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

It is entitled:
Redesigning Single Family Homes: Adaptive Reuse through Architectural Interventions in the Renovation of the Single Family Home

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Redesigning Single Family Homes

Adaptive reuse through architectural interventions in the renovation of the single family home

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

Master of Architecture Thesis
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Abstract
Throughout the 1900’s, architects such as Frank Lloyd Wright have set out to change the existing housing paradigm to meet the needs of society. The traditional Victorian style home was designed primarily for the wealthy with servants, during a time when energy and resources were more plentiful. The Victorian design ethos became the paradigm for the American single family home, even though as a society we have evolved from this state and it no longer meets our needs nor desires. The 2012 census notes 65% of housing units are owner occupied single family homes (SFH).1 However many issues may be present with these homes when an owner considers purchasing one. For example, most homes built prior to the 1970’s oil crisis are energy inefficient. Further, older homes are designed around the Victorian/outdated family structure. This thesis takes an adaptive reuse/design build approach to renovation of traditional homes in the Midwest United States.

There are many older homes on the market currently not being utilized to meet today’s living situations. These homes have the potential to be adapted for different family types, with room and amenity updates to meet modern lifestyles and energy consumption. Through the use of a series of architectural interventions, one can improve the existing structure to provide a home which better meets the needs and desires of society and of the homes occupants. The accomplishment of this must start with proper design thinking to make a meaningful impact on social, financial and environmental levels. Often renovations can be performed for prices below new construction rates. Architects should strive to uphold all of these core values as a larger part of a thoughtful building project.

Recognizing the potential in existing homes, Cincinnati Habitat for Humanity has moved into home renovation alongside building new homes. The organization can house five families in renovations versus three families on new builds for the same money. However, each renovated home is different with varying existing circumstances. Habitat’s designers and construction crews do not have the means and procedures to provide a better build strategy than simply fixing what needs fixed in these old homes. This thesis aims to integrate our architectural modifications, green thinking, and family specific design into a home renovation. By being the primary contractor as well as the designer one can discover the current methods of renovation and hopefully improve on the process and form of the final product while reducing the cost, exposure to harmful materials, and amount of labor. This also enables many of the proposed architectural interventions to be tested in an actual home.

This document includes written research and a design-build project. The research includes: How the single family home has evolved along with the population. How can different family types be better served and through architectural interventions can meet functional and environmental demands.

Starting from when I was four years old I have always been interested in the design of space and construction. My grandparents took me to see the Santa Maria in downtown Columbus, Ohio. After seeing it I drew a section of the ship. Ever since then I have been drawing building plans and touring construction sites. During these trips my father would point out building principles. Eventually this would lead me to a summer and after school job with a local contractor called Affordable Creations. While at Affordable Creations, I learned how to frame a building, installing finishing systems, do light electrical and plumbing connections, how to install HVAC systems, flooring, window installation, and many other common building skills. I worked my way up in this company and eventually got to manage jobsites, bid jobs, make purchases orders, and manage personnel. Later I got another job working for C&N Construction which did a great deal of commercial work. I chose to work with this company in order to gain experience working in commercial construction and to see how larger jobsites are managed.

During my time at OSU I felt there was a complete discourse from construction with the architecture curriculum. Therefore, I decided to take construction management courses, and after taking a few of them I decided to dual major. Due to the low employment rate in architecture throughout my undergraduate education I continued working construction. Upon graduation I got a job working for Turner Construction as a BIM project manager. This job was a good use of my CM skills and architectural detailing experience. It gave me the opportunity to learn how the largest and most successful construction company in the nation operates.
Acknowledgements

Habitat for Humanity

This thesis was assisted with the possibility to incorporate and test research into a Habitat for Humanity House designed and constructed by the author and a fellow Graduate architecture student Michael Pasquale. Thanks to the assistance of Habitat for Humanity for the support financially, emotionally, and knowledge based. During the writing of this document a Habitat for Humanity house was designed and constructed and many of the architectural interventions developed in this thesis were incorporated into the design.

MetroLab Studio

MetroLab is a graduate elective 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 enabled students to experiment with materials, connections, program and architectural form. Students had to experiment with 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.

Top to Bottom:
Fig 0.1-Millrich house existing conditions
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Figure 1.1 The image above is of a typical Bill Levitt development plan. It shows the repetition and efficiency with which he constructed houses. Images from a paper by Mary Burger “A Short Trip Inside and Outside the Box: Buckminster Fuller's Dymaxion House.”
Frank Lloyd Wright is perhaps the most well-known American architect. He stated that “The small house of moderate cost is not only America’s major architectural problem, but the problem most difficult for her major architects.”\(^1\) Wright was dissatisfied with the current paradigm of Victorian housing and heavily advertised his position through his writings and design work. Sixty-five percent of the United States population lives in an owner occupied single family home. Eighty percent of the population lives in a rented or owned single family residence.\(^2\) Being that such a large portion of the population lives in this housing type one would think that it would be the foremost concern for the top architects of the United States and the world. However since the housing shortage of the Post WWII era most of the single family housing designing has been delegated to developers.

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Levittown Development

After WWII the United States government gave large amounts of money to developers such as Bill Levitt. According to Redesigning the American Dream Levitt’s plan followed this model:

“[Levitt] bought farmland in a remote part of a metropolitan area- preferably a place without a planning board- and started raising houses instead of potatoes.”... “Many architects were appalled by the designs the builders threw up. Bill Levitt, for example, was considered one of the best developers of solidly constructed houses. He became a popular hero for the speed with which he built homes for veterans, but he simply built one design over and over again in his first development.”

This cookie cutter model has persisted ever since WWII due to the profitability of the model and American passivity on the issue. The FHA even penalized developers who hired more sophisticated architects by lowering the mortgage value of houses that did not conform to the new norms of design. Hayden’s book points out some of the shortcomings of such a practice:

“[Developers] constructed millions of dream houses lined up on suburban tracts, they broke with traditional regional responses to climate in favor of using standardized plans and materials. Huge picture windows created patterns of heat gain or heat loss that had to be compensated for by year round air-conditioning or intensive heating, depending on whether the standardized house was in Arizona or Massachusetts.”

The developers would clear the property to build as many houses as possible. Removing trees which might have provided shading and natural context. Theses developers, including

4 Ibid (61)
5 Ibid (64)
Levitt, were more concerned with the profitability of the tract and packing in as many homes as possible for the area. The public became very dissatisfied with the lack of variety on these streets. So more models were developed, but this only alleviated a few of the problems. In general, the conformity cut many jobs, professional opinions, local knowledge, and culture from the process. It made developing and pricing easier, since the developer and homeowner no longer needed an architect or appraiser to value a residence. Single family housing has been stripped down to the bare essential of land value (based on location) and size (home area). The design of American housing has remained relatively unchanged for the past 100 years while the families that occupy them have significantly changed. Hayden’s book, Redesigning the American Dream, she notes about 80 percent of the housing stock in the United States was built after 1940 (data from 1999). Similarly, from analysis of the census data, an estimated 80% of Americans live in a single family home. These numbers show the demand for the single family home and its iconic position as the American dream.

These houses encode a Victorian stereotype about ‘a woman’s place’ and a stigma to the past. The single family neighborhood sustains separation of the household from that of work or public life. Together it forms an architecture of gender, supporting a family structure of one breadwinner and one home keeper, an arrangement unsuited to twenty-first-century life.

Even more unsettling is the fact single family homes have been getting larger ever since WWII, while household sizes have been getting smaller. According to the US census in 1950 the average household had 3.5 people per family living in an 1150 square foot house where as today we have an average of 2.5 people living in 2,280 square foot. Married couples with children under 18 years old constituted less than a quarter of all households in 2000.


8 Ibid
Furthermore most of these were dual income households. About a third of all households consisted of one adult living alone. These demographic changes have resulted in many individuals and families experiencing serious difficulties in the home. The standard American house and land fragmentation hasn’t undergone nearly the quantity or magnitude of changes the American household has.

The Victorian model’s design was functional in the 1800’s. The home was divided up into a series of rooms in order to make it easier to heat the space and stop drafts. Being that the only heat sources were fireplaces and passive heating, closing the door to the room was necessary to keep it warm. This also lead to rooms to be smaller. With the industrial inventions of gas, steam, and forced air heating architects were able to make spaces larger. Energy was abundant and cheap, so the home grew without much consequence. Few architects however used the new technology to rethink how rooms and spaces should situate in plan with these new mechanical possibilities. So the Victorian home stayed as the model because the culture wasn’t ready to accept another icon for the buildings.

Frank Lloyd Wright Innovations & Home Evolutions

Wright was one who embraced the new technologies and improved his architecture because of it. His career started in the 1880’s and continued right up until his death in 1959, so he had witnessed much of the technical and engineering advancements first hand. In Wright’s Usonian homes, he used the technology to open up the plan allowing rooms to flow into one another. Wright set out to “change traditional cut-up interiors: ‘boxes beside boxes or inside boxes, called rooms….cellular sequestration that implied ancestors familiar with penal intuitions.’” He let his rooms project outward as they needed to, using cruciform and L shapes to destroy the old square box. He began to see a house as a shelter creating vistas within while capturing views from outside. Except in private areas, he eliminated doors and partitions, “molding a continuous space freed by the removal of posts, columns, corners, and thresholds.” Wright’s designs were a poetic departure from the Victorian norm. “Gone were stuffy, unused parlors, a warren of hallways lined with doors, and ostentatious open staircases. In their place came free-flowing, often asymmetrical spaces that architecturally united family members.” Progressive tract home builders incorporate a more open plan into models, but likely do not commit the time and effort in to design that Wright did. Nor do they match his materiality and demand for craftsmanship, so they are never mistaken for Usonian masterpieces.

9 Ibid
12 Ibid (53)
13 Ibid (53)
14 Ibid(55)
Wright Chimneys

In the 1800’s mostly every room had a fire place. One of Frank Lloyd Wright’s major reformations of Victorian houses was to limit the number of small individual chimneys and have one or two large chimneys which house the flues of multiple fireplaces within the home. He treated the chimney as an outward manifestation of the hearth inside, which he called the heart of the home. Wright felt that the chimney of the house anchors the house into the ground and was an integral piece of the design of a home. For Wright, “a fireplace radiated with symbolism: of home, of family, of primordial caves, of the sun captured indoors.” Today the chimney provides no real function as wood burning fireplaces are almost extinct. They are most commonly vestigial and presented for aesthetic purposes, another lingering element of a victorian home that hasn’t kept up with the evolution of the family.

Wright Windows

The Victorian houses of the 1800’s had few windows which were small compared to today’s picture windows. This was due to small glazing pieces and the potential of heat loss. Larger windows were equipped with shutters which could be closed during the winter or a storm in an attempt to save the glass and retain more heat. As time progressed houses began to have more windows mostly due to cheap energy and industrial made plate glass. A second wave of increased window sizes came with dual pane windows and their increased efficiency. Wright took the opportunity to transform the home and use a wall of windows. He blurred the interior and exterior space and tried to remove the common practice of simply punching holes in a wall. Wright referred to the expansive bands of windows all along an exterior walls as ‘Light screens’. He desired “fewer holes through much greater window area.” Wright was also known to say, “window walls stretching from floor to ceiling turn small houses from boxes-caves- into roofed shelters that invite nature inside.”

16 Ibid(70)
17 Ibid (70)
18 Ibid(43)
section. Clerestory windows were often utilized to provide the main living spaces of the home with light while maintaining privacy for the residents. Clerestory windows have the added effect of making the rooms taller and more spacious, while providing cross ventilation high up where heat usually collects.\textsuperscript{19}

**Evolution of the Function of Rooms**

The American single family home is slowly moving away from many rooms with individual functions to fewer rooms with multiple functions. Today, houses have expansive rooms with merged functions such as expansive, open space in kitchens and family rooms that seamlessly flow together. This merging of spaces has been made possible by the less formal nature of our culture and more prevalent middle class. We have moved away from houses very concerned with formal spaces complete with separate entries like sitting rooms, living rooms, parlors, and formal dining space which were supported by servant quarters and back hallways. Today most of these formal spaces are seldom used, however the formal dining room and the formal living room are still commonly found in today’s houses. These rooms are really a waste of space that owners and designers alike add to the plan without thought, justifying a few holidays a year is enough for the room’s existence.

1800’s culture and the served vs servant class separation made it unheard of to see the kitchen from the dining space. As the compartmentalized Victorian box grew, it became a status symbol to have a separate space for each function as a part of the formal progression of visiting someone’s home\textsuperscript{20}, a stigma that still lingers in some homes. The 1900’s culture shifted the kitchen toward a space for the homemaker and not meant for guests or men. But the 2000’s now favor a large kitchen, preferably with an island or bar for gathering and entertaining. The kitchen has added social and public uses to it’s functional beginning. Likewise the fireplace had


\textsuperscript{20} Ibid. (69-70)
a functional beginning, in the 1800’s the center of the home was the fireplace. Wright attempted to resurrect this important center and gathering point in the hearth. Typically making them the center of the room and merging the functions of heating with cooking. He romanticized the notion of a family gathering together around the hearth. Some Usonian homes of Wright’s integrate the function of the kitchen and public use of gathering space around or about a hearth.

Communal Space

Today’s family is less communal. Homes are built with only one occupant per bedroom and multiple bathrooms as opposed to the 1800’s where one bath served everyone and children shared bedrooms. The increase in number of baths began in the 1920’s when many cities required new homes to have a second bathroom for hired help and service people. With the addition of a second bathroom and needs of the large family structures, the value of a second bath was quickly realized. Today, two bathrooms are considered an unwritten minimum. More deluxe homes often feature a Master bathroom for the exclusive use by the owner.

A Brief on Modern Family Types

The Family Paradigm Shift

The traditional Victorian housing model is designed for the traditional family of a homemaker mother, bread winning father, and multiple school-aged children. In today’s society, this family type does not make up the majority of American families. Yet the housing market is full of Victorian plans. So finding a truly suitable home for a non-traditional family type can very difficult. Furthermore, the average price of an existing single-family home in 2000 was $177,000 and banks now have much stricter regulations on mortgages, so many young couples cannot afford a home. In order to be able to afford a home, young people must move further from the city where land and consequently housing is cheaper. Alternatives may include unrelated roommates to split bills, renting properties, or living with their parents. This juxtaposes with a large number of elderly persons who own their own homes but can no longer afford the property taxes, bills, and maintenance of their homes. In Europe, the multi-generational family is much more common. With the downturn in the US economy, new family structures are a reality for millions of Americans.

Multi-generational Housing

After WWII there emerged the American dream to move out and live on your own. Supported by the large numbers of returning GI’s and young new families and need for housing, the multi generational model was lost. The change happened so quickly that the benefits of multi-generational housing were overlooked. The financial down turn circa 2007 and increased lifespan of the average person have reversed the Multi-generational model. Adult children are taking in their elderly parents. Emily Brandon reported in her book, “Over 3.6 million parents lived with their adult children in 2007, according to recently released U.S. Census Bureau data, up 60 percent from 2000.” This helps both parties financially with more adults helping supply incomes, do maintenance and cooking, share bills and taxes, watch young children, etc. Architects and builders have translated the needs of two adult couples into mother-in-law suites, dual master bedrooms and carriage houses as additions or alterations to the single family home.

Single Parents

There can also be difficulties for single mothers or fathers when looking for housing. Hayden notes, “Single-parent families often lack the support system required if the parent is holding a paid job. Infant care, day care, public transportation so that older children can move independently, closeness to stores and health services, are almost always lacking in neighborhoods where the housing was originally designed for households with

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23 Dolores Hayden, Redesigning the American Dream Gender, Housing, and Family Life. New York: W.W. Norton & Company
a full time housewife caring for husband and children.” The support structure, and time needed to travel to larger retail areas causes problems. Affordable day care close to the home, which enables the single parent to hold a full time job, is typically hardest to find. This forces single parents to not work and go on welfare as child care can account for a third to half of a person’s pay. Alternative options include working from home, but this isn’t allowed under some rental agreements or in some neighborhood ordinances. Furthermore the parent may not have skills or knowledge that is viable to home business. (see Figure 1.11)

Single People

Young single people are often living with other young single people when sharing a traditional home. However, sharing a traditional home designed for the closeness of a family can lead to a lack of privacy. Some desire company, coming home to a large empty house can be depressing. Single people or all ages and lifestyles have trouble finding housing that can provide the right flexibility, variety, intimacy and community they desire.

Divorced parents

Divorced parents also have major issues with affordable housing. “Couples undergoing divorce or separation experience additional frustration. If two incomes are needed to support one mortgage, neither partner may be able to afford to buy the other’s share of a jointly-owner house. At the same time it may not be feasible to relinquish one low interest mortgage in favor of two expensive rentals.” This compounded with the fact that, due to zoning laws, the conversion of a portion of the house into a small apartment or “granny flat” makes a very difficult situation to find appropriate housing.

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25 Dolores Hayden, Redesigning the American Dream Gender, Housing, and Family Life. New York: W.W. Norton & Company
26 Ibid (72)
27 Ibid (100)
28 Dolores Hayden, Redesigning the American Dream Gender, Housing, and Family Life. New York: W.W. Norton & Company (30)
Family Types Conclusion

It becomes quite clear that neighborhoods need housing of a variety of sizes and types in order to allow equal housing opportunities for each of today's family types so that single-parent, gay/lesbian couples, divorced parent, singles and the elderly can live in close proximity of the standard traditional family for which most homes are designed. One standard model is no longer applicable when the family structure and our lifestyles have changed significantly since the original conception of the design of homes was created.

Economic Paradigm Shift

According to the U.S. Census Bureau in March 2009, due to the economic recession, nationally 3.23% of all single family homes were foreclosed and an additional 8.93% of homeowners had a 90 day delinquency warning.\(^29\) Due to rising gasoline/oil prices, it has become more desirable to live in the city or just on the outskirts. There is also a fast growing movement against urban sprawl which has greatly helped the percentage of the population living in cities across America. However, in most cities, this area has already been developed into existing single family houses.

Purchasing a new home from a developer in today's market does not get you a home which necessarily meets your needs, and the supposed options, which are available, are mostly cosmetic items such as granite countertops, stainless steel appliances, carpet and siding colors. One cannot vary much from their existing models. Being that house prices and construction labor rates are at all-time lows due to the recession, it makes more sense to purchase existing homes and renovate them to better suit a family's needs. This process however requires an architect or another design professional in order to ensure that the existing plan is optimized to suit the family. To insure that the process of renovation is done properly, to offer design advice, and to provide potential time and money saving techniques. Being that each existing house is different, one cannot utilize the exact same design changes to modernize these homes; there are many typical design interventions which one can utilize to modernize their homes. This is the value which hiring an architect can provide, being that they have an intimate knowledge of construction and design. Frank Lloyd Wright made great strides in the refinement of Victorian houses to a house of the times to meet the way that its inhabitants would live. As society has progressed, even his model can be found to be inadequate. The family structure upon which he models his structures is no longer accurate. Therefore the design of our homes must change to meet the new family structure paradigm. Designers of today can build upon the techniques he has created. They must go further to meet the desires and needs of the modern family and can successfully transform the existing housing stock into modern housing facilities.

Cincinnati (March 2009)  
2.53% Foreclosures  
6.67% 90-day Delinquency

Ohio (March 2009)  
3.09% Foreclosures  
7.81% 90-day Delinquency

Nationally (March 2009)  
3.23% Foreclosures  
8.93% 90-day Delinquency
Image above is a featured home on the Habitat for Humanity Cincinnati Chapter website. It is one of the new build house models Habitat for Humanity Cincinnati Chapter builds. (Figure 2.1)
Chapter Two
Inexpensive High Design Housing

The most common building type in the United States is the single family home. Most americans live in a single family house, grew up in one, or know many people who have. Homeownership is so important to us that it is even instilled into the American dream. The design of the single family home is an important issue for Architects and builders throughout the world. The size, cost and design of the single family home varies greatly.

In the Southeast United States, Rural Studio designs houses for impoverished people with a low budget of $20,000 per house. While this can be seen as an outlier in the typical housing cost, it can be seen as proof that through ingenuitive design and material use one can build houses for very little money.

There are also a small group of select designers who operate under significantly higher budgets and provide their clients with luxurious mansions. The majority of designers however design for the middle class single family. These designers typically create imitations of European typologies with have been instilled into the American housing paradigm regardless of market or location.

While one cannot classify all designers in simply following the pack, most are simply modifying the interior of the single family house and preserving the traditional exterior form. However, many designers are questioning the current housing paradigm and push the home’s function, design, and affordability.
Drury University Habitat for Humanity House

In 2007 the Students at Drury University in Springfield, Missouri proposed to question what the typical Habitat for Humanity house was. They set out to create a not only affordable house which Habitat for Humanity could build but to make it achieve LEED Platinum. This is quite a challenge being that there are only 44 residences in the United States which have achieved LEED Platinum.¹ The students were lead by Professor Traci Sooter. “Their efforts were combined with more than 5,000 volunteer hours contributed by a variety of different cast members who got to learn more about sustainable building, including Drury Chemistry Students and local fifth-graders. As Sooter states, ‘My architecture students learned how to take a plan and construct it at full-scale. And they saw how a community can come together to achieve a common goal, they’ll take that into their careers.’”²

The Drury University Habitat for Humanity house featured many inexpensive or reused materials to help them stay under budget. For example the interior of the house has stained concrete floors, plywood finishes, and corrugated metal. The house features many green features. First, the house has 30 solar tubes which provide the interior of the house with natural light, some of which are operable and can allow cooling breezes into the house. Second, the house features native landscaping which reduces the need for watering and minimal maintenance.

Third, the house features permeable concrete driveways and walks which allow water infiltration. Through the use of rain gardens, the underground water supply is able to recharge and thus improve the water quality and quantity. This also puts less strain on the wastewater system. The house also takes advantage of proper siting of the building to take advantage of solar heat gain and shading. The house utilizes evacuated solar tubes and radiant heating to heat the home.¹

While this house is not the typical Habitat for Humanity home, it is above and beyond the principles laid out by Habitat for Humanity of simple, decent and affordable. As Habitat for Humanity does not typically hire architects to design their homes and lacks the extensive knowledge of green design and construction, this is not a feasible model for them to use throughout the country. Green design is also very site specific which would not enable them to use this as one of their typical models.⁴ This model shows that energy efficiency and LEED certification is not exclusively available in high priced structures and is possible to be found in Low cost housing.

Rural Studio- Patrick House

Rural studio is an architecture program based out of Auburn University. It was originally founded by Sam Mockabee and has the goal of providing low cost housing to the local inhabitants. Rural Studio is perhaps the most well-known service learning, community based design build program in the country. The program has an annual budget of around $425,000, thanks to solicitation of grants on the campus side. 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. This is very similar to how architects in the profession practice and can be seen as real world experience.

Through the studio students learn about materials and how buildings are constructed while improving the lifestyle quality of the local people. Typically each house is very different and have no common elements besides the student labor and the Rural Studio cause. This was problematic according to Jay Sanders. “But at the end of each year the students and faculty move on, and it all starts over. For us to have a larger impact, we thought we had to do something more important than one project.” He and his students decided to create a work that could be duplicated—an easy-to-build, inexpensive alternative to the ubiquitous house trailer. Their solution was to create a steel frame structure that local people could extend, enclose with available materials, and otherwise manipulate to suit themselves.

3 Ibid - (85-89)
This system was first used in the Patrick House. The Patrick House is a renovation and addition to an existing house. The existing house lacked running water and had issues with water infiltration during storms.¹ The existing Patrick House, like many homes built around the turn of the 19th century, had issues with natural light infiltration and airflow. According to Jay Sanders, the instructor of Rural studio, in the design of the house “The students placed the parents’ bedroom and bath on the ground floor of the south bay, close to the old house, and Kindra’s loft above her parents’ room. The living area and a loft for the younger Willy are in the north bay, and the middle bay has the kitchen, which overlooks the living area. Glazed doors open to the courtyard.” The steel frame was originally planned to be covered in the wood from pallets, but due to time and money constraints, they switched to using common 1x6 lumber similar to what one can find at any hardware store or lumber yard. An occasional white board was added to animate the facade of the building. In the interior of the house they used cheap commercial carpet tiles and used other architectural elements in non traditional manners. For example, they used a gutter as a light tray element, and the siding of the existing house as an interior treatment.

In order to solve the issue of moisture infiltration during storms, the new house was raised up on piers. This enables air movement below the house, allowing condensation to dry and minimizing the absorption or water. Due to the open plan and placement of the operable windows the house the house is able to be better ventilated naturally than the existing Patrick house. The placement of the windows and the use of corrugated plastic for the house overhang allows more light to enter the house and thus reducing the use of artificial light in the home.²

This home is the perfect example of how, through the proper selection of materials and good design, one can provide affordable housing without compromising the size or features of a house.

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Lundberg Design - Breuer-Lundberg Cabin

Lundberg Design is a San Francisco based architecture firm which specializes in utilizing found objects as central design elements. They not only design projects many of which either feature elements fabricated by the office or are entirely built by the Lundberg Design Fabricators. “They fabricate steel staircases, aluminum coffee tables and other custom items for clients in the expansive shop that is the centerpiece of their studio.”¹ The firm is headed by Olle Lundberg who strives to make sure that everyone in the office understands the methods and technologies involved. He believes that knowledge is critical in the transition from sketch to finished product and often his design team will assist or do the fabrication of designed elements.²

One such structure which his design and fabrication teams built was the Breuer-Lundberg cabin. When Olle purchased the property the previous owner had started building a one-story cabin, but sold the property before completing it. At the time there was no power or plumbing, and a septic system was installed but not connected.³ The cabin features a series of found objects and elements. Such as a series of steel framed windows from five previous remodeling projects. These prevent them from being sent to a landfill and still enabling them to be used in the manner in which they were originally intended. While they may not be as energy efficient as new windows being that they are in a structure which is not heated on a year round basis, this is not an issue. As it is only used in the spring, summer, and fall, the structure doesn’t require the most efficient windows.

³ IBED
The most notable of such found objects is the swimming pool which is comprised of a large water tower which used to be a water tank for livestock. At 25-feet diameter and 14-feet deep it creates what seems to be an infinitely deep black pool.

The exterior of the house is clad with reclaimed redwood siding which has a beautiful grey patina which draws upon the local vernacular as seen in barns and mining warehouses throughout the region. Many of the pieces of furniture and architectural elements found in the cabin are rejects from other projects. For example, the coffee table featured in the cabin's living room was originally designed for the Diva Hotel, however it has a flaw in the casting and was thus deemed not worthy to be placed in the hotel. That does not mean, however that it is not still functional. Mr. Lundberg deemed it an excellent conversation piece and decided to place it in the cabin.¹ Other pieces were also custom made for the house. For example, both of the wood storage racks were custom designed for this cabin. Both firewood racks are simply bent sheets of metal, one of which is circular and mimics the shape of the water tower swimming pool. The bathroom is also made of leftovers from one of Lundberg Design's projects. The marble is remnant from an office lobby. "A cypress coffee table built for the Slanted Door restaurant was too thin; a custom Corten steel firewood holder left rust stains on a client's limestone floor."²

1950'S image of a typical American family. From "Same-Sex Marriage goes against basic rights of children." Figure 3.1
“Images of the traditional family still dominate our televisions and magazines, but they do not represent how most Americans live. In 2002, only 7 percent of all U.S. households consisted of married couples with children in which only the husband worked. Dual-income families with children made up more than two times as many households. Even families with two incomes and no children outnumbered the traditional family by almost two to one. The large percentage of households in the “other” category shown in the accompanying graph reflects the relatively large number of female-headed households and households headed by young adults or older Americans, who are less likely to reside with spouses. Among married-couple households, about 13 percent consisted of families with children in which only the husband worked, 31 percent were dual-income families with children, 25 percent were dual-income families with no children, and 31 percent consisted of other types of families, such as older married couples whose children no longer reside in the household.”

Boomerang Children

Boomerang children are those defined as young men and women who choose to cohabit with their parents after living on their own for some period of time. There are many reasons for this such as lack of employment, inability to afford a place of their own, underemployment problems, saving money, and rising tuition costs for college students. Jim Reed of the BBC recently reported that “One in four men and one in six women in their 20s now live with their parents, according to the latest government figures. The number has been steadily rising over the last decade, a trend blamed on people settling down later and the rising cost of going to university.”

Nancy Anderson of Forbes magazine report that this trend might not be such a bad thing for both parties as they adapt to the pinch of this poor economy. “With the sluggish real estate market, many baby boomers can’t move and downsize as they may have planned. They are stuck in large family homes they don’t need anymore. With an estimated 1.5 million homes now in shadow inventory (not currently on the market but owner’s wishing to sell) selling the family home may be a long term proposition. Renting space out at a discounted rate to adult children may be the solution that helps both parties.” Not only is there savings in mortgage payment, there is also the benefit of baby sitters, shared maintenance & housekeeping, errand running, and shared taxes & utilities. These situation can even bring families closer together.

Builders are starting to catch on to this trend and are building houses with this demographic in mind. They include special features such as separate and communal living areas such as kitchen and living rooms, “casitas” (small houses), and “mother-in-law” suites attached to the main home or elsewhere on the property. To maintain a sense of independence for boomerang children or aging parents, separate entry points can be provided.

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4 Ibid.
Some of structures will have dual master suites to accommodate the bi-generational families. If a home is to be renovated to accommodate the growing needs of a young adult, often times the garage is of value. Space can be added for anything from an additional vehicle spot to an apartment or carriage house. The garage tends to be the cheapest place to remodel due to its simpler construction and less intimate occupancy when compared to the home.5

In this layout should the family selected by have a boomerang child, the architect would have take this into account and modify the structure accordingly. For example in Figure 3.3 one can see that the master suite is located on the first floor with an entirely separate suite upstairs for the young adult. The young adult has a separate entrance to his/her apartment above. The apartment has its own kitchen, dining area, bathroom and master suite. Due to the proximity of the parents there is the potential for sharing of the family room as a communal gathering space for both parties involved.

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Empty Nesters

With the aging of the baby boomers and the poor real estate market there is a growing population of individuals who do not want to move out of their current homes for a variety of reason. But they do not need such a big home after their children have left. This group of people are commonly referred to as empty nesters. Historically it was common for empty nesters to move from their current residence into a smaller house after all their children move out. However, with the poor real estate market this is becoming more and more difficult due to the potential loss they would most likely be forced to take on the value of their homes.

This leads empty nesters to become more creative with the unused space and thus allowing them to do things they had never been able to while their children lived with them. Empty nesters, often times, can use the empty space from a child’s newfound independence for an apartment for rent or additional bonus rooms for the parents. Turning the space into an apartment provides them with additional income.

Figure 3.4: Empty nesters and aging in place plan (by author)
to put towards living expenses or their retirement.

Common new purposes for the rooms include a hobby room, den, workout room, walk-in closet, sewing room, billiards, game room, or office. In order to design for a soon-to-be empty nester, one must be able to design a space in which their current children can live, but after moving out, the purpose of the space can be easily altered.

In the design of renovation the Millrich house, if the family selected by Habitat for Humanity were projected soon-to-be empty nesters, we could provide a similar design solution found in Figure 3.4. However there is also the potential that the parents would want to turn the entire upstairs, from what was formerly the children’s rooms, into one apartment for rent or into a large master suite with full walk in closet.
Aging in Place

With the poor economy and people getting attached to the communities in which they live, it is becoming more common that people live in one home throughout their adult lives. This is referred to as aging in place. An aging in place home is defined as a home in which you can live independently for your entire life. In order to accomplish this, one must take into account for the inevitable changes that occur to the human body as it ages. Minor obstacles such as stairs, poor lighting, narrow hallways, tight spaces and door hardware while they would not cause issues for a younger person, could become severe impediments to an independent lifestyle for an elderly person.\(^6\) In designing a home for aging in place, one must ensure that the home is barrier free and optimally all on one level, or at least the main living areas, such as the living room, kitchen, bath, bedroom, laundry, and garage.\(^7\)

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It is fairly simple to build a new home which meets these requirements, however when one is attempting to change the home in which they currently live to a home they can live in the rest of their life, it can be quite challenging. By making simple changes to the construction of a house such as lever door knobs, casement windows instead of double hung, blocking in the walls of the bathroom for grab bars, extra lighting, no threshold showers, and many other optional changes at the time of construction, thousands of dollars can be saved while maximizing the independence of the homeowner.\(^8\)

In designing the Millrich house to potentially meet the requirements to enabling the Lawrence family to age in place, many of these techniques are utilized. In Figure 3.5 the hallways are wider, the plan has a first floor laundry room, and a first floor master bedroom. The second floor of the house converts from a pair of bedrooms for their children to an apartment for rent. This would allow the elderly person to have a source of income during their retirement. There are numerous details which do not show up on the floor plans of the house. Simple changes such as raising the height of the washer and oven to decrease bending over, stove pot filler, lever door knobs, pull out shelves in all cabinets, and more ceiling lights can make a world of difference.

Aging Parents Living With Children

Due to the poor economy and longer lifespans, many elderly people are forced to move in with their families. “Over 3.6 million parents lived with their adult children in 2007, according to recently released U.S. Census Bureau data, up 60 percent from 2000.” There are potential benefits of having an elderly parent move in with their children. “Reliable day care often claims a large chunk of a working parent’s budget. But live-in grandparents sometimes share child-care responsibilities.”

“Sometimes adult children have their parents move in to avoid a nursing home.”

“In a multigenerational household, it can often be difficult to know who is in charge. You’ve got the traditional power structure of the parent having authority and the child saying this is my house and what I say goes,” says Coleman. “There is a high potential for conflict, but there is a good potential for increased closeness.”

When a parent moves in with their children it is optimal if there are a few modifications to the house they are moving into in order to make life easier for the aging parent. If it is possible, the optimal solution is to provide a “mother-in-law” suite on the first floor of the house in order to minimize the assistance required to perform daily tasks and promote independence. Money needs to be allocated to renovate your home to further accommodate them including changes such as larger bathrooms to allow for ADA turn circle, wider hallways (minimum 4’ wide), minimal steps, lower light switches, no threshold showers, grab bars in showers, lever door knobs, casement windows (being that they are easier to open than double hung) and a ramp into the house if necessary.

In designing the Millrich house for an elderly live-in parent, see Figure 3.6, we have employed several of the aforementioned characteristics to maximize the elderly’s sense of independence and mobility. The bedrooms of the existing house were moved to the front of the house to enable the living room to be close to the kitchen to minimize the distance between it and the elderly parent’s suite. This is also an optimal configuration for the passive cooling ventilation shaft being that it is very close to the two first floor bedrooms, thus cooling them at night. The ADA accessible bathroom is also very close in proximity to the elderly person’s bedroom. The hallways are also wider to potentially

10 Ibid. (1)
11 Ibid (1)
12 Ibid (2)
accommodate a wheelchair. There are many design considerations in the bathroom alone which would make life easier for an elderly or disabled person. All of the walls of the bathroom would be lined with a substrate of plywood to make the installation of grab bars and hand rails easy.14 The sink counters would be set at 36”, higher than the 33” normal, so a person does not have to lean down when washing their face. A 48” wide accessible roll-in shower with a hand held sprayer and a built-in shower bench is planned. The porch and the deck also have a minimal step required to enter and exit the house allowing the disabled to spend time outside. This is very important as the elderly often spend little time outside. Due to this fact they often suffer from a vitamin D deficiency. The kitchen is designed to have a set of full height pantry cabinets to enable easy access and a variety of heights for storage. There would be countertops at a variety of heights to enable anyone to use them. “It is best to provide a variety of counter heights to accommodate different tasks and users. Counter heights may range between 29” and 40” depending upon the users.”15

15 Center of Design for an Aging Society, "Designing Homes for the Second
Single Parents

Single mothers/fathers are becoming more common in today’s society. While the causes vary from death, divorce, or separation, there are many housing challenges which can be prevented or minimized through good design. By placing the living room in view of the kitchen, it would enable the parent to supervise the children during the preparation of meals. By providing a central work surface in view of the kitchen, it enables children to do homework while the parent is working in the kitchen or relaxing in the living room. By having an open plan, supervision is easier for the parental figure. As the parent’s life is forced to become so revolved around their children, it would also be nice for them to have a private place for themselves.

Seen in Figure 3.7 there is an open plan in the scheme for the Lawrence house as it is designed for a single parent. While it requires a great deal of effort to move the structural wall to enable the family room to be next to the kitchen, it creates a space more conducive to a single-parent lifestyle. It is also the optimal configuration of the bedrooms in respect to the passive ventilation shaft. This would enable the bedrooms to be conditioned without the use of mechanical systems, which would in turn save the family hundreds of dollars a year. There is also a separate bathroom for just the children to allow the parental figure to have their own space. This is a vast improvement over the existing building plan which only had one bathroom for the three existing bedrooms. There is also a dining area between the family room and the kitchen. This provides a central living space from which it would be easier to supervise children at play or studying while relaxing in the family room or cooking dinner. From the living room or the kitchen, a parent also has a view outside to the deck where children could be playing. The parent is also able to stand directly across from the ventilation shaft and look into both of the children’s bedrooms to supervise their studying or bedtime rituals.

The parent is provided with their own private space in the form of an upstairs master suite with a spacious bathroom and bedroom suite. This space apart can be vital to the single parent’s sanity. With these simple design changes, the life of the typical single parent can be greatly improved. As the majority of the Habitat for Humanity families are single parents, this is a very important case study to present. With the increasing number of single parent families, the demand for this style of houses will only grow.

Figure 3.7: Single Parent plan (by author)
Divorced

“Married adults now divorce two-and-a-half times as often as adults did 20 years ago and four times as often as they did 50 years ago... Between 40% and 60% of new marriages will eventually end in divorce. The probability within... the first five years is 20%, and the probability of its ending within the first 10 years is 33%... Perhaps 25% of children ages 16 and under live with a stepparent.”

With the growing number of divorced or separated families, designers are going to have to step up and start designing homes for them at a large scale. In order to design for divorced parents some designers have added features such as dual master suites for separated parents who wish to remain together for their children. In other applications they have split custody or visitation rights of their children therefore do not need to have as large of a house.

Williams, Brian K., Stacy C. Sawyer, Carl M. Wahlstrom, Marriages, Families & Intimate Relationships, 2005

Figure 3.8: Divorced parent with children (by author)
Often times divorced people have large houses with a great deal of space they no longer need. Divorced people could convert a portion of their homes into an apartment for rent. This potentially would provide them with a source of income which their spouse might have previously provided. If the divorced person does not have custody of the children, then the floor plan found in Figure 3.8 (boomerang children) would be sufficient for their needs. If the parent living in the Millrich house did receive custody of the children, the plan in figure 3.8 (single parent 1st, boomerang children 2nd) would be sufficient as it has a bedroom for the child and a master suite on the first floor and an office/hobby room. The second floor is an apartment for rent which would enable them to have a possible steady source of income.
Young Couples Without Children

Another growing faction in terms of modern family structure is young couples without children. As they do not have children, there is no need to have the common three bedrooms, which most houses on the market have. The only need for a bedroom outside of the master suite would be for guests who come to visit. This leads to the ability to live in a smaller house or alternate room uses for what was originally designed to be a bedroom. The economically and environmentally responsible thing to do would be to buy a smaller house than that of someone with children. This is a principle highly stressed by Sarah Susanka in her growing ‘Not So Big House’ movement. Due to the unavailability of homes with two or fewer bedrooms, many couples simply live in a home that is larger than they require or convert the use of the extra bedroom. Young couples without children are also more likely to entertain so a dining room and open floor plan are essential to the design of their home.

Figure 3.9: Married Couple without children (by author)
Divorced Remarried

With the increased divorce rate in America, another growing family type is the divorced remarried family type. Parents who either one or both is divorced and then remarried can create an interesting set of family dynamics around which to design. This problem can be exacerbated when one or both of the parties have children of their own. There can be potential problems with the two sets of children getting along and also the children getting along with their parent’s new spouse. With the potential for conflict among the two sets of children, it is a best practice if possible, to give the children each their own room thus decreasing the potential for conflict. Hence each of the children will have a space to call their own.
Figure 4.1: Photos and Renderings: June 2012, February, 2013, Proposed Final. By Author
Chapter Four
Architectural Interventions and Adapting Old Homes

“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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The American culture is finally starting to slow from its fast paced, consumption driven economy and changing the housing market. This is creating a comeback for older, walkable, closer to the city neighborhoods. In Cincinnati, the 2010 Census showed vacancy rates in the older central neighborhoods of Hyde park, Clifton And Columbia at 7-8%, while portions of Westchester had up to a 17% vacancy rate.¹ This data shows the local implication of the global phenomena that over ½ of the world’s population now live in cities. In America, outside the central business districts, most of the built forms are very outdated single family homes. They can be lived in as is, but as demand for their land grows, they may become subject to demolition since they do not have much to offer the modern homeowner when it comes to energy efficiency, openness and systems. These architectural interventions pose a new outlook on older homes and renovation strategies for homeowners to spark new life into an old home.

Figure 4.2: US Census Map of Cincinnati
Note only population volume is shown, not density
Insulating With and Without Major Demolition

One of the most labor intensive processes in the renovation of an existing structure is the process of removing the existing interior sheathing. In traditional residential construction this is most commonly lathe and plaster. This process produces a great deal of waste and can also fill the air with particulate matter that can cause health problems. The are many safe practice and renovation guidelines put out by the EPA and other organizations to educate builders and homeowners, so this thesis will not focus on the means and methods of the removal process. We do recommend anyone attempting the work themselves to at least start with the EPA's renovate right broucher to educated themselves. http://www.epa.gov/lead/pubs/renovaterightbrochure.pdf

If the plaster and lathe was removed, the home is basically a shell ready to be rebuilt to modern standards. However for a faster, less dusty process, we want to leave the existing walls in place and fur-in new walls to accommodate the desired insulation, pipes, wires, etc. In order to do this, one would at first remove the existing trim and molding to get the wall surface down to the verticle plane of the plaster. Then one would frame the new wall, install the pipes and wires, insulate and finish. This wall could be built a few ways, depending on the thickness desired for all the new things going in. This process has been diagramed in Figure (4.3). Finishing a ceiling is tougher than a wall, making a plaster ceiling the most labor intensive finish you can ask for. That's why our diagrams suggest covering the joint with a trim board. Trim boards are great at hiding joints, but the industry tends to only think of them as profiled boards. A piece of trim can be almost any material. Its purpose is purely cosmetic, so owners should think of materials or skills they have that can help them develop trim pieces or joints. Joint details Figure (4.3)
Narrow Windows

Most homes are built with 16” on center wood stud framing. This leaves a 14.5” clear opening between studs, assuming the stud width is 1.5” and the framers of the home took care to maintain spacing. In non-load bearing walls adding a large opening is easy since there is relatively low weight on the top plates. In load bearing walls a header can be inserted without using a temporary wall to frame in a new header using the following process. First a new set of king studs must be added to outsides of the cavity receiving the opening. Then the old studs can then be face nailed to the new studs and cut to receive the new header and sill. Insert and secure new header and sill, then cut sheathing or faceboards beyond. This will allow a new window with header to be inserted into the 14.5” clear opening.

In the Millrich house this effort added much needed light to an otherwise dark corner of the house. The only costs were in the window unit itself since lumber was reused from other walls. Most vinyl window manufactures didn’t have a problem making a 14” wide fixed window. A few were able to make a casement window meet this size requirement, though it would have left less glazing width.
Electrical channels

In order to maximize the insulation and R-value of the new wall, it makes sense to not run any new lines or pipes in the new wall, dedicating the cavity to insulation. This is also beneficial in smaller homes where rooms will become cramped with a new wall protruding too far into the existing space. This electrical channel intervention draws inspiration from systems furniture, where wires are run inside raceways or profiles. Here is a simple channel which runs along the interior of the wall surface which would house the electrical lines and duplex outlets (Figure 4.7a). Having all of the electrical lines outside of the wall cavity allows one to easily access it to add a device or free up power if a panel becomes full. The design’s bottom line is flexibility and ease of installation through not having to punch holes for installation or electrical system reconfiguration. Aesthetically, (Figure 4.7b) is a wainscoting inspired construction where the electrical channel rests on top using two interlocking galvanized steel stud tracks to house the wires. These tracks intersect the duplex boxes at regular intervals to provide full containment of the wires and outlets and are finished with plywood firring (See Figure 4.7c). This process allows one to spread electrical outlets around a room from a central stack. Keep in mind there are numerous electrical code regulations, many of which dealing with the mounting height of convenience outlets above floors, counter tops and wet areas, so contacting a professional is necessary early in the design process.
Ceiling Mounted Light Fixtures

Lighting is typically a problem area in older homes. Some rooms may not have fixtures located on the ceiling or they can be too few and far between to light it for significant detail tasks in the evenings. One of the major problems with adding lighting elements to the ceiling of a room is the need to puncture the wall and ceiling or run a surface mounted conduit. Fishing for the wire through the existing ceiling can be tedious and frustrating. R.S. Means publishes the average hourly rate of a certified electrician at $50 per hour. On the other hand, adding a conduit isn’t always architecturally attractive, so the architectural intervention we have designed is a slimmed down version of drop down soffits, similar to what is typically done for HVAC ducts, and a grid of fixtures. In order to create this one would first frame the soffit and the vertical shaft where the wires would run back to the panel. Then they would design and hang the fixtures and the necessary wiring in a grid on the ceiling. Keep in mind there are many opportunities to dress up fluorescent 2x2 and 2x4 fixtures with the screens and grates, whether purchased or fabricated. The cladding shown in (Figure 4.9) features finished plywood.
Window Lighting and Thermal Barrier

One of the common problems in renovating an existing house is the low R-value of the existing windows. The common and quite costly solution is to replace the windows. Alternatively to place a permanent layer of plastic film on the window opening to increase the R-value of the window. However this can look unattractive and needs to be redone every year if one hopes to open the windows to provide natural ventilation.

In order to solve this problem without spending the money required to replace the windows, one can apply another air barrier to the window in order to add R-value to the window. The solution we propose is the use of a 15 mm polycarbonate sheet which by itself will provide an R-value of approximately 3 according to Sundance Supply Inc. If one includes the air gap between the window and the polycarbonate and the insulating value of the existing window one can have a total R-value of around that of a new window at must less cost with no additional structural framing or demolition. In order to allow for the window to still provide natural ventilation into the building, the polycarbonate sheet is divided into two pieces which are hinged at the middle sash of the window to allow it to be raised to allow ventilation. This enables it to be closed at night and in the winter when one hopes to retain heat in the building.

Embedded in the frame of the polycarbonate layer, one can find a strand of LED lights. This enables the window to provide light day and night into the space. The power source for these lights will be embedded into the new window trim and then carried downward into the new electrical wall mounted service which runs along the interior of the space.
Figure 4.7: window lighting and thermal barrier intervention

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<td>triple pane, low e, super efficient</td>
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EXTERIOR SILL DETAILS

- ALL-WOOD TILT DOUBLE HUNG
- HALF SCREEN
- OR
- FULL SCREEN

DAYLIGHT OPENING HEIGHT = GLASS SIZE - 13/16"

SILL DETAILS

- 3/16"
- 2 1/8"
- 1 9/16"
- 3 1/2"
- 1 3/8"
- 2 3/16"
- 1 9/16"

R = 1.58 - 2.22
R = 1.58 < x < 2.22 + 1.64 < x < 7.3
R = 3.22 - 9.52

Etymology

The word window originates from the Old Norse 'vindauga', from 'vindr – wind' and 'auga – eye', i.e. "wind eye". In Norwegian Nynorsk and Icelandic the Old Norse form has survived to this day.

Early Windows

Early windows comprised of nothing more than an opening through which light can penetrate a structure and smoke from a fire could escape. For added privacy and protection from the elements and security of the structure people began to implement the use of wooden or stone screens.

Screens as Windows

For added protection against the elements semi translucent stones were cut very thin to provide light into structures. Upon the discovery of glass and the variety of colors available stained glass was invented. Due to the variety of colors and limited size of the pieces available it was necessary to piece many small pieces together to span an opening. Religious centers began commissioning masterful depictions of biblical images to spread the word of the bible to those without the ability to read.

Crown glass (also known as "bullions"), relatively common across western Europe. With this technique, a glass ball was blown and then opened outwards on the opposite side to the pipe. Spinning the semi-molten ball then caused it to flatten and increase in size, but only up to a limited diameter. The panes thus created would then be joined with lead strips and pieced together to create windows. Glazing remained, however, a great luxury up to the late Middle Ages, with royal palaces and churches the most likely buildings to have glass windows.

Early Double hung windows were often times single paned with wooden sashes and mullions. They had iron counterweights to keep the top window open in the window jams which often took up quite a bit of space beside either side of the window. Modern double hung windows are often highly efficient with multiple panes and their frames can be made of a variety of materials including plastic, wood, or metal. In highly efficient windows there are often times plastic films or coatings to improve the efficiency of inert gasses between the panes. These windows use a system of springs to hold open the top window.
Sizing a 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 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.

\[
\frac{\text{site latitude}}{\text{known latitude}} = \frac{\text{shade length}}{\text{known shade length based on % cover}}
\]

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

Figure 4.9: sunshade depth chart
Figure 4.10: window shading sketches
Window Shading Intervention
Composite Deck Parts

One of the common problems in renovating an existing tract home is the complete disregard for proper window orientation and solar shading. In order to prevent overheating from solar heat gain, one can use a solar shading device. On windows exposed on the south, one should utilize horizontal fins, and on the east and west sides one should use vertical fins. Professionally fabricated shading devices can be quite expensive. In order to reduce this cost one can take preexisting systems and reutilize them in an unconventional manner. In this case, one can use decking systems such as TimberTech decking. TimberTech produces a material which requires no maintenance and comes in standard sizes. In this case we are utilizing the 4”x4” post sleeves in order to hang the decking boards. In certain cases they can house lamps to provide exterior lighting. The boards are then hung from the standard handrail mounting hardware spaced appropriately based on the required shading in the specific region of the country on the angle of the sun.
Passive Heating and Cooling

The largest architectural intervention which was implemented in the Millrich house was the conversion of the existing central chimney into a passive cooling vent stack. This method was traditionally used throughout the world. However, with the advent of the air conditioner and the availability of cheap energy this method was removed from mainstream design. Today energy is much more costly, therefore people are looking for methods to provide passive cooling. Traditionally homes from the late 1800’s to early 1900’s had higher ceilings and taller windows to provide more room for hot air to rise to the ceiling. The true double hung windows which were featured in these homes allowed high air movement to evacuate this warm air and also cooler air movement down low. With the use of air conditioning, today ceiling heights are able to be much lower and still allow the room to remain cool. By reducing the ceiling height to eight feet material costs are significantly reduced. By choosing to renovate an existing house which traditionally utilized passive cooling techniques, one can utilize the existing added ceiling height in the passive cooling strategy.

Traditionally homes had fireplaces for heating, however presently they are rarely used and often times no longer functional. Even though homeowners rarely use their fireplaces, they are still found to be a standard feature embedded into the victorian housing paradigm and are found in most homes built today. Being that there is little difference between the chimneys built at the turn of the century and those found in the homes of today, one can easily see the potential of the chimney to be replaced with an architectural intervention. As long as the structure of the house is independent of the masonry of the chimney shaft, one can easily demolish the chimney without compromising the structure of the home. Before any demolition occurs one must first verify this with a professional due to the differences in construction methods and alterations made by former tenants throughout the life of the structure. After the chimney is removed there should be adequate space to insert a continuous ventilation shaft with the potential to move a great deal of air throughout the house.
Making the Cooling Shaft

Once the chimney was free there were two options to framing the new cooling shaft. one was adding walls floor to ceiling at each level. The other was a straight through one piece shaft. Since I did not want to take more floor area from the small second floor, I ran the vent stack through the existing shaft. A ledger board was added to the rim at the first/second floor opening since I could not get reasonably straight studs longer than 10’. For the effectiveness of the system making a smooth and flush surface on the inside is the key, allowing air to move freely. Return duct liner lines the inside of the shaft with all seams tapped. Capping the shaft with ventilator turbines can increase the rate or air flow over just an opening or vent. In our design we found the ventilators could increase airflow by 30%. Dan Durbin, a Professional Engineer who teaches in the UC Engineering Department, helped with the theory in the shaft’s design and is confident that with a ventilation stack the size of the normal chimney (3’x6’), one can draw 2000-3500 cubic feet of air per hour. Moving air cools, just like a desk fan blowing in a hot room. This can dramatically reduce the amount of air conditioning required annually by not requiring constant AC use during the summer. If used properly by the occupants it can save thousands of dollars in electrical bills throughout the life of the building. (Figure 4.12)
Passive Cooling
The Millrich House

Figure 4.13: The Millrich house features shades on its Southwestern facade and a passive cooling shaft. The section above illustrates how air will move through the house, drawing cool air from the basement and the open windows up through the turbines. Image by Author.
Figure 4.14: Photos of vent stack: By Author
Pre Heat fresh air intake

In order to assist the cooling properties of the ventilation stack, the use of earth tubes can dramatically improve the efficiency of this system. The use of a series of earth tubes which will condition or pre treat the air before entering the building by using the natural, consistent temperature of the ground. This thus will reduce the amount of energy required to heat/cool the air. Being that three feet below the ground is usually around a constant 55 degrees, one can simply use this to heat/cool the air through heat transfer. (See Figure 4.15)

While excavating several feet below ground is often quite expensive, some costs can be saved if well timed.

Figure 4.15: earth tubes and thermal diagram
Figure 4.16: fresh air intake diagram
For example, the Millrich House case study needed foundation repairs, so we could coordinate with the excavator and install our tubes before they backfilled the foundation. In other examples, a system might be designed to work in a minimally excavated area, or paired up with another repair. In order to gain the benefits of earth tubes in an existing structure without a great deal of added cost, one must think creatively and utilize the existing features on the site. Being that most homes constructed in the early to mid-1900’s did not have insulation on their basement walls, one can assume that there is a great deal of heat transferred through the exterior walls of the structures’ basement. The basement also happens to be at the ideal depth for the placement of earth tubes. One of the architectural interventions which we hope to explore is the creation of earth tubes comprised of cinder blocks with which one could condition the air supply into the home in all seasons. One would begin this process by removing a window from the basement along a fully buried exterior wall. Then a series of cinder blocks would be placed standing vertically and bond beams would be used to link the different blocks in order to create a series of zigzagging tunnels through which air can pass. This zigzagging provides added thermal heat gain through more thermal mass for heat transfer. (See Figure 4.17) One would then insulate the newly made cinder block wall within the existing basement with rigid foam insulation, build a new 2x4 wall with treated 2x4’s with an insulated cavity. The studs would then be sheathed in the desired finish material, be it gypsum, wood, or metal. We still need to do a bit of experimentation on how water and particulate matter would be shed from the air flow entrance and if a small fan would be required to assist the air movement through the tunnels. While we do not yet know the effectiveness of this process, it is bound to be better than just using the exterior wall air which could require up to 50 degree heat/cooling changes. (See Figure 4.15) Through further exploration, one could see how effective this relatively cheap cooling method could be and the other potential configurations to maximize its efficiency.
Structural Walls

Penetrating a wall can vary greatly in difficulty. Interior partition walls, framed of metal studs in office buildings or retail centers are often designed to be removed as tenants come and go. But in a home, especially an older one, you need to know what you are getting into before you begin major demolition. To skip a lot of basics, we’ll jump right into puncturing a new opening into a load bearing wall. (This is assumes the structure, aka: span directions have been documented and maybe even revealed to ensure you know.) The standard method for punching this opening would be to build a temporary wall offset from the existing wall where a new opening is desired, just big enough for a person to have enough room to work. The drawbacks for this method of working are the added time and materials needed to make the temporary wall. Not that these steps tend to add a lot of money to a job, but we are thinking of a grassroots, DIY builder, looking to maximize their efforts without having materials to waste. The following diagrams (Figure 4.26) outline a process where a permanent support to the new opening is built inboard of the existing interior wall. Its benefits are: it fully bears down on the existing foundation (assuming 8” masonry or thicker), the support is permanent, and it works well in a tight room.

These benefits also work well if building a window seat or other spacial element that wants to cantilever from the building or become a habitable space because the new double thickness of the wall. A thicker member, like a 2x8, can easily be the inner most stud of the opening, allowing weight to be hung from the wall since a 2x8 has over 800% greater moment of inertia than a 2x4. Architecturally, however, the new support wall must be accounted for in the design of the room. Adding the projection into the room will take away a small amount of the useable floor area, as well as require the baseboards and other trim or finishing elements to
Countertops

One of the other issues commonly faced is the countertop material. People can spend hundreds to thousands of dollars for the countertops in a house. Habitat for Humanity benefits from free labor and plenty of scrap material from the quantity of jobs in which it is involved. It can be in their best interest to reduce their material cost, even if it requires a great deal of labor to fabricate elements. During my employment with Architect Terry Boling, he designed countertops for a local restaurant, which I fabricated utilizing the wood cutoffs from saw mills and scrap or damaged lumber from local companies. (See Figure 4.19-4.20) During the process of working with Terry and developing the tables we discovered how to utilize a great deal of cheap material in the means of OSB and scrap plywood found on construction sites and in the DAAP shop scrap bin. These pieces were cut into two inch wide strips and were laminated together in a manner in which none of the joints were aligned. Strictly in terms of material cost, we were able to create countertops at a little over one dollar a square foot, just buying glue and biscuits.

Figure 4.19 countertop image by author, fabricated by author
be reconsidered.
While this process is quite labor intensive it can be done in an assembly line process and requires simple woodshop tools.
The surface is good for non-wet areas in kitchens and dining areas and it is holding up well as dining tables for a local restaurant. Materials such as epoxy impregnated OSB, corian, or various plastics could solve problems associated with extended exposure to moisture. Again, visiting suppliers and recyclers can reveal a great source of material. Another option to waterproof the surface would be to utilize an epoxy coating or thick varnish. If one uses this material as a tabletop or counter top system they can save hundreds to thousands of dollars.
If the house has little countertop space and has a shortage of square footage for dining space, a bench seat along a wall with a series of bar stools on the other side can be used. By making the table to a moveable unit, it can be situated near the food prep area to provide additional counter top space. This can be done by placing the table on wheels and placing it slightly higher than the countertop. The wheels enable it to be moved around the space and potentially overhang the sink to provide more workspace for the cook.
If one is preparing a larger meal and has multiple people assisting them in the preparation of the meal, one can use the table as an additional prep area adjacent to the sink. This plenty of room for all without getting in each others way. Once the food is prepared, the table and barstools can be moved back into their dining positions.

Figure 4.20 counter top fabrication images, by author
$30 Cabinet

Normally one can purchase cabinets and countertops out of a variety of materials and finishes. Depending on your selection this can be quite costly. Cabinets, if made of natural wood or if pre-manufactured and assembled, can cost thousands of dollars for just the kitchen. One of the most expensive elements of cabinets is the hardware selection. One can spend hundreds to thousands of dollars on hardware alone. Soft close slides and designer hardware can also be quite expensive.

In an effort to reduce cost, one can construct their own cabinets out of cheaper materials. For example, if one were to go to a lumber supplier and ask if they have any damaged or off colored pieces of plywood, you can significantly reduce the cost. Typically one would pay $80 per 4’x8’ sheet but by using damaged or off colored piece of plywood can be purchased for $10 per sheet. Most of the area of these sheets are still useable and from which one can construct the cabinets. The next area where we hope to save money is the hardware of the cabinets. If one is to purchase sheet steel and simply bend it to create
your own handles and pulls, costs can be significantly reduced. For the cost of potentially one handle one can equip the entire kitchen. The other place where a significant amount of money can be saved is the countertop material. Granite and natural stones are quite expensive. However a popular option now is butcherblock countertops. Being that many mills and lumber providers have scrap bins and one can purchase these cut offs for a much lower value than they are normally purchased. With some effort to cut down these pieces and a bit of time to fit them together, one can construct a low cost countertop at under one dollar per square foot material cost.

Process

In the construction of the cabinets, one would begin by cutting out the pieces of the cabinets and then using a biscuit cutter and a drill to join the cabinet with pins and biscuits. In order to create a decorative element of the cabinets, we have selected to exhibit the fact that the cabinet is made of plywood by turning a strip of plywood so that the layers of the veneers, which comprise the plywood, are facing outward. This provides a decorative element while costing next to nothing. After the pieces of the cabinet are fabricated, one can fabricate the door pulls. For this we have decided to use a sheet of stainless steel which we will cut and bend to make stainless steel angles. These angles will be drilled to countersink the screw heads so they sit flush to the cabinet edge. In order to add an architectural element to the cabinet pulls we have selected to make the door pulls appear to be squares which extend to the same point on the cabinet doors as the exposed veneer strips.
Landfill Diverted Granite Patio

This patio is comprised of a series of granite sink cut outs, which is a waste product of the process of installing granite countertops.

The process begins by removing all of the existing turf and placing a geotextile under 3” of compacted pea gravel followed by a geotextile and 1” of sand. The pea gravel allows for drainage and the sand makes it easier to level the stone.

Stones are then squared using a wet saw and layed in a random pattern without regards to their color or texture besides the act of avoiding adjacent similar types. The granite pieces are placed upside down for the most part to avoid slipping and to provide traction. In certain instances, pieces are placed polished side up to serve as accent pieces. The granite is then sealed using a granite sealer to bring out the color of the stone.

While this is a highly labor intensive process, if the right supplier is found and if one owns the 14” wet saw required to cut the stones, it can be relatively inexpensive and provide a perfectly flat surface for outdoor enjoyment for many years.

This is an image of a patio completed by Substanley Enterprises Design in 2005.
Wood Trim to Avoid Finishing Ceiling

With the addition of an interior wall to insulate the house without the demolition of the existing plaster, one has an issue with how the new drywall meets the existing ceiling. Traditionally, one would tape and mud this joint which requires a great deal of time and skill to accomplish. In addition, this makes a great deal of gypsum dust due to the finishing process. In order to hide the joint between them without having to tape and mud the corners and then sand the mud joint, one could use a piece of trim or crown molding. However, trim or crown molding can be quite expensive. To get a similar result with little cost, one could simply use a strip of plywood which has been cut at an angle. This would provide a simple detail with little cost and significantly reduce the required labor.

Figure 4.25: wood trim to avoid finishing ceiling
Plumbing Core/Soffit

In order to supply the house with water and waste water lines, traditionally one must demolish the existing plaster or gypsum in the ceiling of the room below the proposed bathroom in order to hide the pipe and the P-trap of the drains. This process can be quite messy and can potentially expose the renovator to lead paint, silica dust, and other harmful particulates. One must then install all required lines and then patch the ceiling. To avoid this process, one can simply build a 2x4 soffit below the existing ceiling and run the water and waste line along the ceiling. Then one can simply cut out a small section of the existing ceiling sufficient to supply the lines and the P-trap to the bathroom above.

Water and waste lines are traditionally enclosed inside the walls of a structure. To do this, one must cut out a section of the existing plaster running the entire length of the pipes. This can be avoided by the construction of a vertical waste and water supply chaseway. The same chase can be used to supply the upstairs with HVAC and electrical lines.
Economic Paradigm Shift

According to the U.S. Census Bureau, in March 2009 due to the economic recession nationally, 3.23% of all single family homes were foreclosed. An additional 8.93% of homeowners had a 90 day delinquency warning. Due to rising gas prices, it has become more desirable to live in the city or just on the outskirts. There is also a fast growing movement against urban sprawl which has greatly helped the percentage of the population living in cities across America. However, in most cities, this area has already been developed into existing single family houses.

Purchasing a new home from a developer in today’s market does not get you a home which necessarily meets your needs. The supposed options available are mostly cosmetic items such as granite countertops, stainless steel appliances, carpet and siding colors. One cannot vary much from their existing models. Being that house prices and construction labor rates are at all-time lows due to the recession, it makes more sense to purchase existing homes and renovate them to better suit a family’s needs. This process, however, requires an architect or another design professional to ensure that the existing plan is optimized to suit the family. This also insures that the process of renovation is done properly, offers design advice, and provides potential time and money saving techniques. Being that each existing house is different, one cannot utilize the exact same design changes to modernize these homes. But, there are many typical design interventions which one can utilize to modernize older homes. This is the value that hiring an architect can provide, being that they have an intimate knowledge of construction and design. Frank Lloyd Wright made great strides in the refinement of Victorian houses to a house of the times to meet the way that its inhabitants would live. However, as society has progressed, even his model can be found to be inadequate. The family structure upon which he models his structures is no longer accurate. Therefore the design of our homes must change to meet the new family structure paradigm. Designers of today can build upon the techniques Wright has created. They must now go further to meet the desires and needs of the current family and to successfully transform the existing housing stock into modern housing facilities.

5 Renovated houses = $375,000 (average cost 65-80k)

3 New houses = $390,000

Figure 4.29: Habitat renovation vs newbuild, by author
Conclusion

Cincinnati Habitat for Humanity has begun looking into the renovation of existing housing stock. Due to the recent economic downturn, there are an excessive number of homes which are either abandoned or can be purchased at a low price. Last year they renovated 22 houses and hope to have around forty next year. Due to the lower cost of each house by renovating existing houses, they are able to build more structures and thus help more families each year. It costs around 65-$80,000 to renovate each house as opposed to $130,000 to build a new house of equivalent size. Renovating existing houses cuts out a great deal of work including, surveying, site clearing, concrete work, excavation of basement and many other tasks which have already been completed in a pre-existing house. As a recent phenomenon, they are still discovering the hidden benefits of home renovation. As Cincinnati is an older city, many of the homes were all built around 1925 and are not well insulated, nor do they utilize passive & solar strategies. Many of these homes are tract homes which were built without regard to orientation. These homes must now be renovated on a Habitat budget, which typically lends to vinyl, plastic laminate and any other number of long lasting bargain materials which can be installed with little experience. The lack of budget and energy efficiency can be seen as a great potential for a design project. We have the technology to implement strategies that will save on the home’s energy bills while improving the quality of interior space. We can retool, recraft, and reuse many materials of higher quality instead of buying new construction minimum standards. The advantage of an unlimited supply of free labor leads one to think about design and construction in a different manner. As material cost is the most important factor, it leads one to reutilize waste materials of other industries and repurpose common and damaged materials. Many of the newly processes can require extensive labor due to Habitat for Humanities deep pool of unpaid labor.
In the process of designing the renovation of the existing houses one must take into account the future occupants and the way in which they live. Thus, it is important to design for a client as opposed to a ‘model home’ solution. Designing a model home which is simply reproduced is a problem which has been discussed throughout this thesis by builders such as Levitt, Lustron, and many other home builders. Habitat's Clients are typically underprivileged, single, working mothers or other variations of non-traditional families. By taking this information into account, one can design the house to better meet their needs and thus improve their lives. One can create flexible spaces that meet the daily routine and special occasion gathering. One can strategize space to accommodate a much needed extra bedroom or bathroom, or focus on room lighting, views and storage solutions. One can integrate utilitarian spaces to maximize a single parent’s multi-tasking capability.

Single family homes can easily be modified for the family, but industry promotes 'model solutions'. I am attempting to create a series of model solutions which through different combinations of these elements that one can easily suit a home to a families’ specific needs. This series of architectural interventions can be utilized to potentially reduce labor, time, cost, cleanup, or exposure to harmful substances. Through these interventions I hope to generate a system Habitat for Humanity or another single family home renovator could use to successfully renovate an existing home to meet the needs of a modern family. These interventions take into account the features of the early 1900’s housing paradigm and how they can be modified to maximize the functionality and value of the house. The architectural interventions will take into account environmental factors, energy efficiency, green design, cost, and lifestyle design.
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Introduction


Figure 0.3: University of Cincinnati Metrolab, photo by author

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Figure 1.2: Burger, Mary. “Seedbank.” A Short Trip Inside and Outside the Box: Buckminster Fuller's Dymaxion House. Seed Bank, n.d. Web. 12 Nov. 2012.

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Figure 1.9: Floor plan copyright 1993, “The Frank Lloyd Wright Companion” Storrer, William Allin, page 300


Figure 1.11: Floor plan created and drawn by author. 2012

Figure 1.12: Image by author, data from http://www.bizjournals.com/cincinnati/stories/2010/05/03/daily41.html

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Figure 3.3: Boomerang Children Floor plan created and drawn by author. 2012.
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Figure 3.6: Aging parents living with children typical plan created and drawn by author. 2012.
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Figure 4.1: Photos and renderings. Personal photograph and renders by author. 2013.

Figure 4.3: Insulating an existing wall without demolition created by author. 2012.
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