in this area.

Rural Studio’s work in the realm of experimental is both good and bad. Experimentation in architecture and the construction has proposed some interesting solutions to material reuse, but new materials need time to verify their life expectancy and performance. In the example of the Mason’s Bend Community Center, UA students sought to bring together a transportation hub for traveling clinics and educational vehicles, a religious chapel, and an outdoor performance & gathering space. Since the only necessary architectural device to meet these needs is a roof, students created a pavilion of reclaimed auto windshields. The pavilion is a beautiful sculpture full of light, thanks to the auto glass and asymmetrical three point arch. The open-air design naturally vents well in the South’s hot humid climate and the minimal inner elements should not have any trouble weathering nor staying reasonably clean.

20 Ibid - (174)
However experimental construction can bring unexpected complications. Lucy’s House, a $32K single family home built by Rural Studio, features stacked carpet tiles for walls. The tiles are wall/placeholder between the foundation and a wood ring beam, that are attached by steel rods that compressed the carpet tiles. Upon a brief internet search, the following remarks were found: One blogger said the carpet was so tightly compressed it felt like stacked stone, and another blogger mentioned the large overhangs prevent rain from contacting the surface, but these opinions come without credibility or context. Carpet tiles as exterior cladding have yet to stand the test of time that brick and lap siding have already undergone. If successful, it could have huge green potential in the reuse of massively produced products. But experimentation of such a product application shouldn’t happen in a single family residence. The inhabitants of such a building should be educated enough to track its progress, and have the means to correct its problems. Habitat for Humanity believes in conventional materials for the same reason. All new habitat homes in Cincinnati get vinyl siding and asphalt roofs, materials that can easily be replaced by a large selection of contractors in the area.

The Yale Building Project is the oldest Design-Build program in architecture schools in the US. Founded in late 60’s with the guidance of Charles Moore it has evolved into two entities. The Vlock building program is guided by Adam Hopfrner & Herbert Newman, a design build studio for first year graduate students who partner with various non-profit housing agencies. The Yale urban design workshop, headed by Michael Haverland and Alan Plattus, is a non-profit subsidiary of the architecture school composed of graduate students working part time as paid employees. It offers design service to Connecticut residents who don’t have access or funds for architects.

The YBP’s roots were focused on education and practice, making students better professionals with construction knowledge. Projects are always urban houses around the Yale campus where completion and craftsmanship come first and community involvement & service learning are byproducts of the process. It’s an older model of methodology, ‘build it and they will come’, vs. Rural Studio’s commitment to community interaction and collaboration.

25 Ibid Carpenter - (32)
Figure 3.6
Lucy’s House
Hale County, AL
Rural Studio - University of Auburn

Figure 3.7
House for Neighborhood Housing Services - 2005
New Haven, CT
V-Lock Studio - Yale
Since its founding in the 1960’s, the program has created a similar program, the urban design workshop has implemented the process toward community engagement and larger scale work. It operates on a $250,000 annual budget, funded by grants and small service fees. In 2000 it began its largest work with Dwight elementary School.\(^26\) Here students, architects, teachers and community members all collaborated on issues to build a new school. Working on a project of such a large scale offers more experience to students entering the commercial field of architecture compared to projects by Rural Studio.

Yale students can benefit greatly if involved in both Vlock building project and the urban design workshop. In the first they can get their first project completed and learn from all the design decisions they make. The home they build fulfills real world time and budget conflicts while experimenting with design. In the second they learn of community engagement by working in a larger framework of a community to realize a public building.

Architectural form is expressed and articulated in VLock projects, but cladding and construction methods remain mostly conventional. With more than 40 years building in New Haven, the program knows what should and shouldn’t be done with respect to site and climate. In comparison to Rural Studio’s $20K houses, VLock Studio homes must have a much higher budget. Averaging 2,000 square feet per home and incorporating richer interior and exterior materials, the homes don’t fall into the affordable or low income sector. Considering the student labor is free, the studio projects could be market rate, but they would certainly jump into the top market sector if reproduced by a contractor for a private client. Students of the VLock Studio have also expressed concern that their designs would have been richer if they actually worked with a client(s) and that the format of the studio’s competition constrain the process limited design.\(^27\)

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\(^{26}\) Ibid Pearson - (112)


Chapter 3
Educational Value
Auburn’s and Yale’s Programs

In the study of the Yale projects it is clear they follow Charles Moore’s attitude about pushing the limits of traditional stick framing (Fig). The projects encompass geometry not seen in typical residential design but are realized through standard dimensional and composite lumber sections. While students produce many scaled framing models to study these connections the on site photographs lead a trained eye to believe details are still worked out on site. The $20k houses of Rural Studio are much less complex for a second year undergraduate. They are more fitting than the complex Yale graduate projects. However, while Yale students work on and around campus and have the full resources of the school’s shop and other resources, Rural Studio projects are in much less developed areas and the construction necessities more fundamental skills. Carpenter notes the craftsmanship and time in the elements favors the Yale projects. It is likely the volunteer labor or residents, less expensive materials and limited resources limit the craftsmanship of the Rural Studio projects.

Both schools students have qualms about their school’s respective processes and favor students with prior architecture or construction knowledge. At Yale, the design is only the first five weeks of two semesters and mandates students without architecture backgrounds or experience learn too quickly to be avid in the design. At Rural Studio, students tend to specialize and cover certain aspects of the project rather than follow a well rounded, team effort approach. Rural Studio students also spend more time integrating into the community while completing a full semester on design and planning. This allows less experienced students to catch up, but means many projects run over into the summer term for completion.

The true strength of design-builds, according to students, is community engagement. Rural Studio participants highlight this as the cornerstone. Designing for a real client with real challenges lead a Rural Studio student to comment, “I learned more in ten weeks than in the past two years.” A Yale student commented, “These projects could have been so much better if we had direct client contact.”

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29 Ibid Carpenter - (39)
31 Ibid - (36-37)
32 Ibid - (36)
33 Ibid - (35)
Figure 3.8
House 00
Brett Zamore
Thesis Project - Rice University

Chapter 3
Brett Zamore, an architect in the Houston area and founder of Brett Zamore Design, started with similar feelings about the architecture profession as we do. While attending Rice University he was troubled that historic, walkable downtown neighborhoods were being leveled. Many of the old craftsman style cottages were giving way to new, out of scale boxes (Figure). For his thesis he wanted to show the community there was a better way.

He convinced the City of Houston, Rice University, and a few neighborhood non-profits that there was still much value in the old properties as they helped him secure an old shotgun duplex and donate money for its renovation. Brett led the renovation efforts and turned the duplex into a single, open floor plan home for a local artist. With the students leading teams of volunteers and subsidized costs of construction, the home was renovated for a little over $20k. Brett estimated a contractor could have performed the renovations for $75k, while building the home new would have cost around $100k. The home re-emphasizes the aspects of the original design, its passive ventilation techniques, and an architectural character to the neighborhood.

Brent’s idea of saving older American homes and neighborhoods is slowly catching on. He has formed a business out of the renovation process and has performed over 20 residential projects in Houston since the firm opened in 2007. Likewise this line of thinking is funneling down into the education line as students are becoming more fascinated with grass roots design and community projects in lieu of high design, award winning iconic buildings.

Larger Homes Smaller Families
Comparison of the average home to family size 1950-2010

<table>
<thead>
<tr>
<th>Year</th>
<th>People</th>
<th>Square Ft</th>
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</thead>
<tbody>
<tr>
<td>1950</td>
<td>3.5</td>
<td>1150</td>
</tr>
<tr>
<td>1980</td>
<td>2.8</td>
<td>1670</td>
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<tr>
<td>2010</td>
<td>2.5</td>
<td>2280</td>
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</tbody>
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Figure 4.1
By Author. Showing the growth of the home and decline of family size from 1950 to 2012. Composed of data from 2010 US Census, SHoP Architects, and The National Association of Home Builders (NAHB)
Households of Today’s America

The average home size has doubled from 1950 to 2010, while the average number of occupants has declined from 3.5 to 2.5. Furthermore household structures have drastically changed and diversified. In 1940 76% of homes were occupied by married, straight couples with children, now that number is down to 52%. Single parent households and non family households constitute the other 48% of 2010’s demographic. Recent economic times are slowly making older homes in neighborhoods close to downtowns more appealing as they are closer to work and social places. Foreclosures and vacancies have made them affordable, with 2.5% of homes in foreclosure another 6.7% on a 90 day delinquency (in risk of foreclosure) in Cincinnati. Nationally these numbers were worse with 3.2% foreclosed and 8.9% at risk in May of 2010. Most of these home on the market foreclosed or otherwise are all built around the 76% married straight couple with children typology. With careful planning of renovations this variety of family types can all have housing solutions custom to their needs under an existing roof. The process involves understanding the property and the family equally. No two homes or families are the same, but the process can replicated for any home renovation.

Single parents are a family type that has been on the rise since the post war housing boom. Most single parents are mothers who get some to no support from their child’s father. The biggest challenge for single parents is creating the support system for their children. As the parent works above and beyond full time, they must also pay for care of their children. Infant care, day care, after school activities, and nannies can take up to 1/3 of a single parent annual income. The home should be nearby to support systems to minimize travel time and cost. Ideally a live/ work situation or home above the shop allows the parent to provide care to the family while earning an income. In re-designing an older home, function and multitasking are key. A conveniently arranged kitchen can allow single-parent families to cook meals faster. Other functional rooms are where a parent can save time, like having a laundry near the bedrooms or a study space near the kitchen so the parent can assist with homework before or after dinner. Here an open plan should offer flexibility and connection so the parent can maximize value for the family.

2 Ibid.
4 Dolores Hayden, Redesigning the American Dream Gender, Housing, and Family Life. New York: W.W. Norton & Company (165)
Figure 4.2
By Author. Charts illustrating the shift in household types (away from married couples with kids) within single family homes. Data collected from US Census 1940, 1980, & 2010.
Multi-generational housing is another family type seldom designed for in post war housing. US news published that 3.6 million elders lived with their adult children. In multi generational housing either elders can move in with their children, or vise versa. In domestic life where the primary homeowner(s) work, the elder generation can provide some of the family support needed as stated in a single parent situation. Similarly young couples moving in with elder parents can offer added income, home maintenance assistance, and excitement to the daily life of an elder couple. In either case both couples would want some type of privacy and stake in the home. Two master suites, preferably on opposite ends of the home would be ideal. Separate entrances and different areas of ownership and privacy are a must for this to be desirable. Multistory homes may have extra value here do to the levels. A second floor with two adjacent bedrooms might be renovated into some type of suite while the first floor can remain an elder’s aging in place home. The construction doesn’t need to be inclusive to one home/ one building either, the idea of a carriage house or sharing courtyards can get the right level of connection and separation in a multi generational house.

Empty nesters and boomerang children are a growing demographic, where parents no longer have children living at home or their college graduate children have moved back home. For empty nesters, downsizing was traditionally an option but low sale prices on large homes have made empty nesters question selling the nest. Boomerang children don’t easily fit back into their teenage bedrooms and structured family lifestyle they left behind. Perhaps the boomerang child can help convert the big multi-family home into a duplex or so when they do go off on their own, the parents will have a space to rent out. The rising costs of college and shortage on jobs had 25% of males and 18% or females in their 20’s living with their parents. While some parents may want their children out of the home, Forbes writes about the benefits of a boomerang child. They estimated 1.5 millions home owners are willing to sell their big family homes, but don’t have them on the market because they won’t get enough money for them.

There are even more family and household types each with unique design problems. Divorced and divorced remarried couples have unique challenges with children from different partners living under one roof. Widowers tend to have lots of extra space in their homes. Young couples without kids will be looking for fun houses that can easily change into a family home when they decide to have children.

Figure 4.3
By Author. A cost & construction task comparison between renovating houses and building new and how Habitat for Humanity of Greater Cincinnati can house more people per dollar through renovations.

Chapter 4
A home can be renovated to meet many of these different needs. This is done through two simple principles’, document the home as it stands, and know the inhabitants and their family structure well. Documentation of the homes should include framing orientation, utility mains and meters, wall types, and site information at a very minimum. Once documented, particularly structural walls, the plan can be erased down to load bearing walls, and looked at as a semi clean sheet upon which to sketch. The next chapter will show the process of a transformation in Cincinnati.

While re-designing a home for a client is fun and rewarding to those interesting in such work. It also needs value to verify its worth. Cincinnati Habitat for humanity has seen potential in these homes and older neighborhoods as they have begun remodeling homes in lieu of building new homes when the market crashed. While working with Habitat for the last 18 months I’ve learned the non profit can put 5 families in rehabilitation homes compared to 3 families in new model homes for the same costs. Housing more families is not only beneficial for potential habitat partner families and those in need. More families means more mortgages paid back to Habitat. The value in rehabilitating comes from capitalizing on the materials already in place and creating construction tasks that require less subcontracting. For instance the wood in older homes is typically larger and stronger than new construction and perfectly good as it stands. Foundations don’t need to be excavated by expensive machinery on re-habs and cranes don’t need to be rented for hoisting trusses. A skilled site leader can manage people to do renovations with simple hand and power tools. Since the work almost always happens in older neighborhoods, Habitat renovations give the residents on the street a chance to participate in the labor and bring those newly acquired skills back to their own homes. If the whole street or neighborhood gets going on some renovations they can all increase their property values and create a better community.
Replanning Old Homes
Millrich Ave, The Thesis Home

The existing home was built in 1929, a 1,330 sf cottage style home with a single upstairs room, 8’ wide and with knee walls, sloping from 5’ to the 7’ flat ceiling. It had two bedrooms and one bath with an optional third bedroom (third bedroom was very small and a pass-thru to the rear deck). The dining room and living rooms were amply sized but the kitchen was tiny and not functional, not originally designed to have a refrigerator, thus cramped. The stair from the first floor to basement went by way of the kitchen and included a side entry door. While the door is typical to the time period, it left a hazardous ship’s ladder run of stairs from the door’s landing to the basement.

The family moving into this habitat home, a married couple with three kids (two living with them, the oldest son on his own) saw themselves living in the attic bedroom, their daughter in the first floor bedroom and their son in the basement, which would be a makeshift bedroom. While we had already devised a plan to put two children’s rooms and a small bath into the upstairs attic room, the family liked the idea of having the second floor for themselves and its storage potential. So through more meetings and many sketches we arrived at a three bedroom, two bathroom solution. The new plan demolished the dining room in favor of adding the extra bath and making a large, open eat-in kitchen. We also opened up the second floor attic room with a large shed dormer, and moved the side entry door to get a code abiding stair in place. All this was able to be done without changing the structure of the home and working with simple power tools and volunteers.

218% Improvement in energy efficiency and insulation (ResCheck)
+1 Bedroom
+1 Bathroom
34% More usable second floor space
40% more south facing glazing with no summer heat gain
Less hazardous stair
Egress windows
Passive cooling shaft for natural ventilation

Chapter 5
Top  
Figure 5.1 Photos by Author at project start, 2012

Middle  
Figure 5.2 Drawings documenting home as-is. By Author

Bottom  
Figure 5.3 Drawings showing subtraction of unnecessary parts in homes floor plan after documentation. By Author
Figure 5.4
By Author. Plan diagrams and drawings showing circulation and room arrangement before and after renovation.
Figure 5.4
By Author. Demolition and new floor plans of Millrich Ave
Figure 6.1:
By Author. Photos and Renderings showing progress. Top to bottom June 2012 (before start), final rendering, March 2013 (80% complete)
“The small house of moderate cost is not only America’s major architectural problem, but the problem most difficult for her major architects.”

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A Functional Kitchen

The key to a functional kitchen is a good work triangle and plenty of counter top / food preparation space. A functional kitchen can make preparing a meal faster and less challenging if designed well. The work triangle consists of three stations food storage (pantry & refrigerator), food preparation (sink and counter top space) and cooking (oven range, microwave and any other small appliances). placing all these together and having clear walking lines between them creates a functional kitchen. For the Millrich house we had two additional challenges in the kitchen’s design. First, since the space of the former dining room was sacrificed for the added bedroom and bath, the kitchen had to seat up to 6 at the dinner table. Second was circulation, as the room also hosted the side entry door, coat closet and access to the rear deck. Stand-alone tables and chairs took too much area from the room since space is needed to move around the table to each seat. A built in, restaurant style both fit 6 in the corner near the picture window, but made the room cramped and left little room for storage and appliances. Since our homeowner has ample sewing skills, we created a hybrid of the two where a bench occupies the wall along the picture window and is raised to a bar style seating. The bar style peninsula table is just above the countertop height and mounted on wheels so it can be maneuvered and used for food preparation too. The remaining three seats are bar stools allowing 6 to sit for dinner and can be arranged as needed for the occasion. This arrangement works well allowing both the refrigerator and pantry to sit next to each other with unobstructed flow to the sink and range, and unobstructed views through the big window and glass door.

Figure 6.2
Rendering of kitchen with moveable table/ bar. by author
Steep Stairs

Many older homes have steeper stairs. Early 20th century Midwestern single family homes often feature side entry doors, where a person enters 2/3 of the way up from the basement to the first floor. This was for service people to enter a home with tools, etc. and to not disturb the formal rooms like the living room and dining room. The lower portion of these stairs are often very steep and or have minimal head room.

Stairs this steep won’t meet modern codes today but are grand-fathered in. Walking them is difficult and a hazard if carrying a large object such as a full laundry basket. Moving the side entry door to another location or removing the opening (if the home has ample doors elsewhere) allow the existing stair and landing to be demolished for a new run of stairs. The Millrich house’s basement floor had a steep slope and needed a level box for the stair to rest on. This was built first so the stair manufacturer could take exact measurements on the new stair’s rise and run for a perfect fit. The existing basement slab had a floor drain near by and too much slope for the stair to be put in without the level box.

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Top Figure 6.6 Photographs of existing and new stairs. by author
Bottom Figure 6.7 Sections of existing and new stairs. by author
Passive Heating and Cooling

One of the major architectural interventions with green potential is the replacement of an existing chimney into a passive cooling ventilation stack. Old homes from the 19th century were only cooled passively. Ceiling heights of 10’ to 14’ created further separation between a room’s occupant and the dead hot air trapped near the ceiling. True double-hung windows allowed air movement high and low across a room for more passive cooling. In the Mid 20th century residential construction was focused on standardized dimensions. Ceiling heights shrunk to a norm of 8’. Double hung windows got shorter with the top sashes often getting painted shut or were replaced by windows with less operable area. This places the hot air trapped in the upper half of the room closer to the occupant. Throughout the 20th century, cheap energy lead to active cooling (fans, swamp coolers and refrigerated air) in the typical housing market.

While the home modernized, the chimney remained relatively the same, making room for an architectural interventions with green potential. As long as the wood frame on the house is independent of the masonry shaft, it can be demolished without any structural changes. This must be verified first, preferably by a professional, due to the differences in construction methods and any alterations and repairs made over time. After the existing chimney is removed, a continuous shaft with great potential to move air through the house will be available.
The series above illustrates the sun’s movement throughout the year on the Habitat for Humanity home in Cincinnati, OH (Millrich Ave). The long shadows and their orientation on the compass show how low the sun begins and ends each day. Comparing the same clock hour against the solstices displays how much higher the sun climbs during the late spring / early summer seasons. The house’s Northwestern orientation creates unique solar conditions where the SE & SW facades are normal to the sun at 11:15am and 1:30pm, giving it two potential maximum solar gain moments. Understanding the sun’s seasonal relationship to the building is important in designing windows that will allow heat gain in Winter and be shaded in Summer.
1:30 pm SE facade
is in complete
shade. SW facade
is normal to sun
<71.07
Sizing a Window Shade

South Facing Walls

Understanding the relationship between a building site’s line of latitude and azimuth angle is essential to designing solar shades. The National Oceanic and Atmospheric Administration (NOAA) sponsors an online solar calculator that quickly gives solar data regarding any site. The following chart was made from collecting data from the NOAA solar calculator on a series of Latitudes and Cities north and south from Cincinnati. The key observation is that the azimuth angles remain proportional to the shade depth based on a desired percentage of coverage at solar noon. Thus this chart can help design a shade for any site by applying the latitude degree of any building site.
(site latitude) = (shade length) / (known shade length based on % cover)

**SUN SHADE DEPTH CHART BASED ON LINE OF LATITUDE**

<table>
<thead>
<tr>
<th>LATITUDE</th>
<th>SUMMER</th>
<th>WINTER</th>
<th>EQUINOX</th>
<th>YEARLY Δ</th>
<th>100%</th>
<th>75%</th>
<th>50%</th>
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<tbody>
<tr>
<td>LANSING, MI</td>
<td>44°</td>
<td>69.4</td>
<td>22.6</td>
<td>46.0</td>
<td>46.9</td>
<td>18.4</td>
<td>14.1</td>
</tr>
<tr>
<td>42.7°</td>
<td></td>
<td>71.6</td>
<td>24.7</td>
<td>48.1</td>
<td>46.9</td>
<td>17.9</td>
<td>13.7</td>
</tr>
<tr>
<td>CINCINNATI</td>
<td>39.1°</td>
<td>75.1</td>
<td>28.3</td>
<td>51.7</td>
<td>46.9</td>
<td>17.0</td>
<td>13.0</td>
</tr>
<tr>
<td>36°</td>
<td></td>
<td>77.4</td>
<td>30.6</td>
<td>54.0</td>
<td>46.9</td>
<td>16.5</td>
<td>12.6</td>
</tr>
<tr>
<td>ATLANTA, GA</td>
<td>33.7°</td>
<td>79.7</td>
<td>32.9</td>
<td>56.3</td>
<td>46.9</td>
<td>16.0</td>
<td>12.2</td>
</tr>
<tr>
<td>TALLAHASSEE, FL</td>
<td>30.5°</td>
<td>82.9</td>
<td>36.1</td>
<td>59.5</td>
<td>46.9</td>
<td>15.4</td>
<td>11.8</td>
</tr>
<tr>
<td>28°</td>
<td></td>
<td>85.4</td>
<td>38.5</td>
<td>62.0</td>
<td>46.9</td>
<td>15.0</td>
<td>11.4</td>
</tr>
</tbody>
</table>

* BASED ON A SHADE WHERE BOTTOM OF SHADE IS 4" ABOVE WINDOW HEAD

Top  Figure 6.13  Sketches: From Heating, Cooling, Lighting By Lechner illustrating various shades and reflectors
Bottom Figure 6.14 Sun shade depth chart. by author. Composed from information gathered from NOAA Solar Calculator
Sizing a Window Shade (Continued)

South Facing Walls

Solar Noon and clock noon vary constantly though a time zone. Solar noon is what should be factored in calculating window shades against maximum solar gain since that is when the sun is normal to a south facade. Figure 6.15 illustrates the shadow that would be cast by a shade that extends 9” (50% cover at solar noon), 13” (75% cover), & 17” (100% cover) from the face of the walls. Note the shade is wider than the window. For every 6” of width added to a shade on each side from the edge of window, approximately half an hour of full glass coverage is gained. To maintain a static coverage percentage throughout the day would require an operable shade and many more parts and engineering. Figure 6.17 & 6.18 on the following pages were designed for Cincinnati Ohio, over a 3’ wide, 5’ tall window with the shade mounted 4” clear above the window head.
For 100% shading while the sun is at solar noon, 1” must be added to the width of the shade (toward the south) for each 5 degrees the facade is rotated from true southern orientation (Figure 6.16). Note shade depth seems excessive the more the building rotates away from 90 degrees. But shortening the depth will result in less coverage when the sun is normal to the facade.
Window Shading Intervention
Simple Parts & Scraps

For the project with Habitat we needed to create shades for the Southwest facing facade since we increased the glazing from approximately 9 sf to 39 sf. Without shades, the benefits of the added light would have been offset by the increased heat gain to the kitchen and rear bedroom.

To look architecturally correct, the shade needed a color pallet to coordinate with the cladding materials and craftsman detailing of the 1929 original home. The shade also needs two basic elements. A bracket that would mount to the house and support the shade, and the shade itself, which would span between the supports over the window(s). Longevity and maintenance were a concern, since repairing the shades could be complicated for the homeowner. Thus typical shelf brackets with a nickle plated finish and hardwood scraps from a local wood retailer would keep the assembly low cost and weather resistant.

100% Summer Solstice coverage
5% Winter Solstice coverage
260% Increase in southern glazed area

(While decreasing the summer heat gain factor)
Top & Middle  Figure 6.17 Rendering of exterior with sun shade. by author
Bottom  Figure 6.18 Section detail of sun shade. by author
Window Boxes & Thick Walls

Window boxes not only allow a room to open up to the exterior through the increased glazed area, but they create a comfortable extension of the room. A typical wood or vinyl window can easily have a thick drywall or wooden wrap to fit into a thicker opening, however, using the Frank Lloyd Wright practice of meaningful design presents the notion to create a window seat. The use of a window box has many advantages; it can be a place to inhabit, it can help heat or cool the space with proper solar orientation and shading, and it can add an architectural feature to a plain wall. This will require a skilled DIY person to design and install along with a good understanding of geometry and drafting skills, but the task is not impossible. The necessary tools to get the solar data are free and available online, which makes this do-able with the desire to learn. Making a mock up of cardboard and propping it against the home is a simple analog way of seeing how the sun will interact with the new window box. Close attention must be paid to the structural support of the window box’s weight, the weather proofing, and the insertion in to the existing wall. Hiring a professional for advise is always an option.

The key is to understand the sun’s angle with respect to the building as the sun changes in elevation throughout the day and throughout the seasons. The key points are the Winter and Summer solstices, where the minimum and maximum sunlight is available, on December 21st and June 21st respectively, and the Fall and Spring Equinoxes, the midway points to the sun’s yearly cycle. If shading is the key purpose, yearly temperature averages need to also be considered as you will use the average temperature to help pick a day to provide 100% shading. If solar gain is the main desire, understanding the amount of solar radiation available throughout the day and seasons is key. (FIG shade examples in Cincy). A great free tool is the solar calculator sponsored by the NOAA (National Oceanic and Atmospheric Administration) Figure 4.10

Heat Gain

Calculating the heat gain is more of a challenge. For true results you’ll want to contact an engineer, as the variables are too vast to cover in this thesis. Instead, we will cover a case study thermal building; a 10’x10’ room with an 8’ high ceiling (illustrated on page 47). To show the data in use, we’ll first sample a this basic room and demonstrate its solar potential. The unit will face south and be at the 40° line of latitude (a little north of Dayton, OH). Throughout the day there is approximately 1550 btuh per square foot of solar energy available to south facing surfaces during winter solistice. In an idealized form,
something that gained 100% of the available solar heat, likely requiring movement or rotation to follow the sun, could potentially gain 5,000 btuh’s. If the 10’x10’x8’ box were built with one window wall (Figure 6.10), it would only lose 3.8 BTU/DD Ft on a single day, well below the recommended 5.6 maximum in Stein’s Chart1. In the event of a window (6’W x 5’H) in the same 10’x10’ building: 30SF X 1550 BTUH SF = 46500 BTU. Conventional building heat loss of 7 BTU/ DD = 420sf*7*30(deg difference)= 88200 btu’s 46500/88200= 52%. The bottom line is picture window sized above can provide 52% of the daily heating need based on a 30deg temperature difference between interior and exterior.

Window Box Installation

To speed up the process and lower the invasive demolition process this window box only requires cutting a minimal width into an existing wall to create a deeper, stronger, more stable box through double wall construction. Making one is an advanced DIY endeavor, be sure no utilities run through the wall and headers are properly sized for load bearing applications.

1. & 2. Determine approximate width of window and remove wall finish to studs beneath. 3. Actual stud spacing will determine width of box once cavity is opened. 4. Frame new wall with header in desired opening, demo part of ceiling to make sure structure above bears on new wall (if applicable). 5. The sill of the two walls should create a wide landing for the base of the window box. 6. From here the new box can be framed up, be sure to include enough space to insulate to match the existing home. 7 & 8. Installing a window unit of custom glazing can be done, insulation with the highest r-value per inch will keep the box to its slimmest. Match the existing home’s insulation at the very least 9. Plywoods & trim or drywall can finish and hid the construction joints.
Figure 6.20
Rendering sequence of window box installation. by author
Passive Heating and Cooling

One of the major architectural interventions with green potential is the replacement of an existing chimney into a passive cooling ventilation stack. Old homes from the 19th century were only cooled passively. Ceiling heights of 10’ to 14’ did create further separation between a room’s occupant and the dead hot air trapped near the ceiling. True double hung windows allowed air movement high and low across a room for more passive cooling. In the Mid 20th century residential construction was

1850’s
Before the great fires of New York and Chicago wood and masonry structures may be integrated. If so the chimney cannot be removed without major structural work.
focused on standardized dimensions. Ceiling heights shrunk to a norm of 8’. Double hung windows got shorter with the top sashes often getting painted shut or were replaced by windows with less operable area. This places the occupant closer to the hot air trapped in the upper half of the room.

1950’s
The standardized construction of mid 20th century homes should have wood and masonry structures independent.

Intervention
The upper portion of the chimney can become a passage for hot air to escape. The lower portion where the chimney was can be returned to room’s area or become a built-in feature. An insulated door is necessary to retain the home’s air while the heat or air conditioning is being run.

Figure 6.20
Diagram of passive and active HVAC in a typical room during different time periods. by author.
Passive Cooling

One of the major architectural interventions with green potential is the replacement of an existing chimney into a passive cooling ventilation stack. Old homes from the 19th century were only cooled passively as stated in chapters 1 & 2. Throughout the 20th century cheap energy lead to active cooling (fans, swamp coolers and refrigerated air) in the typical housing market. Although while the home modernized, the chimney remained relatively the same, making room for this architectural intervention. As long as the wood frame on the house is independent of the masonry shaft, it can be demolished without any structural changes. This must be verified first, preferably by a professional, due to the differences in construction methods and any alterations and repairs made over time. After the existing chimney is removed, a continuous shaft with great potential to move air through the house will be available. Working with fellow thesis student Nate Substanley and UC engineering professor Dan Durbin, we calculated the twin turbines atop the cap will increase airflow by 30% creating approximately 3 air changes per hour with a slight breeze and open windows.
Keynote Legend

- 110: Remove existing masonry fireplace from beam bearing level to top
- 295: New wall
- 217: House vent
- 230: Existing opening to remain
- 313: Existing vent to remain
- 318: 1/2” C.S. grade OSB
- 530: Ex boards
- 350: Areas of existing structure
- 302: 1/4” Dia lag screws @ 1/2” o.c. Offset & Alternate screws 2” from top and bottom
- 330: 2x6 rafter, slope to drain

Left: Figure 6.23 Section of vent shaft at Millrich. by author
Right: Figure 6.24 Photos of vent shaft at Millrich. by author
Cladding Materials

Due to the fact that siding comes in a typical 12’ or 16’ length, the segments must be overlapped if the wall is longer than the piece of material. In vinyl this overlap isn’t the most attractive joint, so implementing a system like the corner pieces vinyl crashed into removes the bad joint and creates more opportunity for facade expression. This page shows an aluminum wrapped 2x4 creating a vertical divider between the two materials, preventing the vinyl lap from existing on the long side of the home (40’). Other similar pieces could be steel stud track, fiber cement boards, or vinyl trim boards. For other cladding mock-ups we found a stock of plywood cut-offs (8’x4’) and got the idea to test our own siding. Scrap aluminum was used for flashing, allowing the joint to be part of the design. Polyurethane was applied to the faces and exposed end grains of the plywood, although its life span will be subject to how many driving rains are endured and how well the protective coating was applied and covers the end grains of the wood.

![Figure 6.x](image)

By Author. Vinyl Siding intervention
Cladding Material Cost Analysis
For the Millrich House

16 Square

Labor & Material Estimates (RS Means 2010)

<table>
<thead>
<tr>
<th>Material</th>
<th>Labor Cost</th>
<th>Material Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vinyl</td>
<td>$2.99/sf</td>
<td>$4,784</td>
</tr>
<tr>
<td>Fiber Cement</td>
<td>$3.91/sf</td>
<td>$6,256 +30%</td>
</tr>
<tr>
<td>Wood</td>
<td>$4.41/sf</td>
<td>$7,056 +47%</td>
</tr>
<tr>
<td>Brick (typ)</td>
<td>$6.50/sf</td>
<td>$10,400 +217%</td>
</tr>
<tr>
<td>Cultured Stone</td>
<td>$11.25/sf</td>
<td>$18,000 +376%</td>
</tr>
</tbody>
</table>

14 square Vinyl + 2 Square wood

(1400sf * $2.99) + (200sf * $4.41) = $5,068 +5%

Reused Materials

Material Estimates

<table>
<thead>
<tr>
<th>Material</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>100sf Alum. coil</td>
<td>$60</td>
</tr>
<tr>
<td>Exterior Plywood</td>
<td>$15</td>
</tr>
</tbody>
</table>

2 square Wood & Alum. Shake

((200sf/32sf) *$15)+$60 = $154

Note: Materials only, will require labor to cut plywood into siding and cut & bend metal backs

Figure 6.x
By Author. Vinyl Siding intervention
Cincinnati Habitat for Humanity owns several residences set for renovation in the 2012-2013 build year. They are testing the waters on renovating versus new construction. In this process, they are still discovering the benefits and challenges of home renovation. As Cincinnati is an older city, many of the homes were all built around 1925. They aren’t well insulated, nor do they utilize passive & solar strategies. These homes must now be renovated on a Habitat budget, which typically lends to vinyl, plastic laminate and any other number of bargain materials. However, we see the shortness of budget and energy efficiency as great potential for design improvement. We have the technology to implement strategies that will save on the home’s energy bills while improving the quality of interior spaces. We can retool, recraft, and reuse many materials of higher quality already in the home instead of buying new construction minimum standards (reusing or recycling hardwood floors). The advantage of large supply of volunteer labor through Habitat leads one to think about design and construction in a different manner. As material cost is the most important factor, it leads one to utilize waste materials of other industries and repurpose common and damaged materials. We hope this thesis challenges how one thinks about revitalizing a hundred year old home and that we continue to experiment and build in this building type in the future.

Designing for a client as opposed to a ‘model home’ solution is just as important. Habitat’s Clients are typically underprivileged, single, working mothers or other variations of non-traditional families. Habitat does an excellent job of allowing the family to generate wealth through its zero-interest loans, but it cannot do much to make the mother’s day-to-day routine easier. By knowing and understanding our family we remodeled the interior to suit their needs. We can create flexible spaces that meet their daily routine and special occasions. We can design spaces to accommodate a much needed extra bedroom or bathroom. We can focus on room lighting, views and storage solutions. We can integrate utilitarian spaces to maximize a single parent’s multi-tasking capability.


