I, Benjamin A Meyer, hereby submit this work as part of the requirements for the degree of: Masters of Architecture in: College of Design, Art, Architecture and Planning It is entitled: Sustarketability for Homes

This work and its defense approved by:

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Sustainability
For Housing

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Abstract

Architectural design can utilize sustainability and market forces to create competitive housing and community alternatives.

The desire for bigger is better without concern for authenticity and over utilization of resources has left the housing market riddled with over-sized generic homes, depleted land, and a forgotten sense of community. At first glance it would appear that marketability and sustainability are mutually exclusive. Even though sustainable building practices have been increasing yearly, 30 percent in 2006, this accounts for only 2 percent of the total residences and commercial buildings built in the United States (McGraw-Hill 4). This investigation seeks to identify ways to create economical housing alternatives that combine sustainability and marketability. By analyzing precedents, comparisons will be brought between the exemplars and the status quo, and how each of these addresses or fails to address marketable and sustainable design. From this analysis an appealing and competitive housing alternative will be devised that also conserves for future generations.

“Expensive solutions are a sign of mediocrity, and an idea without a price tag is never acceptable.”
– Ingvar Kamprad, IKEA Founder

Figure 1: Photo at proposed site in Clifton, taken by author 12/04/2007
# Table of Contents

**Abstract** .......................................................... iv

**Introduction** ....................................................... 2

**Sustainable Tools** ................................................

- International Code Council
- LEED Neighborhood Development
- LEED for Homes
- NAHB Green Homes
- Cradle to Cradle Certification
- BEES
- Health and the Built Environment 14

**Marketable Tools** ................................................

- SmartMarket Report
- Market Engagement Framework
- US Census Data
- Resource Priority Survey 26

**Precedents** ............................................................

- Foxpointe
- Houses at Sagaponac
- Habitat Trails
- Price Hill Eco Village
- Great Oak Cohousing
- Aranya Community Housing 42

**Design Project** ....................................................... 58

- Introduction
- Status Quo
- Context + Site
- Site + Home
- Home + Detail
- Conclusion

**Bibliography** ..........................................................
Sustarketability

Figures

Figure 1: Photo at proposed site in Clifton, taken by author 12/04/2007

Figure 2: Design Process

Figure 3: Leading “Green” sympathizer, http://www.internoodle.com/Kermit/KermitPics/KermitLyingDownLookRight.gif

Figure 4: ICC Vision Diagram, International Code Council, http://www.iccsafe.org/

Figure 5: LEED ND logo and partners, LEED for Neighborhood Development Rating System. U.S. Green Building Council, http://www.usgbc.org/

Figure 6: LEED ND certification thresholds, LEED for Neighborhood Development Rating System. U.S. Green Building Council.

Figure 7: Minimum Point Requirements, LEED for Homes Rating System. U.S. Green Building Council.

Figure 8: NAHB Green Homes Logo, National Association of Home Builders, NAHB Model GREEN Home Building Guidelines.

Figure 9: Levels of NAHB Green Building, National Association of Home Builders, NAHB Model GREEN Home Building Guidelines.

Figure 10: Cradle to Cradle cycles, www.mbd.com/c2c/

Figure 11: Certified technical nutrient, Solutia, Inc. Ultron Fiber, http://www.mbd.com/c2c/itemDetails.php?item=74


Figure 13: BEES output: Overall Siding Performance, Using BEES to Select Cost-Effective Building Products, by Barbara C. Lippiatt and Amy S. Boyles, National Institute of Standards and Technology (78).

Figure 14: Model Linking the Built Environment and Health, Understanding The Relationship Between Public Health and the Built Environment

Figure 15: Travel and Emission Indicators for Infill vs Greenfield Site, Understanding The Relationship Between Public Health and the Built Environment

Figure 16: Sprawl and Community Impact, Understanding The Relationship Between Public Health and the Built Environment

Figure 17: Green home building demand projection graph, McGraw Hill Construction, Residential Green Building SmartMarket Report.

Figure 18: Builder Energy Priorities: Green Home Building Options, McGraw Hill Construction, Residential Green Building SmartMarket Report.

Figure 19: Sustainable construction Comparisons and Obstacles, McGraw Hill Construction, Residential Green Building SmartMarket Report.


Figure 22: ZIP code boundary map

Figure 23: Summary of Significant Census Data, United States Census Bureau,

Figure 24: Summary of resource Priority Survey results

Figure 25: Questionnaire provide to participants for Resource Survey

Figure 26: Hanover II by Ryland Homes, http://www.ryland.com/find-your-new-home/27-cincinnati/1116-foxpointe/15765-hanover-ii.html

Figure 27: Site before development, www.mapblast.com

Figure 28: Site during development, www.maps.google.com

Figure 29: Sagaponac development plan, http://www.housesatsagaponac.com.

Figure 30: List of Sagaponac architects, http://www.housesatsagaponac.com.

Figure 31: Location of Stan Allen House, http://www.housesatsagaponac.com/

Figure 32: Rendering of Stan Allen House, http://www.housesatsagaponac.com/

Figure 33: Plan of Stan Allen House, http://www.housesatsagaponac.com/

Figure 34: Allen House Interior View, http://www.housesatsagaponac.com/

Figure 35: Allen House Exterior View, http://www.housesatsagaponac.com/

Figure 36: Section of site strategies, http://www.ASLA.org.

Figure 37: Habitat Trails Variances, http://www.ASLA.org

Figure 38: Organizational diagram, http://www.ASLA.org.

Figure 39: Logo and street planter, www.enrightridgeecovillage.org

Figure 40: Jim Schenk, www.enrightridgeecovillage.org

Figure 41: Community gathering, www.enrightridgeecovillage.org

Figure 42: Maypole festivities, http://directory.cohousing.org

Figure 43: Shared area and interaction, http://directory.cohousing.org

Figure 44: Great Oak site plan, http://directory.cohousing.org

Figure 45: Dinner at the common house, http://directory.cohousing.org

Figure 46: Aranya site plan, Rethinking Modernism fro the Developing World

Figure 47: Basic site amenities provided, Rethinking Modernism fro the Developing World

Figure 48: Model home designs, Rethinking Modernism fro the Developing World

Figure 49: Street view of community, Rethinking Modernism fro the Developing World: The Complete Architecture of Balkrishna Doshi.
This investigation begins by looking at different tools for developing and evaluating design. Tools are divided into two groups based on their assessment area: sustainability and marketability. The scope of each tool section covers a range of previously established and emerging standards. The sustainability tools section begins with the International Code Council (ICC), and then covers progressive standards including LEED ND, LEED Homes, National Association of Home Builders (NAHB) Green Homes, Cradle to Cradle Certification, BEES 2.0 Life Cycle Analysis and Public Health and the Built Environment. The marketability tools section includes regional census data, the Residential Green Building SmartMarket Report, Market Engagement Framework, and a survey design specifically for the needs of this thesis to investigate resource priorities among local individuals, the Resource Priority Survey.

In order to properly assess the current market situation and deliver an improved design product, it is necessary to analyze similar precedents found in the current marketplace. The precedents chosen have been organized from private ownership to those focusing primarily on community. The first precedent, Foxpointe designed by Ryland Homes, serves as the model of what is currently leading the market in single-family residence. Ryland Homes is a member of the NAHB trade organization, which builds 80% of the houses in the United States. Foxpointe will be used as the baseline when evaluating the other precedents. The precedents chosen as exemplars in order of private to community are: Houses at Sagaponac, Habitat Trails, Price Hill Eco Village, Great Oak Cohousing, and Aranya Community Housing.

These precedents and tools will facilitate a design process that includes site design, home design, material selection, and operation design. Site design will include an analysis of ownership, community connection, program and utility distribution, and unit costs. Home design will investigate spatial connections, hierarchy of spaces, and frequency of uses and selling prices. The material selection category will address finishes, construction methods, durability, regionality, and financing methods. Operation design will consider water cycle, energy consumption/generation, maintenance schedules, and life cycle cost savings.
Sustainability Tools

Introduction

“Green” is a widely debated topic. Recent estimates suggest around 40 different local green building standards in the United States as well as the larger national groups (Martin, Swett, & Wein 7). The fact that governments are adapting policies means they are acknowledging responsibility towards sustainable practices. This section will analyze sustainable tools, beginning with the development of the Ohio Building Code (OBC) representing the legal minimum. Next, the more progressive sustainable tools such as LEED, NAHB Green Building, BEES 2.0, and Cradle to Cradle, will be reviewed and analyzed. These standards are currently being used and adopted by governments to supplement the current minimum. They are voluntary programs in which anyone can choose to participate. Finally, the benefits of these higher standards will be reviewed to understand the environmental and community impact they can offer.

Sustainability Tools

International Code Council

In 1911 the Ohio legislature, finding it necessary to regulate the construction, repair, alteration, additions, sanitation and fire protection for public buildings, passed an act detailing the first building code written for application throughout the State of Ohio. Over the course of the next 40 years, completion of the codes and responsibility of enforcement was unclear and confusing. Departments were created and broken, leaving the building code out of date and powerless (Ohio Board of Building Standards 2).

In the late 40s, the Ohio Program Commission developed a committee to prepare a comprehensive building code in which every amendment or addition must await legislative action and approval prior to enactment. Early into this process it became clear that the slow moving legislature and opposition from the industry would make this process nearly impossible. A solution was reached when the 1955 Ohio General Assembly passed legislation that allowed the formulation of a building code by administrative procedures. This created the Ohio Board of Building Standards to formulate the code requirements, and the Ohio Board of Building Appeals to provide administrative appeal from others. After it was enforced, it seemed that the building code may finally serve in a productive and working fashion, but the board neglected to make updates appropriate for the developing industry (Ohio Board of Building Standards 3).

In 1973 and again in 1976, the Ohio Building Officials Association requested that the Ohio Building Code be replaced by a national model code. The Board of Building Standards compared the three existing regional codes: Building Officials and Code Administrators International, Inc. (BOCA), International Conference of Building Officials (ICBO), and Southern Building Code Congress International, Inc. (SBCCI) (www.iccsafe.org). In 1978 the Board decided to use the BOCA National Building and Mechanical Model Codes. These codes were revised as to not contradict existing Ohio Revised Code. Until the merger of the three regional models into one, and eventually the adoption of the International Code Council (ICC), BOCA was used as the basis for the
Ohio Building Code (Ohio Board of Building Standards 3).

In 2002, Ohio adopted the combined international code, the ICC. The purpose of ICC was to combine the three separate regional groups, BOCA, ICBO, and SBCCI into one single set of comprehensive and coordinated nation model construction codes (www.iccsafe.org). These codes sought to surpass regional limitations and foster consistent code enforcement and higher quality construction. The ICC’s declared vision is to “protect the health, safety, and welfare of people by creating better buildings and safer communities.” The Mission is to “provide the highest quality codes, standards, products, and services for all concerned with the safety and performance of the built environment” (www.iccsafe.org). Core values listed include: customer value, integrity and trust, member-focus, professionalism, public service, and quality. ICC provides a single forum to address all issues including: disaster mitigation, energy conservation, accessibility, innovative technology or fire protection (Ohio Board of Building Standards 4). Ohio had transformed from a small local counsel struggling to establish basic guidelines, to an international one size-fits-all model.

The history of OBC illustrates the challenges that can occur when you change from small, local, personalized regulation to large national model codes. Code dictates the construction practices that will be used in a community, and by using a model code you are not able to easily respond to local building traditions and community designs. What we are left with is an institutionalized generic construction. The self-proclaimed purpose of the ICC is “manufactures can…focus on being more competitive in worldwide markets” (www.iccsafe.org). This means the purpose of the ICC is to promote globalization. This only benefits manufactures and not local communities. The locally generated code provided a solution to local tradition but did not have the resources available to adapt with the construction industry.

The decision to adopt model codes was the state and local governments attempt to alleviate themselves from the burden of keeping up with the construction industry. Today they face a similar problem with environmentally responsive codes. The procedure they are using is similar to the model code dilemma, where they are adopting universal programs to supplement their existing regulations. The adoption of a national program is counter-intuitive to an environmental solution because the most environmental solution that a local government could enact responds directly to the local conditions. This gets back to the initial dilemma of the local governments inability to maintain pace with the industries changing demands.

The fact that the government is not able to perform this task at its most appropriate level indicates that the responsibility should be put back on the local licensed professional. Previously non-licensed professionals were doing the majority of construction, so the government felt the need to assume the responsibility for the safety of those buildings. By establishing a code they can accommodate non-professionals in the construction process. This is beneficial to everyone except the licensed professional. Now the licensed professional can be replaced by a government regulated model code. Relying on the code ignores the non-mandated services that a licensed professional offers such as regional appropriateness, environmental studies, and construction trade integration.

The rate of change can only occur as fast as the industry’s slowest member. Government and model codes are setting the pace for environmental responsibility by bottlenecking the process with inappropriate standards. No matter how quickly design professionals
or the general public accepts the concept, change will never occur any faster than what the government is willing to move. The ICC’s vision to “protect the health, safety, and welfare of people by creating better buildings and safer communities” (www.iccsafe.org) is in direct conflict with the goal of a licensed architect, which is “the protection of the health, safety, and welfare of the public” (National Council of Architectural Registration Boards). This conflict represents the dual and often ambiguous responsibility of local government and architects. By utilizing and re-institutionalizing the practice of architecture, the burden to keep up with the industry can be taken off local government and given back to the licensed professional.

Figure 4: ICC Vision Diagram

Sustainability Tools

**LEED ND**

LEED (Leadership in Energy and Environmental Design) Neighborhood Development is a national set of standards for neighborhood location and design developed by the US Green building Council (USGBC), the Congress for the New Urbanism, and the Natural Resources Defense Council. Over the last 6 years LEED New Construction has gone from $792 million to roughly $10 billion in 2006. As of February 2007, there was over 829 million square feet of certified LEED registered space. The number of LEED Accredited Professionals has grown from 500 to over 35,500 (Martin, Swett, & Wein 7).

LEED ND principles include smart growth, new urbanism, and green building. The goal is to set standards for assessing and rewarding environmentally superior development practices within the rating system (LEED ND 1). “LEED provides rating systems that are voluntary, consensus-based, market-driven, grounded in accepted energy
and environmental principles, and that strike a balance between established practices and emerging concepts” (LEED ND 1).

What makes LEED ND unique from the other LEED rating systems is that it focuses primarily on neighborhood development including design and site selection, encompassing what it takes to relate the neighborhood to its larger region and landscape. Projects may include entire neighborhoods, fractions or multiple neighborhoods. LEED is composed of a few prerequisites and multiple credits. Credits are considered optional but each credit contributes to the points total. The points are then classified into silver, gold, or platinum certification. The certification process includes a mandatory pre-review stage, certification of an approved plan, and finally certification of a completed neighborhood development (LEED ND 2). It is hoped that the development of these codes “will encourage developers to revitalize existing urban areas, reduce land consumption, reduce automobile dependence, promote pedestrian activity, improve air quality, decrease polluted storm water runoff, and build more livable, sustainable, communities for people of all income levels” (LEED ND 1).

The different LEED rating systems overlap in multiple areas. Many times when a project is being considered for LEED, clients want to receive the LEED certification at the lowest possible cost. This means that all of the different systems towards LEED certification are explored with the goal of expending as little money and effort as possible. All of the LEED systems have overlapping requirements and many at different scales. Site strategies are considered for LEED NC, LEED ND, LEED CS, and LEED Homes. A project like a condominium complex can be registered under any of these four possibilities. Each system has its own area of emphasis but only LEED ND focuses on site strategies. A project on a difficult site could skate by without addressing that issue if they used one of the other LEED rating systems and could still achieve LEED certification.

As a system of certification, LEED Neighborhood Development has no clear scope. The term “neighborhood” is not restricted by a specific definition, but generally refers to sites with multiple facilities. It provides a means of sustainable site selection and development intended for large-scale projects. The entire development does not need to fall within the scope of the LEED rating system. So, a project can be strategically broken up to have only a portion certified and leave the remaining to sub-LEED standards.

LEED does not provide people the tools for better design, only a yardstick for better design. This means it does not provide guidelines like a building code that are meant to be applied to all situations, and it requires a designers understanding of the issues. Government policies that mandate LEED are good because they inherently require a designer to interpret, making the design professional valuable. As a code supplement, it is poor.

**Certification Levels:**
- Certified 40-49 points
- Silver 50-59 points
- Gold 60-79 points
- Platinum 80-106 points

Figure 6: LEED ND certification thresholds
LEED for Homes & NAHB (The National Association of Home Builders) are rating systems designed to facilitate homebuilders and contractors in the construction of sustainable homes. LEED for Homes was developed because of the popularity of LEED New Construction (NC) for commercial projects. Unlike other LEED rating systems, the project team is organized to give the project management role to a third party LEED for Homes Provider. These Providers are local and regional organizations chosen by USGBC and under contract to recruit and register projects, coordinate and oversee Green Raters, certify the homes, coordinated with USGBC and provide quality assurance for the certifications (LEED NC 4). The Providers act very much like a home inspection team. This system still follows the same basic outline as LEED NC with a few prerequisites and many optional credits.

<table>
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<th>Prerequisites (minimum)</th>
<th>Minimum points</th>
<th>Maximum points available</th>
</tr>
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<td>3</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>Location &amp; Site Linkage (LS)</td>
<td>0</td>
<td>0</td>
<td>10</td>
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<tr>
<td>Sustainable Sites (SS)</td>
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<td>5</td>
<td>22</td>
</tr>
<tr>
<td>Water Efficiency (WE)</td>
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<td>3</td>
<td>15</td>
</tr>
<tr>
<td>Energy &amp; Atmosphere (EA)</td>
<td>2</td>
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<td>38</td>
</tr>
<tr>
<td>Materials &amp; Resources (MR)</td>
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<td>2</td>
<td>16</td>
</tr>
<tr>
<td>Indoor Environmental Quality (IEQ)</td>
<td>7</td>
<td>6</td>
<td>21</td>
</tr>
<tr>
<td>Awareness &amp; Education (AE)</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>16</td>
<td>156</td>
</tr>
</tbody>
</table>

These guidelines are based on 8 principles:

1. Lot Design, Preparation and Development
   How resource-efficient site design and development reduce housing impacts on environment and energy; home orientation to utilize passive heating and cooling.

2. Resource Efficiency
   Using materials responsibly while still creating excellent buildings; using engineered wood vs. traditional lumber.

3. Energy Efficiency
   Paying attention to energy consumption both within the home and during the building process.

4. Water Efficiency

5. Indoor Air Quality

6. Operation, Maintenance, and Homeowner Education
   Poor maintenance can minimize advantages of a home’s green features.

7. Global Impact
   Avoidance of harmful products like those containing volatile organic compounds with form ground level ozone pollution and are potentially harmful to occupants (www.epa.gov).

8. Site Planning and Land Development
   Avoid building in an environmentally sensitive area with potentially large impact on the environment.

(NAHB vii; McGraw Hill 15)
Instead of credits and prerequisites, there are “line items” and “thresholds” for each rating level and a minimum number of additional points that can be added from any of the “guiding principles”. The bronze, silver, and gold ratings are achieved by reaching these thresholds [NAHB 1].

Both LEED for Homes and NAHB Green Home have similar certification issues as LEED ND. It may make sense for a designer to find a system with different or lower requirements to have a home certified. NAHB was developed by combining systems of 28 existing voluntary programs, including LEED [NAHB 4]. This means that there are 28 other paths to call a home “green.”

Both systems are trying to overcome the competition by establishing themselves as a recognizable brand for sustainable homes. The positives from this include increased market demand and acceptance. Even after all of the efforts that both systems put towards the various principles and credits, one of the only publicly recognizable sustainable brands is the Energy Star Brand, which focuses solely on energy efficiency. Although energy efficiency is a significant goal for sustainability it should not be the only focus. The large negative to these rating systems is that they are attempting to define responsible construction universally. Much like the model codes, what works in California will not necessarily work in New York.

### Sustainability Tools

**Cradle to Cradle**

William McDonough Architect’s Hannover Principles were originally commissioned by the city of Hannover, Germany to be standards for the millennial World Fair “Humanity, Nature and Technology”. Nine principles emphasize the importance of nature in general, and acknowledge human activities have the ability to damage it. The principles also stress the importance of nature’s right to coexist with us and that we should design our systems of energy and material flows to be part of the natural cycle by “eliminating the concept of waste”. The principles finish by addressing the limitations of human design and the importance of open communication to accomplish them. Additionally stressed, is the perception of the document as a fluid and evolving work that changes with our understanding of the world.

The Hannover principles were the precursor to William McDonough’s Cradle to Cradle
idea, book, and ultimately the certification process. The principles represent an awareness of human impact on the environment and a responsibility to proceed into the future in a way that doesn’t deny this awareness.

The Cradle to Cradle Certification process is a system devised to mirror, this 9 principle philosophy. The Cradle to Cradle certification is based on three key concepts “waste equals food”, “use current solar income”, and “respect diversity”. Cradle to Cradle certification is a supply-side approach to sustainability in the marketplace with a goal to remove toxic and harmful elements from the supply stream. It certifies ingredients, products, and processes for manufactured goods to eliminate their harm to the environment. This system provides a simple pre-approved list that is easy to understand and choose from. The hope is that manufacturing suppliers embrace the certification and create environmentally distinguishable products generating higher demand in the future.

The article, “Cradle to Cradle Certification: A Peek Inside MBDC’s Black Box” by Jennifer Atlee is a technical description of McDonough Braungart Design Chemistry’s Cradle to Cradle Certification process, a critical look at how the standards are set, and how the certification aligns with William McDonough’s philosophy. The first half describes the elements affecting certification as: Material Hazard Assessment, The Nutrient Cycle, Energy, Water, and Social Responsibility. The second half takes a critical look at what it means to be certified at the Silver, Gold and Platinum levels of the Cradle to Cradle Certification, and how MBDC goes about determining and ensuring the results.

The Cradle to Cradle method puts the burden of cost on the manufacturer to pay McDonough Braungart Design Chemistry to investigate and certify the suppliers and processes they use to produce a product. Cradle to Cradle Certification leaves disclosure rights to the commissioned party. It is up to the manufacturers to release the input data to the public and provide complete transparency.

The Cradle to Cradle Certification is more of a model on how industry can evolve, rather than a solution to the problem. A difficulty with the Cradle to Cradle Certification method is that it is only an indicator of how good a product is without giving any reference points as to how bad the alternatives are. The Cradle to Cradle certification is so elite that only a few dozen products have ever been certified, and the highest level, platinum, hasn’t yet been awarded to any product or process.
Life-Cycle Assessment, or LCA, is a method practitioners use to quantify the balance and impact of alternative products on the environment. This assessment uses 6 basic steps: 1) Raw material acquisition, 2) Product manufacturing process, 3) Home building process, 4) Home maintenance and operation, 5) Home demolition, and 6) Product reuse, recycling or disposal. BEES (Building for Environmental and Economic Sustainability) is a LCA tool the construction industry can use. BEES has its own 10 impact categories: acid rain, ecological toxicity, eutrophication, global warming, human toxicity, indoor air quality, ozone depletion, resource depletion, smog and solid waste (NAHB 2).

In the article “Life-Cycle Assessment Practitioner Survey: Summary of Results” by Cooper and James, a survey of practitioners is used to investigate the issues critical to LCA: how the information is accessed, where the information comes from, and what are the current barriers. Most practitioners use off-the-shelf software, like BEES. The collection of inventory data is the most time consuming part of the LCA process, and method complexity is the largest barrier to the LCA process. The article suggests that the LCA tool developers/providers reduce the costs and time needed to perform the analyses, to increase ease of use.

The LCA method mainly utilizes software to present large amounts of data collected from manufacturers, individual, and peer-review contributions for comparing similar products. It provides a means for practitioners to investigate alternatives. The sources of the data are from various levels of manufacturer interest and incomplete for a wide ranged product analysis. The LCA method puts the burden of costs on the practitioner by consuming time to collect, analyze and choose products in a potentially incomplete and inconsistent way. This time cost is validated by the results of the survey, which indicate LCA method complexity as the largest barrier to its use.

The BEES system tries to include all of the subjects of LEED with simple product selection. This causes an oversimplification of the issues. Life cycle costing doesn’t determine whether the product is desired or useful, and doesn’t consider the usefulness of a product within an entire system. BEES focuses on the economic and environmental viability of a product and its alternatives from the beginning of manufacturing to the end of a product’s useful life. BEES provides transparency of products and processes, so the consumer can make an informed decision.
This report was prepared for the LEED ND Core Committee by Design, Community & Environment, Dr. Reid Ewing, and Lawrence Frank and Company, Inc, Dr. Richard Kreutzer. The purpose was to assess the current state of research regarding the relationship between elements of neighborhood design and their effect on public health. The report then provides recommendations about how this information can be integrated into LEED ND. The report is divided into 5 areas: Respiratory and Cardiovascular health, Fatal and Non-fatal Injuries, Physical Fitness, Social Capital, and Mental Health.

Respiratory and Cardiovascular Health
This section addresses the relationship between compactness of land uses, organization of the transportation system, and their effect on the amount people drive (Design, Community & Environment et al. 3). From 1960 to 1990 the percentage of workers with jobs outside their counties of residence increased by 200%. Sprawl results in more miles and hours driven. The built environment (density, access to transit, pedestrian amenities, allocation of jobs and housing, and regional location) has the greatest affect on length of trip, duration of trip, and vehicle speed (Design, Community & Environment et al. 12). All of these elements in-turn affect the amount of air pollution created, which then directly affects respiratory health in the area. Specifically, increased air pollution causes reduced lung capacity, increased instances of severe asthma, and ultimately impacts life expectancy (Design, Community & Environment et al.3).

The conclusion is that controlling and limiting the spread of development will reduce distances and travel and encouraging alternative forms of travel will improve cardiovascular and respiratory health. One way to encourage this is to have mixed use land. This strategy makes foot, bicycle or transit easier because the distances are shorter and it is easier to combine trips (Design, Community & Environment et al. 22). Another element to reduce air pollution is development of an infill site versus an on-the-edge new development site. In all researched cases, infill development generated substantially lower emissions (Design, Community & Environment et al. 23). Street patterns are also another important element. A neighborhood with good connectivity and easy to understand grid patterns encourages driv-
ers to take the most direct path. Traditional grid patterns can reduce emissions by 57% compared to more conventional networks (Design, Community & Environment et al. 26).

Fatal and Non-Fatal Injuries
Research has shown a correlation between traffic accidents/fatalities and traffic volume, vehicle speed and street environment. Evidence to support this claim includes a recent study showing that each one percent reduction in vehicle miles reduces total crash costs by 1.0 to 1.4%. Risk of pedestrian injury is also greatly increased by volume, with chance of injury increasing 13 x at busy intersections (Design, Community & Environment et al. 33). Per capita, traffic casualties are about four times higher for residents in low-density suburbs than for residents in higher density urban neighborhoods. This occurs because on average suburban residents drive three times as much and twice as fast as urban dwellers. Speed is also influential. Decreased speed increases reaction time and reduces the severity of impact if a collision does occur. Finally the street environment is also important. In an environment with many pedestrians or bicyclists, motorists come to expect them and are more likely to exercise caution when driving (Design, Community & Environment et al. 34).

Physical Fitness
Health has been directly related to physical activity. Moderate physical activity can reduce the risk of heart disease, stroke, cancer, osteoarthritis and osteoporosis, fall-injuries, diabetes, high blood pressure, depression and anxiety, and obesity. Medical expenses related to inactivity are estimated at $76 billion in 2000 (Design, Community & Environment et al. 69). U.S. Department of Health and Human Services guidelines recommended at least 30 minutes of moderate-intensity physical activity five or more times a week. Conversely, studies have shown that there is great potential to increase physical activity throughout each day (Design, Community & Environment et al. 70). 83% of trips are short, non-work related, and take place close to home. More than a quarter of trips are easily walkable (within 1 mile). 63% of trips take place within a bikable distance of 5 miles or less. Even with these shorter distances, 90% of all trips are driven by auto. These findings are important because they indicate a need for designing an environment that encourages physical activity. The elements of the built environment that affect physical activity the most are: overall neighborhood characteristics, population and employment density, land use mix, street connectivity, continuity of network, recreational facilities, street scale and design, safety, and direct links to public health. In other words, neighborhoods with shorter blocks and higher levels of connectedness, and more trails and bicycle paths

<table>
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<td></td>
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</tr>
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<td></td>
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</tr>
<tr>
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<tr>
<td></td>
<td></td>
<td>PM2.5: 59%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CO2: 55%</td>
</tr>
<tr>
<td>Montgomery County, MD</td>
<td>Infill 42% lower than</td>
<td>Infill</td>
</tr>
<tr>
<td></td>
<td>Greenfield</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CO: 52%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NOx: 69%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SO2: 11%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PM2.5: 50%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CO2: 54%</td>
</tr>
<tr>
<td>West Palm Beach, FL</td>
<td>Infill 39% lower than</td>
<td>Infill</td>
</tr>
<tr>
<td></td>
<td>Greenfield</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CO: 75%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NOx: 72%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SO2: 94%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PM2.5: 47%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CO2: 50%</td>
</tr>
</tbody>
</table>

Figure 15: Travel and Emission Indicators for Infill vs Greenfield Site
tend to encourage more walking and biking and increased physical fitness (Design, Community & Environment et al. 87).

Social Capital
Social capital can be defined as the feeling of belonging and trust that community member needs will be met. Social capital occurs in two types of networks: formal and informal (Design, Community & Environment et al. 89). Formal networks are groups that people actively join: associations, organizations, groups. Informal networks occur through casual association among neighbors, friends, and strangers (Design, Community & Environment et al. 89). This social capital has been directly linked with positive health results that include prolonged life, better health overall, cardiovascular health, faster recovery from illness, improved mental health as well as many more. Environmental elements that reduce social capital include length of commute time and homogenous income and age. Walkability, mixed use land, and size (smaller is better) increases social capital.

Mental Health
Many scientists believe that the suburban environment of strip malls, ugly arterial roadways, billboards, and monotonous buildings can make people feel isolated and depressed compared to a more traditional urban environment (Design, Community & Environment et al. 101). This is in contrast to the suburban dream of escaping the urban environment to be happier, safer, and closer to nature. Numerous studies have examined the relationship between driving and stress. Longer commutes can cause higher blood pressure and a higher self-report of stress. There has been no proved relationship between mental health and sprawl.

As described in the later census section, the chosen urban site for this development already possesses many of these qualities (access to transit, access to recreational facilities, and diversity of population). New development design will aim to improve land use mix, pedestrian amenities, bicycle amenities, roadway networks, and street cross sections. To summarize from each of these elements, the most important built environment elements seem to be:

Regional Accessibility and Location of development- reduces auto use and air pollution
Population and Employment Density- benefits transportation, air quality, and traffic safety, while encouraging increased physical activity.
Land Use Mix- areas facilitate pedestrian, bicycle, ridesharing, or transit travel and reduces vehicle travel and emissions. It can also increase social capital and mental health.
Access to Transit- reduces car ownership, vehicle trips, miles traveled and emissions while improving physical fitness and public health.
Streetscape Design/Pedestrian Amenities- increased walking and bicycling has significant impact on health.
Bicycle Amenities- the quality and density of amenities for bicycles correlates to higher levels of bicycling for recreational purposes. Access to Recreational Facilities- Greater access and higher densities of facilities can increase the number of people who are physically active.
Distance from Roadway- Close proximity to cars has a greater impact on health than is found further away.
Diversity of Population- Single-use, single-income areas result in civic disengagement and lower levels of political involvement.
Roadway Networks- The street environment affects diver behavior and thus the rate of traffic accidents and physical activity rates. Street Cross Sections- street width, on-street parking, and pedestrian facilities improve traffic safety. (Design, Community & Environment et al. 3-101)
### Table 5-1  Features of Sprawl that Weaken Sense of Community

<table>
<thead>
<tr>
<th>Feature of Sprawl</th>
<th>Contribution to Weakening Sense of Community</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leapfrog development</td>
<td>Strong</td>
</tr>
<tr>
<td>Low density</td>
<td></td>
</tr>
<tr>
<td>Unlimited outward extension</td>
<td></td>
</tr>
<tr>
<td>Transport dominance by motor vehicles</td>
<td></td>
</tr>
<tr>
<td>Highly fragmented land use governance</td>
<td>Moderate or minor</td>
</tr>
<tr>
<td>Great variance in local fiscal capacity</td>
<td></td>
</tr>
<tr>
<td>Widespread commercial strip development</td>
<td></td>
</tr>
<tr>
<td>Reliance on filtering for low-income housing</td>
<td></td>
</tr>
<tr>
<td>Land uses spatially segregated</td>
<td>None</td>
</tr>
<tr>
<td>No central ownership or planning</td>
<td></td>
</tr>
</tbody>
</table>


Figure 16: Sprawl and Community Impact
Marketability Tools

Introduction

A large dilemma in green construction is not designing the most sustainable building possible but designing the most sustainable building that someone is willing to buy. To explore consumer willingness, this section will look at different sources for market information. The McGraw-Hill Residential Green Building SmartMarket Report provides survey data from construction professionals about current and developing strategies they are implementing towards green construction. The Residential Green Building Report is an academic study geared to improve market engagement for developers and builders by creating a framework based on multiple sources including the McGraw-Hill Report. The Resource Priority Survey, given to parents of local freshman architecture and interior design students, rates the importance of limited resources within the population. Finally, the census data will show local Clifton market conditions to those of the surrounding area and the United States.

The Market of such an expanding and relatively new idea of responsible housing development is largely affected by consumer behavior. In the book, The Tipping Point by Malcolm Gladwell, those individuals who accumulate knowledge about products, prices and places are called Mavens. These individuals can single-handily spread either positive or negative information into the market place based on their own trials. Mavens are also usually placed into the diffusion model's category of Early Adopters. The diffusion model is an academic way of looking at how a contagious idea or product or innovation moves through a population (Gladwell 200).

If we look at the diffusion model more closely, the very small group that tries out the initial idea are the Innovators. Then a slightly larger group learns about the idea and begins using it, these are the Early Adopters. Finally comes the larger population groups, the Early Majority and the Late Majority, the Deliberate and the Skeptical Mass, and the Laggards. If you plot this expected progression it creates a perfect epidemic curve, starting slowly, tipping slightly as the Early Adopters start using the product, and then rising sharply as the Majority catches on (Gladwell 198-200). The tipping point occurs just after early adopters start accepting the idea and using the product.

Marketability Tools

SmartMarket Report

The McGraw-Hill report, using conservative estimates, predicts that green building will have reached its tipping point in 2007 (McGraw-Hill 9). McGraw-Hill also predicts that if the green homes market penetration continues to grow rapidly, then green homes will become a product of choice for the early majority buyer, and market penetration will rise sharply (McGraw Hill 9).

In 2005, green building comprised approximately 2% of homes built in the U.S. This translates to approximately a $7.2 billion market size (McGraw Hill 8). This same year 31% of builders reported more than moderate involvement with green building (McGraw Hill 4). With both supply and demand continuing to increase, they project that by 2010, between 5% and 10% of new residential construction starts will be green projects equaling $19 billion to $38 billion for the residential construction marketplace (McGraw Hill 8). If this estimate is correct, the sheer number of participants will force the rest of the market up to its standards to remain competitive.
Market drivers are most commonly energy costs increases, consumer demand and superior performance. Obstacles included higher perceived initial cost, consumer willingness to pay, and lack of consumer education on green building. Motivators for builders themselves include “doing the right thing” (92%) and “lowering lifecycle costs” (87%) (McGraw Hill 5). The McGraw-Hill report identified an emerging common consensus among community and industry pointing to 5 elements of consideration: Energy efficiency, indoor air quality, water conservation, resource efficiency, and construction process (McGraw Hill 6).

Products most commonly used in residential green building include some form of energy efficient technology, most being the use of Low-E (emissivity) windows (82%); the use of environmentally preferable building materials (95%), most using OSB instead of plywood (80%); and the consideration of open space preservation techniques (90%), most attempting to minimize vegetation disruption (67%) (McGraw Hill 18).

When building homes, the top three practices listed in McGraw-Hill included energy efficient techniques (82%), indoor air quality
(66%), and water conservation (66%) (12). Generally speaking, a green home should have lower operating costs. In 2006, according to the U.S. Department of Energy, the average American family spends $1,291 on home energy per year. It is estimated that green home features can lower this cost by as much as 50% (McGraw-Hill 7). Rebates and government incentives also add an additional benefit, with some local and state governments and utility companies giving credits to homeowners using energy efficient features in their home. An individual who purchases specific energy saving products, windows, insulations, etc, and a solar water heating system could earn up to $2,500 in rebates from the government. Building contractors and product manufacturers also receive tax credits for energy efficient products (www.energy.gov).

When asked “what is the best way to arrive at a responsible design?” surveyed builders believed (over 50%) the concept design phase was the best stage to influence green design. Customer request came out at 22%, just barely beating out budget (18%) as the 2nd most important stage (McGraw Hill 11).

Specific residential green building options are perceived differently depending on who you ask. Builders rated high-efficiency HVAC systems and appliances, and Low-E glass windows as the top three most important things you can do to improve energy efficiency. High efficiency HVAC also topped the list of indoor air quality improvement.

In this same category were formaldehyde free finishes, minimum off-gassing, and low VOC paint. Water conservation was perceived as best accomplished through storm water mitigation (75%), water conserving utilities (75%), water conserving fixtures (73%), water filtration system (49%), and gray water recycling (34%). The use of high performance, engineered wood ranked #1 in perceived best way to reduce material use and resources by builders. Also included were alternatives to wood (68%), allergen free materials (63%), recycled building materials (63%), and sustainably harvested lumber (61%) (McGraw-Hill 17).

This survey was prepared in conjunction with NAHB, who as mentioned earlier, build 80% of residential homes. This means that the surveyed builders not only have the ability to respond to the market but also to drive the market. This could be for the good or bad of sustainable construction.

### Commercial Construction Comparisons

<table>
<thead>
<tr>
<th>Commercial Construction had the same top trigger and obstacle to green building. However, there were some differences, as listed here.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>COMMERCIAL</strong></td>
</tr>
<tr>
<td>Certification programs seen as second largest trigger to green building.</td>
</tr>
<tr>
<td>Education and awareness on green building concepts second largest barrier.</td>
</tr>
<tr>
<td>Contractors less likely to consider higher costs an obstacle.</td>
</tr>
</tbody>
</table>


---

**Most Important Obstacles to Increased Residential Green Building**

- Consumer Reluctance to Pay More: 29%
- Higher First Costs: 24%
- Codes and Regulations: 24%
- Lack of Education about Concept: 24%
- Cost and Approval Time: 23%
- Consumers Do Not Care: 22%
- Politics: 21%
- Liability: 13%
- Not Enough Information: 21%
- Lack of Products: 21%

In May 2007, Jeff Martin, Brian Swett, and Doug Wein collaborated to write the Residential Green Building Report, a market engagement framework for developers and builders. This report listed three primary elements critical to expanding the green homes market: consumers, industry, and government. Ideally, they wrote, there would be a large number of knowledgeable green-homebuyers who understand value-proposition and green home products. The industry would also be strong consisting of developers, guilders, sub-contractors, and other professionals familiar with building, marketing, and selling green homes. Lastly the government would support green home building through policies focused on sustainable development (Martin, Swett & Wein 3).

Market, Community, and resources all have a significant impact on the green building market. When all of these elements combine, pressure towards responsible housing increases (Martin, Swett & Wein 3).

Acute resource pressures can include water scarcity, traffic congestion, land-density constraints, air-pollution, energy capacity and price. These pressures then can affect consumer preferences, industry innovation, media attention, and the regulatory environment (Martin, Swett & Wein 3). Energy costs have been increasing steadily over the past five years and show no sign of leveling off. Market can be affected externally by job growth rates, interest rates, fluctuating costs of home ownership, and migration patterns (Martin, Swett & Wein 3).

Advancements in the field:
- Many financiers provide Energy Efficient Mortgages (EEM)
  - Loan money for energy improvements
  - Validated according to Home Energy Rating System (HERS) Accreditation Standard
  - Banks and other providers vary by region

Leadership examples from the field:
- Alan Associates
  - Has built passive solar designed homes in Santa Barbara, CA since the early 1970s
  - Goal to produce homes that generate energy, purify waste-water, produce zero waste, and purify the air

McIntire Neighborhoods
- Premium green builder in Boulder, CA crafting 400 homes each year
  - Sets records for consistent customer satisfaction of over 90%
One of the greatest barriers to green design seems to be the perception by both the public and builders regarding increased cost of green homes. The Urban Land Institute estimated the use of green materials at a 3-4% increase in cost over conventional construction materials (Martin, Swett & Wein 9). McGraw-Hill finds that green building can be accomplished for comparable costs to standard construction, “with better up-front planning and/or energy or other cost savings as a result of green construction” (Martin, Swett & Wein 9).

The Natural Marketing Institute, in a 2006 survey, found that the majority of green home purchasers (51%) were consumers from what they called “Lifestyles of Health and Sustainability” and “Naturalites” (Martin, Swett & Wein 12). If speaking in diffusion model terms, these people would again be the early adopters. This survey then identified characteristics this type of consumer is more likely to possess including the purchase of green products, higher education level, self identified maven, and use/purchase renewable power in the next year. This consumer group, when asked about priority when building and purchasing a home in the next year, reported concerns about products being biodegradable, chemical-free, containing recycled content, energy efficiency, energy star certified, environmentally friendly, low fumes, natural, non-toxic, and sustainably harvested (Martin, Swett & Wein 13). These individuals are also more likely to have a zoo membership (12.0% compared to 8.8%), museum membership (11.2% compared to 8.2%) and use products that are known to be more environmentally conscious such as Aveda, Seventh Generation and Celestial Seasonings (Martin, Swett & Wein 13).

The purpose of this report was to create a tool, The Market Metric Lens (MML), that developers could use to assess an areas “market potential” for green home development. The MML simply systematizes the McGraw-Hill report as well as the Natural Marketing Institute data so that different regions can be compared. This is helpful only to assess an area’s current status and compare it to another area. It does not give the developer a simple go/no-go answer on which areas to invest.

The key to Market Engagement Framework is the term “Engagement.” All of the results and conclusions from the report are generated by making contact with industry leaders and governments. The concept of collecting all data available before making large-scale decisions is not new. It is necessary. The strength of this report is in giving direction on where to locate the needed information.

**Table 1. Relevant Behavioral Differences in Green Homebuyers and Remodelers**

<table>
<thead>
<tr>
<th>Behavioral Attribute</th>
<th>General Population</th>
<th>Green Homebuyers/ Remodelers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchases of “Green” Products</td>
<td>* Denotes statistically significant difference</td>
<td></td>
</tr>
<tr>
<td>Hygiene Shower</td>
<td>0.5%</td>
<td>0.4%*</td>
</tr>
<tr>
<td>Renewable Power</td>
<td>0.5%</td>
<td>0.4%*</td>
</tr>
<tr>
<td>Alternative Healthcare</td>
<td>11.5%</td>
<td>48.4%*</td>
</tr>
<tr>
<td>Socially Responsible Investing (SRI)</td>
<td>10.6%</td>
<td>18.3%*</td>
</tr>
<tr>
<td>Healthy Foods and Beverages</td>
<td>13.1%</td>
<td>14.5%</td>
</tr>
<tr>
<td>Skateboard Enthusiasts</td>
<td>24.0%</td>
<td>37.7%*</td>
</tr>
<tr>
<td>Skateboard Enthusiasts</td>
<td>0.4%</td>
<td>0.4%</td>
</tr>
<tr>
<td>Natural Foods and Beverages</td>
<td>61.5%</td>
<td>38.6%</td>
</tr>
<tr>
<td>Animal</td>
<td>9%</td>
<td>17%</td>
</tr>
<tr>
<td>Cleaning Supplies and Household Products</td>
<td>77.0%</td>
<td>52.3%</td>
</tr>
<tr>
<td>Seventh Generation</td>
<td>2.7%</td>
<td>1.7%</td>
</tr>
<tr>
<td>Energy-Efficient Appliances</td>
<td>24.3%</td>
<td>55.3%</td>
</tr>
<tr>
<td>Energy-Efficient Electronics</td>
<td>52.3%</td>
<td>64%</td>
</tr>
<tr>
<td>Dietary Supplements</td>
<td>74.3%</td>
<td>63.6%</td>
</tr>
</tbody>
</table>

**Memberships to Clubs/Organizations**

- Library | 12.8% |
- Nature Conservancy | 4.0% |
- Sierra Club | 7.2% |
- Zoo | 11.6% |
- Museum | 0.2% |
- Performing Arts Center | 1.3%
- Horticultural Center/Garden Club | 7.7% |
- Safari Club | 0.0% |

**Publications**

- The Wall Street Journal | 7.7%
- The New York Times | 9.7%* |

**Television/Radio**

- PBS | 20.3%
- PBS | 37.7% |
- Home and Garden Channel | 20.4%
- NPR | 28.0%
- The Oldie House | 19.2%
- The Oldie House | 24.4%

Figure 21: Natural Market Institute survey
The census analysis focuses on 2006 data for the 45220 zip code area in the Ludlow-Clifton neighborhood of Cincinnati, OH. The 45220 zip is defined by the area bounded to the North by I-75, Vine Street to the East (also including the Zoo and UC East Campus). The South is roughly bounded by Martin Luther King Boulevard, and Central Parkway to the West. The data from the 45220 area will be compared in a scalar sense to Cincinnati, Hamilton County, Ohio, and U.S. 2000 data. The focus of the investigation will be in four categories: Demographic, Social, Economic, and Housing. Items have been chosen from within these categories based on their relevance to the design question. The goal is to identify population characteristics of interest when designing a residential development.

Demographic
In the Ludlow-Clifton area, 50% of the residents live alone. This percentage is double the national average and higher than Cincinnati, Hamilton County, and Ohio. The high student population in this area could be part of the reason why there are so many single households. This area has an owner occupied rate of 27%, less than 1/2 the national average and at the same time the average housing size is smaller, 2.35 versus 2.69 people at the national average. The higher percentage of renter-occupied housing, 73%, is also smaller household size than the national average of 2.4 at 1.67 people.

Currently, 66.6% of residents are Caucasian and 21.7% are African American, compared to the rest of Cincinnati which has 53% Caucasian and 42.9% African American (United States Census Bureau).

Social
In this area, 25.4% of residents have a bachelor’s degree (15.5% nationally) and 29.6% have a graduate or professional degree (8.9% nationally). The percent of the population enrolled in school is 73.1% (22.8% nationally).

Economic
The Ludlow-Clifton area has a much higher percentage of walkers-to-work (13.6%) compared to the national average of 2.9%. Mean travel time to work is also less at 19.1 with the national average at 25.5. When comparing this area to Ohio, there is also a much higher management, professional occupation rate of 58.2% versus 31%. Individuals in the health, education and social services occupations were also much higher compared to the rest of Ohio 36.9% locally to 19.7% statewide. The median family income is $50,000 compared to Cincinnati, which is $37,543. The Ludlow-Clifton area is close to the national average with only $46 increase on the national level. The number of families in the $100,000 to $200,000 family income, is however, well outside the normal proportion that is reflected in the other local, regional and national censuses.

Housing
Ludlow-Clifton has a very high percentage of pre-1940 homes (41%). Cincinnati is also higher at 40% compared to the national average of 15%. Most occupants, however, just recently moved into the home they are in between 1999 and 2000 (36%). The majority across all other census areas is 1995 to 1999. Median room # is 3.7 for Clifton. An interesting statistic from the house-heating-fuel category is that of the 76 homes in...
Hamilton county that utilize solar energy, 63 of them are within Cincinnati city limits. There are a high number of residences with no vehicle or only one per household; this correlates with the high number of people who walk to work. Across the board, owner occupied home values are significantly higher than at the other scales. This is reflected in the high percentage of houses valued at $150,000-$1,000,000 in the 45220 area, driving the median home value in the area to $178,500, almost $60,000 higher than the national median. This trend has a direct impact on the high percentage of people paying $1500 per month or more on their mortgage (United States Census Bureau).

Overall the census information reflects that the Ludlow-Clifton differs greatly from Cincinnati, all the way to the national level in all categories. This mostly likely can be attributed to the high number of surrounding education facilities (University of Cincinnati, Cincinnati State) and hospitals (University Hospital, Children's Hospital, etc.). These facilities require staffing and attract a mostly transient, highly educated demographic. This demographic is driving most of the other outlying data when compared to Cincinnati, Hamilton County, Ohio, and the nation. A design in this area has the difficulty of responding to the unique conditions of the population while still trying to meet traditional housing expectations of the general public. The design will cater to the Ludlow-Clifton population by utilizing elements such as higher income, higher level of education and the propensity towards walking. As noted in the McGraw Hill report and the Residential Green Building report, this population is considered more open to the idea of sustainable design and more likely to pay for the resulting amenities.
Purpose
This survey was created for the purpose of investigating how people use and prioritize their resources. The focus of the Resource Priority Survey is mainly in relation to the built environment, but some questions deal with consumer consumption in general. This survey is being used as a tool to help make design and market decisions for a proposed developed community in the Ludlow-Clifton area. The survey juxtaposes two groups, college thesis students and parents of college freshmen. The similarities and differences in the decisions these two groups make will help to drive the design project.

Populations
The questionnaire was given to two different populations:
1. The first are thesis students who live in the Clifton area and are transient in nature. The students represent potential homebuyers in the near future to the Clifton area. The first group was distributed to senior graduate architecture thesis students in DAAP at the University of Cincinnati. They were given the survey in thesis studio to complete within a one week time period in November 2007. Out of the 70 students there were 29 responses, and only 24 were fully completed and used in the analysis.
2. The second group are parents of UC students, who could afford to own a home in the Clifton area and are more permanent in nature. The group consists of parents of freshman undergraduate architecture and interior design students in DAAP. They were given the survey to take home and complete with their parents over Thanksgiving break 2007. It was distributed to all 160 freshman students and there were 65 responses, and only 46 were fully completed and used in the analysis.

Design
The 12 first questions (“Current Home Questions”) in the survey were designed to collect Demographic data from the participants. The first section also asked the participants to rank their resource priorities (1-9) when they were deciding to purchase their current home. The next section, Questions 13-48 (“Decision Questions”) was designed to represent a full matrix of decision possibilities, a Sample Space, of the following resources:

<table>
<thead>
<tr>
<th>Limited Resources</th>
<th>Unlimited Resource</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>Community</td>
</tr>
<tr>
<td>Water</td>
<td></td>
</tr>
<tr>
<td>Air</td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td></td>
</tr>
<tr>
<td>Money</td>
<td></td>
</tr>
<tr>
<td>Property</td>
<td></td>
</tr>
<tr>
<td>Energy</td>
<td></td>
</tr>
<tr>
<td>Space</td>
<td></td>
</tr>
</tbody>
</table>

Limited Resources are defined as desired supplies that have limited availability to the user and can be used up or converted into money. Unlimited Resources are more abstract and can exist in any quantity without conceivably giving up a Limited Resource. While developing the list, it was discovered that there are really an unlimited number of Unlimited Resources. For the purposes of clarity, comparison, and to restrict the scope of the survey investigation, only one Unlimited Resource was chosen, community.

Each Decision Question is setup to pose a decision between two of the nine listed resources. In this way the sample space is the framework for the Decision Questions: Food vs. Water, Food vs. Air, Food vs. Time, Food vs. Money, etc. all the way out to 36 scenarios. A question was then developed for each scenario that was intended to generate a decision about one resource over another resource. The questions were then mixed randomly to discourage direct correlation among the questions. Neither of the groups were aware of the purpose of the survey or how their answers to the questions would be evaluated.
Process
This portion is an investigation of the variation between the Stated Priorities and their Derived Priorities of both the Thesis Student and the Parents.

The participant is asked in the Current Home Question at the beginning of the survey to rank the Resources being investigated 1-9 when they were deciding to purchase their current home. This Self-Evaluated rank of priority (Figure I A, shown on orange) is then compared with the set of their derived resource priorities (Figure I A, shown in green), given the set of answers to the matrix of Decision Questions. The derived priorities are the sample space of a matrix of 36 questions, each question requiring a choice between two resources, as stated in the Survey Design section.

The Derived Rank was created by averaging the population’s ranking for all of the indi-

<table>
<thead>
<tr>
<th>Property</th>
<th>Computed Average</th>
<th>Self-Evaluated Rank (1-9)</th>
<th>1/Self-Evaluated Rank (9-1)</th>
<th>Calculated Rank (1-9)</th>
<th>1/Calculated Rank (9-1)</th>
<th>Variance of Average</th>
<th>Variance of Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshman Parent’s Resource Priorities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>4.24</td>
<td>4</td>
<td>6</td>
<td>2</td>
<td>8</td>
<td>3.15</td>
<td>5.13</td>
</tr>
<tr>
<td>Energy</td>
<td>6.17</td>
<td>7</td>
<td>5</td>
<td>8</td>
<td>1</td>
<td>5.24</td>
<td>3.36</td>
</tr>
<tr>
<td>Food</td>
<td>5.56</td>
<td>6</td>
<td>9</td>
<td>8</td>
<td>2</td>
<td>4.31</td>
<td>7.28</td>
</tr>
<tr>
<td>Air</td>
<td>7.97</td>
<td>8</td>
<td>8</td>
<td>2</td>
<td>1</td>
<td>6.43</td>
<td>8.95</td>
</tr>
<tr>
<td>Space</td>
<td>6.97</td>
<td>9</td>
<td>5</td>
<td>9</td>
<td>1</td>
<td>5.03</td>
<td>6.79</td>
</tr>
<tr>
<td>Money</td>
<td>3.15</td>
<td>2</td>
<td>1</td>
<td>5</td>
<td>3</td>
<td>4.30</td>
<td>6.17</td>
</tr>
<tr>
<td>Time</td>
<td>2.43</td>
<td>1</td>
<td>8</td>
<td>9</td>
<td>5</td>
<td>4.83</td>
<td>5.79</td>
</tr>
<tr>
<td>Community</td>
<td>5.13</td>
<td>5</td>
<td>3</td>
<td>7</td>
<td>4</td>
<td>3.00</td>
<td>4.57</td>
</tr>
</tbody>
</table>

Total Variance

| Property       | Computed Average | Self-Evaluated Rank (1-9) | 1/Self-Evaluated Rank (9-1) | Calculated Rank (1-9) | 1/Calculated Rank (9-1) | Variance of Average | Variance of Rank |
|----------------|------------------|----------------------------|----------------------------|                      |                        |                     |                  |
| Thesis Student’s Resource Priorities |                 |                            |                            |                      |                        |                     |                  |
| Water          | 4.30             | 4                          | 8                          | 5                    | 2                      | 4.38                | 6.17             |
| Energy         | 4.83             | 2                          | 3                          | 6                    | 5                      | 5.00                | 5.79             |
| Food           | 5.67             | 6                          | 6                          | 8                    | 9                      | 6.71                | 7.92             |
| Air            | 5.30             | 8                          | 5                          | 9                    | 1                      | 5.42                | 7.00             |
| Space          | 3.46             | 7                          | 4                          | 4                    | 1                      | 5.24                | 6.43             |
| Money          | 2.54             | 9                          | 3                          | 1                    | 2                      | 4.75                | 8.95             |
| Time           | 2.75             | 8                          | 7                          | 9                    | 6                      | 5.92                | 10.24            |
| Community      | 2.42             | 6                          | 6                          | 8                    | 4                      | 7.00                | 10.24            |

Total Variance

Figure 24: Summary of resource Priority Survey results
individual resource categories. After that, the averages were re-ranked in order from 1-9. This is possible because the numbers used to represent priority don’t necessarily have an even distribution between each integer, i.e. the distance from 1->2 doesn’t have to equal the distance between 2->3. This is made possible by utilizing data collected from a large enough population, because more responses should begin to even out the gaps in interstitial variation. The variances of the averages and the ranking were used to identify.

Conclusion

Results of the self-evaluated resource priorities in the student aggregate were (1) Money, (2) Time, (3) Space, (4) Community, (5) Energy, (6) Food, (7) Water, (8) Property, and (9) Air (see Figure 1A). Comparatively the results of the actual resource priorities as demonstrated through the series of decision questions ranked: (1) Money, (2) Energy, (3) Water, (4) Community, (5) Time, (6) Property, (7) Food, (8) Air, and (9) Space. The largest areas of discrepancy between self-ranked and decision based rank were Space (V=6.27 variance (V)) and Time (V=3.39 variance (V)) meaning that individuals perceived these areas to be of high priority, but when asked through scenario based decisions, actually made them lower priority. Conversely, thesis participants ranked Water (V=1.39 variance (V)) and Energy (V=0.54 variance (V)) low on their self-evaluated scale, and then when asked, much higher on the decision making questions.

When analyzing the Freshmen Parent group in a similar sense, in the series of decision questions, ranked: (1) Money, (2) Space, (3) Community, (4) Property, (5) Time, (6) Energy, (7) Water, (8) Air, and (9) Food. In the results of the actual resource priorities demonstrated through the decisions questions, Freshman Parents ranked: (1) Money, (2) Property, (3) Water, (4) Time, (5) Food, (6) Energy, (7) Community, (8) Air, and (9) Space. The largest areas of discrepancy between self-ranked and decision based rank were, again, Space (V=4.57 variance (V)) and Community (V=3.21 variance (V)) meaning they perceived these areas to be of high priority, but then lowered them once asked scenario based decisions questions. Items they ranked low on the priority scale and then reported with a higher level of priority on the decision questions were Food (V=2.51 variance (V)), and Water (V=0.91 variance (V)) (see figure 1B).

The results of the data established two main characteristics about the two populations. The first is that Parents had a higher variation in rank. This means that the Parents had a greater variance (V=51) from the priorities that they ranked and the decisions they made in the survey. Conversely, the Students (V=16) were more in line with what they believed to be important and the decisions they made through the survey. The second and even more interesting characteristic is that although the parents had a greater difference between what they ranked and the choices they made, the entire Parent population was more consistent in their ranking than the students. This is apparent in the Parents Variance of Average (V=12.9) being lower than the Students (V=16.5). When you combine these two results, it means that the Parents are more consistently off by a greater degree than the Students; and that the students have a wider variation of preferences within the population, but are more in tune with their resource priorities.

Design Implications

Property- Both groups ranked property higher in their decisions versus their self-ranking. This means that they like the idea of ownership more than they are willing to pay for it. The parents ranked property on both scales 4 steps higher than the students. Through design the individual should feel like they own more than they are paying for.

Water- Both survey groups self ranked the
importance of water much lower than their decision based ranks. This indicates that water conservation and quality strategies would be a large selling point to both of these groups, but it must be done at a low cost.

Energy- Energy was ranked in both the self-evaluated and decision questions exactly in the middle. This implies that the groups are aware of their energy usage and cost and are willing to pay for energy conservation strategies, although they are not their first priority.

Food- Food was self-ranked in the parent group lower than their decision based ranking. For the decision based questions, food was defined in terms of quality. For the self-ranking questions, food was defined in terms of proximity and # of choices. Design implications include less emphasis on proximity to food choices as long as those choices available are of high quality.

Air- Air was ranked the lowest for both groups in the self-evaluated and decision rankings. This means people care very little about air quality issues and aren’t willing to pay more for better air. Any design strategies involving increase air quality

Space- In the self-evaluation portion, the ranking space was defined as the importance of # of bedrooms. For the majority of the decision question, space was defined as actual square footage or perception of square footage in the home. The residential design could benefit from the drastic differences in space ranking based on a minor definition alteration by not increasing the square footage of the home, but by allowing a wider range of potential # of bedrooms in the same square footage. Based on the survey information, the size of the room doesn’t matter as much as the # of rooms.

Money- Money is the only resource that was consistently at the top of both groups calculated and self-evaluated rankings. This makes sense because money is the only resource on the list that could be converted into another resource.

Time- Both groups ranked time in the upper half of their priority scale. This is important because they see their time as worth more than energy, water, food, air and community. Any design strategies that involve conserving any of the resources ranked below it would have to be done so in a way that didn’t impede on previous time constraint or may actually even improve them.

Community- The site context is the Ludlow community which already exists. Through their rankings, it is apparent that both groups would enjoy the strong existing community. This concept is primarily important when buying the home and not necessarily valued in their day-to-day lives.
Section __________ Name __________ ____________________________ (optional)

The student is to administer the questionnaire to his/her parent. Preferably the questionnaire will go to the parent who makes most of the family’s purchasing decisions. Each Decision Question in the survey is meant to be independent of the others. Please answer the questions honestly and without judgment. This survey is for educational purposes only. No personal information will be shared or distributed to any 3rd party.

CIRCLE YOUR ANSWERS for most questions. FILL IN YOUR ANSWERS when there is an available ______ space.

**Current Home Questions**

1. **How Do You Live?**
   1. How long have you lived in your current home? _______ years
   2. When do you anticipate moving?
      - Less than 1 year
      - 1-2 years
      - 2-5 years
      - 5-10 years
      - 10-15 years
      - More than 15 years
   3. At your current home, how many of each do you have?
      - Bedrooms
      - Bathrooms
      - Cars
      - People
   4. Current value of home?
      - Less than $100,000
      - $101-200,000
      - $201-400,000
      - $401-500,000
      - Greater than $500,000
      - I Lease
   5. Total household yearly income?
      - less than 30k
      - 31-50k
      - 51-70k
      - 71-90k
      - 91-110k
      - Greater than 110k
   6. Choose the type of location that best describes where you live:
      - Rural
      - Small Town
      - Suburban
      - Within City Limits
      - Downtown City
   7. On average, how much time do you spend per month on energy (gasoline, electric, natural gas, propane, etc.)?
      - less than $100
      - $100-250
      - $251-400
      - $401-550
      - $551-700
      - More than $700

   **Design Questions**

10. What is your primary energy source used for heating your home?
   - Electric
   - Natural Gas
   - Propane
   - Wood
   - Solar
   - Geothermal
   - Oil

11. What is the size of your home lot?
    - 0 acres
    - 0-5 acres
    - 5.1-10 acres
    - 11-20 acres
    - Greater than 20 acres

12. How many times a week do you eat outside of your home?
    - 0
    - 1-2
    - 3-5
    - 6-10
    - 11-20
    - Greater than 20

13. Do you feel that you use too much energy (gasoline, electric, natural gas, propane, etc.)? YES NO

14. Do you prefer to grow/raise your own food rather than purchasing prepared meals? YES NO

15. Have you purchased an air purifier for your home? (IONIC Breeze, Smoke Filtration system, etc.) YES NO

16. Do you prefer to save time by paying someone to mow your grass? YES NO

17. Would you want a larger yard if it required a lot more time to maintain it? YES NO

18. Do you feel you spend too much money on energy costs? (gasoline, electric, natural gas, propane, etc.) YES NO

19. Would you spend more money on a fence if it would only benefit your neighbor’s view? YES NO

20. Do you desire a pond or other large water feature in your yard? YES NO

21. Would you eat outside of your house more frequently if you had a smaller kitchen? YES NO

22. Don’t you prefer an SUV or other large vehicle rather than smaller car? YES NO

23. Are you more likely to take shorter showers than use a low-flow showerhead? YES NO

24. Would you live in a GREAT community downwind of a sewage treatment facility? YES NO

25. Would you prefer to have a large living space, if it had NO operable windows? YES NO

26. Would you live in a home that obtains an expressway to save 15 minutes on your daily commute? YES NO

27. Would you rather Own a small home more than front a larger home? YES NO

28. Are you more likely to lower the temperature on your water heater that use a low-flow showerhead? YES NO

29. Do you prefer to have a FIN or BORROW specialty finance (pay-blower, stream sources, power tools, etc.)? OWN BORROW

30. Do you prefer to buy items on credit more than saving up cash to purchase them? YES NO

31. Would you prefer to walk/bike an errand you would normally drive, so you can save gasoline? YES NO

32. Would you commute 30 minutes longer each day to live closer to your family and friends? YES NO

33. When buying food, do you consider the energy savings of locally produced products? YES NO

34. If you had to choose an ideal vacation, which factor is more important in your decision? Dining selection Water activities

35. Do you believe drinking water should always be free? YES NO

36. Would you be willing to have a smaller living room if your neighborhood had a large shared Clubhouse? YES NO

37. Would you purchase Carbon Credits to offset your negative CO2 impact on global warming? YES NO

38. Do you prefer to open your windows for an extended portion of the year to conserve energy? YES NO

39. Would you be willing to use a significant portion of your yard for solar energy collection devices? YES NO

40. Have you considered building an addition onto your home? YES NO

41. Would you ever pay more than $20 for a GREAT sandwich? YES NO

42. Do you enjoy eating GREAT food alone more than eating PLAIN food with friends and neighbors? YES NO

43. Would you commute 20 minutes further to enjoy cleaner air? YES NO

44. Would you prefer to have solar panels on your home more than buying energy from a power plant? YES NO

45. Do you prefer swimming with others more than swimming alone? YES NO

46. Do you travel more than 30 minutes for your major food purchases? YES NO

47. Would you get a new dishwasher to reduce your water consumption? YES NO

48. Do you buy bottled water based on the brand’s embedded energy? YES NO

49. I Don’t Buy Bottled Water

Figure 25: Questionnaire provide to participants for Resource Survey
**Precedents**

**Introduction**

In order to properly assess the current market situation and deliver an improved design and product, it is necessary to first analyze similar precedents found in the current market place. The precedents are organized from projects focusing mainly on private ownership to the other end of the spectrum where projects focus primarily on community. The first precedent, Foxpointe, serves as a model of what is currently leading the market in single family residence across the country. Foxpointe will be used as a baseline when evaluating the other precedents. The precedents that fall in the spectrum of private community are: Houses at Sagaponac, Habitat Trails, Price Hill Eco Village, Great Oak Cohousing, and Aranya Community Housing. Through each precedent elements of site, housing, material and operations will be evaluated and then compared with the base standard (Foxpointe). Each individual precedent will focus primarily on the specific portions of these elements that they most pertain to.

**Precedents**

**Foxpointe**

The Foxpointe community is located in Batavia, OH and was built and developed by Ryland Homes. The company’s operations include all aspects of the home buying process, from design, construction and sale, to mortgage origination, title insurance, escrow and homeowners insurance brokerage services (stocks.us.reuters.com). Along with Cincinnati, Ryland also operates in other regions including Texas, Chicago, Baltimore, Washington D.C., Orlando, California and many more. The company targets first and second time homebuyers with their financial options and design. The homebuyers only part in the design of their home come in the form of selecting from options and upgrades displayed in the Company’s model home and design centers (stocks.us.reuters.com).

Another advertised feature is listed as “Energy Conservation.” It lists a 90% high efficiency furnace, low E windows, R-15 exterior wall insulation, and R-38 attic insulation. Exterior construction and finishes are comprised of “architectural singles,” brick front, included patio backyard. The interiors are comprised of 2 HVAC systems, 9’ ceilings, crown molding, fireplace, hardwood floors in entry and kitchen, 42” cabinets, and elongated toilets (Ryland.com).

An example of one of the typical designs found in this community at the average selling price of $280,000 is “Hanover II” with 2525 square feet of living space, 4 bedrooms and 2.5 baths (Ryland.com).

Foxpointe advertises themselves as a quiet and private community where almost every home site backs up to 7 acres of “open space” (Ryland.com). The layout involves only two streets to reduce the amount of traffic and increase privacy. Shared amenities include picnic area, playground, and walking trails. Average listed home price is roughly $280,000.

Figure 26: Hanover II by Ryland Homes
Foxpointe is approximately 26.9 miles and 36 minutes from Cincinnati. This means residents on average will be commuting longer times and drive more. As mentioned in the Public Health and the Built Environment report, this contributes to air pollution, higher incident of traffic accident and fatalities, loss of social capital, and an increased stress and depression. The two dead end streets that wind through Foxpointe have been shown to cause less interaction and less walking (Public Health 101).

The site was once forested and farmland, far from any major metropolitan areas or amenities. This, again, causes more travel and increases isolation. When the developers began working on the site they quickly cleared almost all trees and greenery, excluding a tiny patch in the center for a “playground.” Natural erosion control and storm water management were ignored and areas were leveled to facilitate quick and easy development. Rather than changing development design to conform to the natural conditions, the land was sacrificed to fit their predefined mold.

Foxpointe did attempt to address the issues of community and health by including a walking trail, playground, and picnic area. However, the community design and de-forestation of this area makes them unwelcoming and they fail to serve their intended purpose of providing a natural setting. These areas also do not connect to the surrounding community and thereby reinforce the development’s isolation and strict boundaries.

Strategy focus is bigger is better, and tries to meet the price point with the largest quantity of space possible. The purchaser/user has little involvement in the Foxpointe home design. They choose from regularized plans and can select from designated features at an additional cost. The user isolation removes a sense of permanence and self identify in the home buying process. Ryland Homes is located in multiple cities and brings the same design and approach to all cities. So not only is the user oversimplified, but also greater location strategy. Homes are simply arranged within compact property boundaries without regard to solar orientation or views.
By using the same strategy across the country, Ryland Homes is able to use prefabrication for large portions of the buildings. This makes for fast assembly and reduced material and labor cost. The majority of finishes are low cost - low durability, including the primary use of carpet as a floor treatment. Carpet accounts for 2-3% of landfill volume by weight (californiagreensolutions.com).

Energy conservation strategies listed on the website are simply the regional recommendation provided by the United States Department of Energy, but are portrayed as above and beyond. The homes do use 2 HVAC units, which provide more localized thermal comfort. Many material and equipment choices have an expected 10 year lifespan (NAHB) leading to high replacement costs. This includes asphalt shingles, flooring, work surfaces, large appliances and fixtures.

Precedents
Houses at Sagaponac

The houses at Sagaponac is a development of 35 houses in Southampton on New York's Long Island. Sites range from 1 to 3 acres (www.housesatsagaponac.com). This development was started by Coco Brown and architect Richard Meier in the early 1990’s. Brown sought to bring together national and international architects, both well known and up-and-coming. Architects involved included Samuel Mockbee, Philip Johnson, Graves, Smith-Miller/Hawkins, and many international participants such as Shigeru Ban, Antonio Citterio, and Jean-Michel Wilmotte. Brown once said about architects: “Architects can be very self-important, dressing in black like priests and making grand abstract pronouncements about how we live and how we ought to live,” he said. “They do have enormous egos” –Coco Brown (gutter.curbed.com)

It would seem that his vision sought to break this “self-important” barrier and asked the architects themselves to create a development that was practical and ego-free. The houses are not hugely over-sized mansions,
but rather modest and contemporary homes designed by a mix of both old masters and talented young architects. After the 34 architects agreed to participate an “owner’s brief,” delineated criteria including restraint of gesture, modesty of size, a sense of introspection, respect for the county setting, and an unpretentious sensibility. The houses are sensitive to the wooded landscape and relatively modest and sensible. Designs range from 2,000 to 4,500 square feet and $1 million to $3 million. The houses are diverse with each adding a completely unique element to the community. The site plan involves a 13-acre reserve with walking paths, vegetable gardens, a tree farm, and a community center. The various designs are in all stages, with some completed and some to never be built (Brown 6-9).

One specific example is the Stan Allen house, completed September 2007. Stan Allen is the dean of the School of Architecture at Princeton University and the principle of SAA/Stan Allen Architect. The 3 bedroom, 3.5 bath has vast open interior spaces encompassing 3,200 sq feet on a 0.92 acre lot. The house is not meant to be a full time living space, but an informal weekend residence (Allen 1). Allen used local traditions by incorporating eastern-cedar-siding and an “active” roofline (Hans 1). Bringing outdoor in, he utilized the wooded setting, creating outdoor courts and gardens integrated into the living spaces, and natural light through the vast number of roof lights, louvers, screens, and battens (Allen 2).

Aric Chen writes in his review “Domestic Architecture Reborn”: Recent decades have eroded much faith in architecture in general, particularly in the United States. Deflated by the failed, mid-twentieth-century experiments of modernism-urban renewal, monolithic public housing projects, empty windswept plazas- the profession found its social mandate largely discredited by the late 1970s.” Chen believes that the houses at Sagaponac is an attempt to break through to the new future of architecture (Chen 10). Unlike previous multi-architect projects (California Case Study Houses, etc) these houses are a more practical, and are “primarily defined by its opposition to the status quo” (Chen 11). They make a legitimate argument for the great benefit that architectural design, even in a domestic setting, can still provide.

The Houses at Sagaponac addresses issues of site, home, materials, and operation design. The first issue is site. The home arrangement is based on existing suburban zoning conditions. The developer stated that avoiding zoning conflicts was one of his primary goals (Brown 7). Because it
doesn’t challenge any preconceived notions of how suburbs should be, the benefits of the projects are limited by this traditional arrangement. The homes are on traditional cul-de-sacs and located at the center of large lots making them isolated from surrounding residences and the community. The tree farms and the community gardens exist on a periphery unused suburban lot. They are not integrated within the community, easily accessible or within walking distance. The homes are conceived of as second homes/vacation homes. The idea of community gardens would require a paid individual or community cooperative to maintain the areas for practical use when other residences are not on-site. Another drawback of the location and nature of the vacation home is the required commute necessary to reach the site. Not only do residence drive to these homes, there is also an airport that many residents can use to fly into their home. This extremely depletes any sense of permanence or investment in the community that living on a day-to-day basis would build. The neighborhood exists as a sculpture gallery for fine pieces of architectural work and not a thriving community.

The individual home design challenges the notions of traditional architecture being produced for the Hampton area. It utilizes solar orientation and views to the site. All home designs are unique to themselves. Even though one of the initial goals was to produce affordable ego-free housing, the homes still manage to have a very high cost per square foot and are unattainable to the average American. With that said, it is still successful in the sense that these are not mega mansions costing gross amounts of money.
The materials used in the Allen house are high-end and durable. This is only possible due to the budget and the purchasing power of the potential user/consumer. There was an attention to local materials such as the use of eastern cedar shake. Using local products supports the local economy as well as reduces environmental impact and transportation cost.

The operation design in the Allen house is affected by a high exterior surface area and high ceilings, which can increase heating and cooling costs. The designer makes an effort to use passive heating and shading devices to reduce this effect. The residence is unoccupied for a large portion of the year and depending on the strategy, may need to be heated or cooled while unoccupied.

The site arrangement is very similar to the Foxpointe layout except that the lot sizes are larger and there was slightly less site clearing. Neither are near existing infrastructure with Sagaponac being even farther from any metropolitan area. Sagaponac considers the house to be a more long-term structure/investment by purchasing materials that have longer life-spans. It doesn’t benefit from the prefabrication and quick assembly that Ryland utilizes when building homes. The goal of Sagaponac was to be entirely unique, however they still fail to involve the client in the design process similar to Ryland. Coco Brown’s focus was purely on architecture as opposed to being purely about the market, like Ryland, but neither wanted a client to get in the way of their goals.

Precedents
Habitat Trails

An example of a community that is designed to serve both people and the environment is the Habitat Trails community designed by the University of Arkansas Community Design Center and associated with Habitat for Humanity. This project consists of 17 units on 5.09 acres, each averaging approximately 1,100 sq feet. In order to keep the project non-profit and affordable, the houses were built at $55.00 per foot.

Project goals included:
1) Establish a repeatable model for affordable neighborhood development that solves for economic, environmental, and social metrics
2) Inflect local municipal codes to allow for low-impact neighborhood technologies involving higher densities
3) Offer high-value residential solutions to under served populations and their surrounding communities.

“In each case UACDC challenged students and clients to break the mold through a design approach that considered the natural and urban or residential environment as well as economic, social and political concerns,” said Catherine Roussel, director of education for AIA. “The results are convincing models that may lead to new, more desirable development patterns” (uark.edu)

The acreage, once farmland, had an existing hydrological drainage, catchment, and recharge pattern. Utilizing this, the storm water runoff generated by the new development will be retained and treated through “contiguous network of bioswale corridors, infiltration trenches, storm water gardens, sediment filter strips, “green streets,” and constructed wet meadow” (ASLA.org). This ecologically based storm water management costs approximately $200/linear foot less than traditional systems. “We explored the concepts for a low-impact development with the CDC, and they brought them to life,” Marty Matlock of the Ecological Engineering Group in the UA Division of Agriculture’s department of biological and agricultural engineering. “We are meeting the regulatory requirements of the city while maximizing ecological services for the community” (uark.edu).

The streets throughout this neighborhood are called “skinny streets,” and are surfaced with pervious grasscrete parking strips and granulated stone which minimizes the use of impervious pavement and also reduces overall noise and motorist speed (ASLA.org). Rather than the standard 30 feet, these streets are only 20 feet wide (uark.edu). These streets are pedestrian friendly and encourage a sense of community. The street becomes part of the community landscape, provides and environmental watershed solution, and adds to the larger local ground-
Figure 37: Habitat Trails Variances

water quality. “It’s kind of like multitasking remediation,” said Mark Boyer, associate professor of landscape architecture. “These native plants work on the water and pollutants, provide aesthetic appeal and benefit birds and animals in the area” (uark.edu).

The Arkansas architecture students placed a large emphasis on the importance of community through unit clustering, one-third of the site is open community space and wildlife habitat. The design aimed to unite public and private spaces and utilized one of the oldest indoor to outdoor design elements, a front porch. The homes seem to reach out to the street, inviting community interaction and also extending the smaller internal spaces while improving ventilation though the home (ASLA.org). Shared landscapes, walking trails, playground, and cookout facilities allow for limited private resources to be extended, and residents are able to enjoy an amenity-rich neighborhood (ALSA.org). “This takes us to a whole new level,” said Debby Wieneke, executive director of the Benton County chapter of Habitat for Humanity. “Normally we have one simple home on one lot. Now boom: we’re going to put 17 families on five acres with a wetlands area in one corner, a neighborhood park in the middle, and a vast variety of plants, trees and landscaping that we’ve never had an opportunity to do before” (uark.edu).

In order for this project to work with its small streets, non-conforming runoff treat-
ments, and alternative impervious surface materials, it was critical that local government, fire departments, water and utilities departments, and street department needed to be involved. Variances from the local code were needed to proceed with these unique ideas.

Habitat Trails will be used as a precedent for its attention to site, home and details. The site is a new development on the outskirts of an existing community. It was once farmland, so to respect this, the UACDC made it a goal to maintain previous hydrological patterns while at the same time reducing actual drainage cost. The goal of the grasscrete was to have a more permeable driving surface and by doing so, they were able to narrow the driving section and separate driving areas from parking areas. By separating parking areas from the driving areas it has decreased speed and encouraged walking. To achieve these goals they identified needed variances in existing code to create a better solution for the users and the site. The home arrangement is designed around a community area, which allows for an increased sense of ownership and community interaction and gives children a place to play.

The homes are a mixed of single family and duplex units. This allows density to remain higher while minimizing impact on the site. The porches are designed as a critical social and sustainable element. Homes are very inexpensive and are built by other community members and the owners themselves through sweat equity. This gives the owners pride and investment in both the community and their own home. Homes are financed at an extremely low cost, which is half what most homes can be built at. They utilize outside labor trades who discount their building rates. Habitat for Humanity also accepts material donations to lower cost.

Operations of the water cycle occur uniquely through the existing storm water collection and reduce overall cost by $200. Although the site water usage was improved, the homes and residents had an opportunity to further this process by collecting, treating and recycling individually. For example, gray water systems could have been utilized to reduce wastewater amounts.

In comparison to Foxpointe this site has given particular attention to existing land patterns, community needs, and has managed to keep housing prices at almost half of what most houses in the Foxpointe community are being built at. They directly involve the homeowner in not only design decisions, but also the actual construction itself. The community areas are not small second-thoughts, but are actually part of the site organization and central to the design. Rather than clearing that area and using existing ideas for housing development, Habit Trails sought to re-think current development standards, most impressively water management. They provided a water solution that not only restored its previous site flows but lowered cost and increased the sense of community, all within the same strategy. The development and execution of these new ideas took time and the involvement of the government and code officials, something most likely only a non-profit or educational facility would spend the time or energy to do.
“Foster a sustainable urban neighborhood that promotes social, economic, and fun-filled lives contributing to preserving the planet” (www.enrightridgeecovillage.org)

Jim Schenk and his wife moved to East Price Hill 31 years ago. He wanted a place that valued green living, organic food, resource conservation, alternative energy and cooperative relationships. His wife, having grown up in the city, felt what better place than Price Hill. In 1978 they founded Imago, a nonprofit educational organization in Price Hill. “Our idea was to look at how we would live if we held the Earth and its people as sacred, and offer workshops and conferences about sustainability.” (Schenk 1) They purchased an eight-acre stretch on land on Enright and began an outdoor Earth center.

In 1993, with the desire to take their dream further and a group of residents empowered by their dream, Imago sought a very ambitious goal to transform a 50-block area into an eco-village. Unfortunately, due to a lack of a larger majority resident commitment and the influx of transient renters, this project was unsuccessful (Schenk 1).

Even after a disappointing 6 years the Schenks were not yet ready to give up. They had been watching houses age and deteriorate, and a once strong owners markets turn to rentals and foreclosures. In spring of 2004, Imago and a small group of residents on Enright formed the Housing Task Force and started purchasing and renovating high-risk houses on the street (Howell). Goals were to improve the image of the street both among residents and those off the street, to create a walking trail through the woods around Enright, to have shared meals with residents, and to foster a better relationship between children and adults. Their mission statement: “Enright Ridge Eco-Village, a community inspiring Earth-friendly living, nurtures an intimate and prosperous neighborhood within its uniquely forested urban setting in Price Hill in Cincinnati, Ohio” (Schenk 2).

Over the next 4 years their efforts grew as more and more Enright residents began working together towards these shared goals (Howell). Today this group seeks to purchase houses on the brink of foreclosure for less than market value and renovate them with deliberate efforts to use environmentally friendly appliances and materials (Howell). Renovation goals included insulation, energy efficient HVAC, new windows, energy star appliances, recycled carpeting, no VOC paint, CFL light bulbs, weather stripped exterior doors, dual flush toilets, solar assisted hot water, no mow landscaping, and low flow showerheads (www.enrightridgeecovillage.org).

The community has 4 committees including housing, promotions, and environmental green group. The committees work on projects that increase the safety, beauty, energy efficiency and value of Enright Ridge. Most of the 90 families living on this street are engaged in community enrichment and green activities. The promotions committee organizes community breakfasts and dinners, 15 residents participate in a food co-op.

Figure 39: Logo and street planter

Figure 40: Jim Schenk
supplied by an organic grocer, 3 residents have installed rain gardens to differ rainwater runoff. To encourage environmentally friendly transportation, a bike shed is being installed at the top of the street (Howell). The core leadership group also educates other residents on the street about home energy goals with information on alternative power, and encouraging neighborly sharing (Howell). The village also contains Imago (www.imagoearth.org), a 16-acre nature preserve with hiking trails and educational programs, and the Cincinnati Zen Center (www.cincinnatizencenter.org).

When asked why he (Schenk) didn’t just build an eco-friendly community from scratch in a rural area, Schenk stated: the majority of people in our country and in the world now live in urban areas. Urban sprawl and the destruction of habitat, excessive energy consumption and loss of community can be reversed if we can make our urban neighborhoods life sustaining. We can change the face of our cities and our country side if we are successful (Schenk 6).

The elements used from Price Hill Eco Village are site, home and details. This precedent is an existing urban restoration. It is a small grass-roots movement among a small group of residents to restore urban infrastructure. They maintain private ownership, but they add value to the community by collectively agreeing on how the houses will be renovated and who will buy them. The site is not only anti-sprawl, but encourages individuals who have left the urban area to return due to the new and exciting ideas.

The homes are existing structures built around the early twentieth century. The renovators choose the homes, update them and then put them back on the market. The materials used in the renovation process are updated and strive to be more environmentally friendly than what was previously there. Residents are then educated after purchase to incorporate additional measures for energy conservation and water conservation. All of these items are voluntary, so the individuals purchasing the property do not necessarily uphold them.

Price Hill Eco Village is an example of existing structures being renovated to enhance a cumulative desire of increase community, happiness and benefit the environment. Price hill Eco Village offers a glimpse of what Ryland homes could be in 100 years. Price hill was once urban sprawl itself, only difference is, are the Ryland homes even able to last as long that they will need updating and be livable? Unfortunately, the overall sense from this precedent is that without Mr. Schenk this movement would likely fizzle and die.
What is Co-Housing?

Initially, the concept of co-housing “bofællesskaber” began in Denmark and it has gradually spread to other countries and continents. Cohousing concepts aim to re-establish many of the advantages traditional villages had in the context of life today. With suburban sprawl of single-family houses consuming massive quantities of land and energy, higher-density multifamily housing can preserve land and open space, as well as facilitate effective mass transit. These communities can range from 6 to 40 households and unlike most intentional communities and communes we know in the U.S., cohousing only seeks to offer a new approach to housing, not a new way of life or ideology (McCamant & Durrett 11-19).

These developments redefine the concept of neighborhood to fit contemporary lifestyles. They combine the autonomy of private dwellings with the advantages of community living. McCamant & Durrett write in their observations of cohousing in Denmark, “each household has a private residence, but also shares extensive common facilities with the larger group, such as kitchen and dining hall, children’s playrooms, workshops, guest rooms, and laundry facilities.” Each private dwelling has much of its own to be sufficient including its own kitchen, but the common facilities provide opportunity for community dinners, and important aspect to the neighborhood for social and practical reasons. Shared ownership also includes tools, typewriters, camping equipment, and even vacation homes. The sharing of resources gives all residents access to wider variety of conveniences at a lower cost per family than previously possible. In the United States we already see variations to this theme in congregate housing for the elderly and shared housing where multiple families share one space. Cohousing combines the advantages of an intergenerational community while maintaining the autonomy of private dwellings (McCamant & Durrett 199-205). In general a cohousing community has:

1. Participatory Process: Residents participate in the planning and design of the development so that it directly responds to their needs.
2. Neighborhood Design: The physical design encourages a sense of community.
3. Private Homes Supplemented by Extensive Common Facilities: Each household has a private residence - complete with a kitchen - but has access to all of the common facilities. The common house is designed for daily use and supplements private living areas. Facilities often extend beyond the common house to include children’s play areas, vegetable gardens, and the like.
4. Complete Resident Management: Residents take complete responsibility for on-going management, organizing cooperatively to meet their changing needs.
5. Non-Hierarchical Structure: While there are leadership roles, responsibility for the decisions are shared by the community’s adults.
6. Separate Income Sources: There is no shared community economy.

(www.gocoho.org)
Resource sharing is the most obvious advantage to cohousing, but the social atmosphere also offers its own advantages. The community’s design encourages social interaction by providing small courtyards along walkways, common facilities, picnic tables, and garden areas directly outside each house. One resident stated “our primary motive for wanting to live in a community was the desire for a richer social atmosphere, for both children and adults. The many practical advantages which we later discovered, we hadn’t even thought of in the beginning” (McCamant & Durrett 29).

In the United States, new forms of housing are needed and inevitable, and cohousing is an appropriate and applicable model. The average size of the American household continues to decline from 5.8 in 1790 to 2.6 in 1990 (McCamant & Durrett 29). This trend goes against previous centuries of multi-generational, multi-family living. The idea that the nuclear family should live on its own without the support and assistance of the extended family or surrounding community is a relatively new concept, even in the U.S. Each household is expected to prepare its own meals, do its own shopping, and own one of every needed appliance regardless of the number of occupants. We have also become increasingly reliant on purchased childcare and expensive pre-packaged meals. With the increasing cost of living, this puts great financial demand on these smaller households (McCamant & Durrett 199-205).

When preparing a development plan for cohousing, you must define the group’s goals, priorities, financing capability, and design. The program should allow new members to be easy integrated and focus on less time consuming construction and costs. Social characteristics, general design criteria, common facilities, individual residences, outdoor areas, construction, and financial expectations are all outlined in the program. The plan should also involve a mission statement, or a definition of the communities environmental, financial, and social objectives (McCamant & Durrett 160-165).

Financing a cohousing development can seem tricky, with all of the different individual interests involved. One way to simplify this is to organize the community as a cooperative. With this option, the entire community is owned by the residents as a nonprofit corporation, and each household buys a share in the corporation equivalent to the price of their home (McCamant & Durrett 235). Other compromises come in limiting the number of custom features. McCamant and Durrett state the most effective way to keep housing prices down is to have a few set floor plans repeated over and over versus every home being custom.

Great Oak Cohousing
Completed in 2003 on 7 acres, Great Oak Cohousing in Ann Arbor, Michigan is home to 98 residents. The 12 buildings include 37 townhouse style residences and common buildings. Each resident is expected to give 7 hours per month of labor to the collaborative good of the community (directory.cohousing.org). This can include preparing meals, childcare, or arranging community events. Shared community meals occur 5 times per week with 5% of the food grown on-site. The common house includes an industrial kitchen, laundry room, dining...
The community utilizes a Solar Hot Water system that augments the natural gas powered water heaters. 2 rebates from the state of Michigan totally $2800 brought the total installed cost to $3740. With an expected energy production equivalent of 144ccF of natural gas, they estimate the payback period to be 26 years (www.gocoho.org).

Great Oak is based off of Sunward cohousing, also in Ann Arbor. Two members of this community, watching the desired resident waiting list grow to over 40, decided to use the knowledge they learned from Sunward and help bring a new cohousing development to the area. They formed the Cohousing Development Company (CDC) with a local builder Bill Kinley. By February 2001 four households had put money down for a unit and 25 others were also signed on. Architects began working with the CDC to create an ecologically-sensitive building and site design that preserved the land’s natural beauty as much as possible, while also creating an intergenerational, friendly atmosphere (www.gocoho.org).

**Precedents**

**Aranya Community Housing**

In the early 80’s Balkrishna Doshi set out to understand the huge boom in squatter settlements in India. Due to population growth and a lack of economic development, large numbers were migrating to the cities and building homes of industrial waste, cardboard or whatever was available (Indiabuildnet.com). Doshi and his team developed multiple studies on this phenomenon including “Low Cost Housing”, “Integrated Rural Development Plan for the Village Charodi”, “Centre for Community Welfare and Employment Training Bengre.” They discovered that many of these “shacks” often doubled as living and working places, some even have public amenities such as trees and are protected from the street by a zone of transition (Indiabuildnet.com). Most areas also have a rear access alley and open to community shared areas. The largest element always missing seemed to be utilities, essential for a healthy community (Steele 116). Previous government attempts to create low-income housing were ridged, grid-like and with relatively high costs (Steele 118).
Trying to tackle this problem of housing the poor and improving social harmony at a time of rising social strife, Doshi projected a site in Indore India roughly 197 acres which would contain 605 apartments divided into 11 blocks for both middle income and low income people (Indiabuildnet.com). The four general goals were (1) to create a township where a sense of continuity and fundamental values of security exist in a good living environment; (2) to achieve a community character by establishing harmony between the built environment and the people; (3) to create a balanced community of various socio-economic groups, encouraging cooperation, tolerance and self help generated through physical planning process; and (4) to evolve a framework through design, where incremental physical development can take place within legal, economic, and organizational guidelines (Steele 119). The design also included amenities such as plumbing, washroom, kitchen, and a single room that would be extended to the inhabitants in that surrounding cluster (Indiabuildnet.com). With these basics pre-assembled the home owner is then free to follow standardized requirements, but vary endlessly in what they build. The demonstration houses illustrate the array of options and emphasize family and neighborhood (Davidson 69). Materials to construct a house may be purchased from a co-operative with a payment plan and they are free to use any material they choose. Since few purchasers have construction skills, schemes also provide training programs to teach buyers building techniques (Steele 120).

A hierarchy of payment schemes reflects the income levels of the various groups, and makes a variety of site and service options available. The down payment was based on the average income of the family and the loan balance pain in monthly installments (Davidson 70). Socially, this development, through creation of common spaces, brings together different religions and socio-economic groups allowing for cross-subsidies, financial viability, co-operation, neighbourliness, tolerance and cohesive social relationships (Davidson 65).

Analysis to be added.
Design Project

Introduction

The goals for the design project are listed in three categories: Sustainability, Marketability, and Community.

Sustainability: Achieve a greater sense of balanced natural values.
Marketability: Increase design value while producing a more competitive home.
Community: Obtain a greater balance between individual and community aspirations.

The design portion of the project seeks to integrate the sustainability tools and marketability tools with a realistic potential housing development in the Clifton neighborhood of Cincinnati, Ohio. Like the research, the analysis focuses on four major scales: context, site, home, and detail. The design process differs by not looking at each scale independently but by investigating interactions between the two progressive scale levels which are defined as the context + site, the site + home, and the home + detail interactions. For each of the interactions a series of typologies were developed which seeks to isolate a range of possibilities within each architectural decision. Within the range, each decision is ranked based on research in terms of sustainability, marketability and community.

Initially, all of the typologies at all three scale-interactions are used to evaluate the status quo. This is to be used as a baseline for the success of the final output, and is meant to represent a standard National Association of Home Builders (NAHB) member development. In order to isolate decisions one interaction will be changed at a time in succession, beginning with the status quo, altering to the context + site, again reevaluating to the site + home, and finally ending with the home + detail interaction. The final outcome will be to generate a scheme competitive to the status quo, with an overall higher level of sustainability, marketability, and community.

Design Project

Typologies

The context + site interaction typologies look at conditions where the development site and the surrounding community connect. This is done in terms of energy + distribution, water + distribution, waste + distribution, location + proximity, location + property values, and site + public access. Energy + distribution looks at home the development receives electricity and how it is distributed within the community. The channels of distribution range from centralized power production, then networked independent production, and then isolated home power production. Water + distribution identifies the source and means of the development’s water supply. It ranges from centralized purification and distribution, then local well tapping, to independent rain collection. Waste + distribution analyzes how the community’s waste is managed. The options begin with a centralized processing plant, to local septic and pumping, and finally local remediation. Location + proximity looks at the minimum distance it takes to get from the development to get to the closest grocery, school, worship center, library, park, medical facility, restaurant, post office, fire station, and public transportation. The range for these amenities goes from a one mile radius, to a two miles radius, to a four mile radius, and finally an eight mile radius. Location + property values investigates the minimum distance to a range of homes valued from less than 100k to homes valued greater than 500k. The distance between the range of property values is listed
in terms of a one mile radius, two mile, four mile, and eight mile radius. Site + public access evaluates how the proposed development’s streets interact with the existing community fabric. The development possibilities include no outlet streets, through streets, and extension of the community block system. These are all ranked in terms of sustainability, marketability, and community.
The site + home interaction typologies look at conditions where the development site interacts with the individual homes. This is investigated in terms of energy + source, home + slope, home + neighbor, home + parking, rental + owned, home + orientation, road + sidewalk, and home + food source. Energy + source looks at the type of energy each individual home chooses to use. The sources include fossil fuels, geothermal, solar, and wind energy. The home + slope analyzes how the home attaches to the ground. The conditions range from a leveled site, to a terrace site, to an excavated site, and finally columns connecting to the ground. Home + neighbor evaluates how closely each home is physically connected. The possibilities range from isolated homes, to alley separated, to attached, and then stacked. Home + parking looks at how cars are stored for a home. The options range from indoor garage, street parking, to communal lots. Rental + owned investigates how ownership is mixed within the community. The options are isolated rental and owned, to mixed rental and owned occupancy, and finally attached rental and owned uses. Home + orientation looks at how the building is placed on the site. This is done in terms of a random orientation, topography based orientation, and solar based orientation. Road + sidewalk looks at how the paving surfaces interact with one another. These range from a buffered separation, to continuous pavement, mixed low traffic, and finally pedestrian oriented. Home + food source investigates how the home consumes food. Options range from externally prepared food, to shared food within the community, and finally individual production.

The home + detail interaction typologies look at conditions where the individual homes interact with the construction details. This is done in terms of energy + delivery, home + construction method, wall + view, roof + shelter, wall + material, wall + protection, retaining walls, and road + surface. Energy + delivery looks at how energy is distributed through the home. Options are forced air, and radiant, and then passive heating and cooling. Home + construction method investigates assembly methods for the individual home. These range from stick framing, prefabricated panels, and modular components. Wall + view analyzes the percentage of window. This can range from 10%, 40%, to 75% glass. Roof + shelter looks at different material types for roof cladding. Options are asphalt shingles, wood shingles, metal seams, and finally continuous rubber. Wall + material investigates the exterior wall cladding surfaces. They range from synthetic, wood, metal, and finally brick. Wall + protection evaluates the type of exterior wall assembly including barrier wall, rain screen wall, mass wall, and a low energy assembly wall. Retaining walls look at different methods for retaining earth. Options are cast concrete walls, stacked unit walls, and vegetated slopes. Road + surface looks at methods for paving road areas. These include poured paving, opening joint paving, and finally loose laid aggregate. These elements are all rated based on their sustainability, marketability, and community.
## Home + Detail

### Energy + Source

- **Fossil Fuels**
- **Geothermal**
- **Solar**
- **Wind**

### Home + Slope

- **Level**
- **Terrace**
- **Excavate**
- **Columns**

### Home + Neighbor

- **Isolated**
- **Alley**
- **Attached**
- **Stacked**

### Home + Parking

- **Garage**
- **Street**
- **Communal**

### Rental + Owned

- **Isolated**
- **Mixed**
- **Attached**

### Homes + Orientation

- **Random**
- **Topography**
- **Solar**

### Road + Sidewalk

- **Buffer Separation**
- **Continuous Pavement**
- **Mixed Low Traffic**
- **Pedestrian Oriented**

### Home + Food Source

- **Prepared**
- **Shared**
- **Individual**
Initially, all of the typologies at all three scale interactions are used to evaluate the status quo. This is to be used as a baseline for the success of the final output, and is meant to represent a standard National Association of Home Builders (NAHB) member development.

The context map shows the location of all of the current NAHB member developments in the Cincinnati area. The absence of these developments within city limits is readily apparent.

The sample development plan represents a basic layout for one of these communities. The 2300sq foot homes are layout out on _ acre lots.

The axonometric view represents the interaction of the homes to the site. The site is generally leveled or developed on previously leveled farm land.

The section is meant to display the detail decision for the homes typically found in one of the NAHB developments.

The status quo is given a rating based on the typology decisions across all three interaction levels. For the average home, minimum income level is calculated to be $48,950/year.
The context + site interaction maintains all of the qualities of the status quo, except for the location of the development site.

An urban infill site is chosen to maximize the sustainability, marketability, and community available to the development. The plan conforms to local building and zoning codes, but the high development cost for maintaining these standards make the average home price $579,000. This is more than double the competitive status quo model.

The solution is rated in terms of its sustainability, marketability, and community. For this average home, the adjusted minimum income is calculated to be $107,200/year.
Design Project
Site + Home

The site + home interaction maintains all the qualities of the context + site solution, except for the decisions regarding the homes connection to the site.

In this design the homes interaction to the site is minimized by using the typologies chosen to improve the rating. These typologies are indicated on the axon.

The plan view shows how different income levels and home values were mixed across the site.

The solution is rated in terms of sustainability, marketability, and community. The adjusted minimum income is $77,157/year.

### Design Project
Site + Home

<table>
<thead>
<tr>
<th>Site Size</th>
<th>25 acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Homes</td>
<td>88</td>
</tr>
<tr>
<td>Development Costs + Revenue</td>
<td></td>
</tr>
<tr>
<td>Land</td>
<td>$2,500,000</td>
</tr>
<tr>
<td>Roads+Utilities</td>
<td>$3,000,000</td>
</tr>
<tr>
<td>Fees + Carrying</td>
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</tr>
<tr>
<td>Construction</td>
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</tr>
<tr>
<td>Home SF</td>
<td>2,500 sf</td>
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<tr>
<td>Total SF</td>
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<tr>
<td>Cost / SF</td>
<td>$130 /sf</td>
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<tr>
<td>Total</td>
<td>$28,600,000</td>
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<tr>
<td>Total Costs</td>
<td>$35,600,000</td>
</tr>
<tr>
<td>Profit</td>
<td>$3,560,000</td>
</tr>
<tr>
<td>Total Revenue</td>
<td>$39,160,000</td>
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</table>

### Individual Home Pricing
- Costs per House: $404,545
- Profit per House: $40,455
- Average Home Price: $445,000

### Homebuyer Financing
- Down Payment (20%): $89,000 20%
- Financing (80%): $356,000 80%
- Mortage Payment: $2,368 /mo

### Monthly Operating Expenses (CPI %)
- Housing: $2,368 34%
- Transportation: $1,061 15%
- Food: $848 12%
- Apparel/Services: $2,47 9%
- Heating + Cooling: $100 1%
- Monthly Expenses: $4,625 63%
- Monthly Expense Savings: $640 9%

### Household Income Affordability
- Yearly Min. Income (Mortgage Based): $84,841
- Yearly Expense Savings Increase: $7,684
- Adjusted Min. Income: $77,157 /yr
The home + detail interaction maintains all the qualities of the site + home solution, except for the decisions regarding the details of the individual homes.

In order to improve the overall marketability, sustainability, and community rating in this design, the typology decisions are shown in the section.

The plans show three home options for different property values specified across the site. These are meant only to be examples of how to meet the criteria at the detail level.

The solution is rated in terms of sustainability, marketability, and community. The adjusted minimum income is $58,720/year, only $9,000 more than the status quo, making this a competitive solution.

### Design Project

#### Home + Detail

The home + detail interaction maintains all the qualities of the site + home solution, except for the decisions regarding the details of the individual homes.

In order to improve the overall marketability, sustainability, and community rating in this design, the typology decisions are shown in the section.

The plans show three home options for different property values specified across the site. These are meant only to be examples of how to meet the criteria at the detail level.

The solution is rated in terms of sustainability, marketability, and community. The adjusted minimum income is $58,720/year, only $9,000 more than the status quo, making this a competitive solution.

### Site Size
- 25 acres

### Number of Homes
- 88

### Development Costs + Revenue

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost 1</th>
<th>Cost 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land</td>
<td>$2,500,000</td>
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<tr>
<td>Roads + Utilities</td>
<td>$2,000,000</td>
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<tr>
<td>Fees + Carrying</td>
<td>$1,500,000</td>
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<td>Construction</td>
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<td>Total</td>
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<tr>
<td>Total Costs</td>
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<tr>
<td>Profit</td>
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### Total Revenue
- $32,736,000

### Individual Home Pricing

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<tr>
<td>Costs per House</td>
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<tr>
<td>Profit per House</td>
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### Average Home Price
- $372,000

### Homebuyer Financing

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<tr>
<th>Description</th>
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<tr>
<td>Down Payment (20%)</td>
<td>$74,400</td>
<td>$120,000</td>
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<tr>
<td>Financing (80%)</td>
<td>$297,600</td>
<td>$270,000</td>
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</table>

### Mortgage Payment
- $1,980 /mo

### Monthly Operating Expenses (CPI %)

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount 1</th>
<th>Amount 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housing</td>
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<td>$2,000</td>
</tr>
<tr>
<td>Transportation</td>
<td>$591</td>
<td>$600</td>
</tr>
<tr>
<td>Food</td>
<td>$591</td>
<td>$600</td>
</tr>
<tr>
<td>Apparel/Services</td>
<td>$148</td>
<td>$150</td>
</tr>
<tr>
<td>Heating + Cooling</td>
<td>$100</td>
<td>$100</td>
</tr>
</tbody>
</table>

### Monthly Expenses
- $3,410

### Monthly Expense Savings
- $1,017

### Household Income Affordability

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount 1</th>
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<tbody>
<tr>
<td>Yearly Min. Income (Mortgage Based)</td>
<td>$70,923</td>
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<tr>
<td>Yearly Expense Savings Increase</td>
<td>$12,203</td>
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<tr>
<td>Adjusted Min. Income</td>
<td>$58,720 /yr</td>
<td></td>
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</tbody>
</table>
Initially it was assumed that sustainability was an additional cost to a home. Traditional marketing methods looked at the up-costs of added sustainability. Through this design it has been shown that by careful typology decisions within the scale interactions, it is possible to produce an architectural solution that utilizes sustainability and market forces to create competitive housing and community alternatives. From the status quo to the final solution, the average home price increase $113,250, but by accounting for sustainability, marketability, and community savings in terms of housing, transportation, food, services, and heating/cooling, the adjusted minimum income increased by only $9,000/year. This results in a competitive alternative to the status quo but with an even higher level of balance between individual and community aspirations, and a greater sense of balanced natural values.


Ohio Board of Building Standards. History and Development of the Ohio Building Code and Ohio’s Relationship with Model Codes from BOCA and ICC. Ohio, Board of Building Standards.


