10-2011

Barriers to Implementation of Sustainable Construction Practices in the Homebuilding Industry: A Case Study of Rochester, NY

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BARRIERS TO IMPLEMENTATION OF SUSTAINABLE CONSTRUCTION

PRACTICES IN THE HOMEBUILDING INDUSTRY:

A CASE STUDY OF ROCHESTER, NY.

by

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A THESIS

Presented to the Faculty of

The Graduate College at the University of Nebraska

in Partial Fulfillment of Requirements

For the Degree of Master of Science

Major: Architecture

Under the Supervision of Professor Mark Hinchman

Lincoln, Nebraska

September 2011
This study will evaluate the current barriers to standardization and widespread implementation of sustainable practices in the residential homebuilding industry. A literature review evaluates and defines the relevant tenets of sustainability creating a cohesive definition of sustainable building practices for the purposes of this study. These defined features were used to evaluate current practices and certification programs. An analysis of the current scholarship on barriers to sustainable development combined with this information to create a framework for a case study of homebuilders and their practices in the greater Rochester, New York area. This study was conducted in order to ascertain the understanding, attitudes, perceived barriers and extent of application, of sustainable practices within the greater Rochester marketplace. The study identified
several barriers to the standardization of sustainable development within the market but
the most prevalent was the lack of information that would allow practical implementation
of practices, clarify the reasoning behind the need for these practices and the benefits to
the trade. Most notably over 87% of homebuilders did not perceive residential housing
as having any negative impacts on the environment. Educational systems and
certification programs have failed to communicate effectively a comprehensive view of
sustainability. These information gaps extended to create and enhance known
infrastructure issues and perceived market barriers to sustainable development. The
intent of this research is to clearly identify the barriers to sustainable development within
the homebuilding marketplace creating a basis for the trade to address these issues.
Understanding these barriers will establish a path to overcoming these impediments
allowing the market to open up to widespread implementation of sustainable practices.
The negative impacts of housing are palpable. Clearing the barriers to standardization of
sustainable residential development practices will negate these impacts to both the
ecological and built environments, benefitting the health of both the planet and its
inhabitants.
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Introduction:

Since the post World War II inception of Levittown, the American suburb has grown exponentially. As post war standards gave preference to the affordable single-family detached dwelling in residential neighborhoods, homebuilding practices shifted. Quick and inexpensive building methods took center stage to meet the explosive demands for housing in suburban areas. This established the consumptive mass-produced homebuilding practices, which since have become the standard for residential development.

In April 2011 alone, over 550,000 privately owned homes were built in the United States. This fast paced growth of the built environment has palpable effect on the ecology through destruction of ecosystems, reduction of virgin lands, depletion of natural resources, and inherent energy usage. The impacts of the buildings on the natural environment have long been understood. This knowledge has propelled commercial and institutional sectors of development to be focused on promotion of sustainable building

1 U.S. Census Bureau, U.S. Department of Housing and Urban Development, np.
practices. Certification programs such as the U.S Green Building Council’s Leadership in Energy and Environmental Design (LEED) have taken the lead role in promoting standardization of sustainable development practices in this sector of the industry.

Although LEED has gained widespread acceptance in the commercial and institutional sectors, its application within the residential sector has been minimal. There are many certification programs that attempt to lead the residential homebuilding industry to improved sustainability in their practices, however with the exception of ENERGY STAR which offers minimal benefit to the field of sustainability, none have achieved widespread acceptance.

Determining the barriers impeding the residential homebuilder from standardizing sustainable development practices is key to altering this deficit. The principles of sustainable development are not clearly understood by the average homebuilder. Current construction practices focus mostly on energy efficiency. But the industry, out of ignorance or misunderstanding, has ignored other aspects of sustainability including:
reduced natural resource consumption, and human health within the macro and microenvironments.

In looking into the history and patterns of sustainable building practices in the residential construction industry, it is clear that the majority of case studies in the residential sector are focused on energy efficiency: primarily, zero-net energy homes. Although this is an important factor which positively impacts the industry, environment, and the inhabitant, it does not address sustainability as a whole. This has led to the concern that sustainable development practices within the homebuilding industry are concentrating solely on energy efficiency, which is a rather myopic view of the field. As this has become clear in the literature, it is obvious that there are many conflicting views as to what denotes sustainable building.

In order to clarify and direct this research practically, there is a need to define the tenets of sustainable building practices. The word is bandied about through the literature with varied meaning, which needs to be derived from each independent study. Few
incorporate a definition beyond the statements derived from the Brundtland Commission report, which very broadly states:

“Sustainable development seeks to meet the needs and aspirations of the present without compromising the ability to meet those of the future.”\(^2\)

Sustainability is still a topic that remains in contention. There remain many grey areas to defining sustainable features that find the balance between protecting ecology, societal interests and the economy. The literature does not establish an affirmed boundary of the tenets of sustainability therefore the best practices for implementation within the homebuilding industry remain vague.

The public’s growing awareness of environmental quality and rapid growth in the general marketplace of environmentally friendly products has propelled sustainability to the forefront of national dialogue. Although many consider this movement towards sustainability to be a trend, statistics show that green construction will become mainstream throughout the industry.

\(^2\) World Commission on Environment and Development, 1.49.
Determining builders’ attitudes, knowledge base and factors that are potentially impairing their practical evolution towards sustainability is essential to creating a clarified path for the industry to alter their methods. A shift to standardization of sustainable practices within the homebuilding industry will not only create a method of branding for developers but also allow them to fully take advantage of the market growth potential for sustainable development. Developers, who delay integration into this system, risk becoming antiquated in their practices putting their brand in jeopardy.

This study will determine the current barriers to standardization and widespread implementation of sustainable practices in the residential homebuilding industry. The study will begin with an evaluation of the broad principles of sustainability, and how they affect residential construction practices. This will result in a template for analysis of the homebuilding industries’ implementation of these principles. The primary programs currently enacted to promote and oversee green construction practices in the homebuilding industry will be briefly reviewed for compliance with the basic standards of sustainability. Further, the barriers to standardization of sustainable development in the homebuilding industry will be identified including information gaps, infrastructure
issues and marketability. This conceptual work collectively coordinated practical research in the form of a survey of homebuilders to evaluate the current knowledge base, attitudes, status of practice and perceived barriers within the greater Rochester, New York area.

The intent of this research is to clearly identify the barriers to standardizing sustainable development in order to create a basis for the trade to address these issues. Understanding these barriers will lead to more sustainable homes, improving both the macro and microenvironments, inhabitant’s health and promote growth in the currently struggling homebuilding industry.

For the purposes of this paper, the terms “sustainable” and all variations will be interchangeable in intent and meaning with the term “green”.
PART I : Defining and Evaluating Sustainable Development Practices
Chapter 1: Getting a Grasp on Sustainability

A Brief History

In 1983, the World Commission on Environment and Development convened to address the growing concerns of worldwide degradation of the environment and its potential consequences on society. Tasked with creating a focused international aim towards achieving sustainable development by the turn of the new millennium, the commission’s report, *Our Common Future* (also known as The Brundtland Commission Report), proposed a path for achieving this goal. The Commission’s aim of environmental focus was not intended to reverse the forward motion of industrialized society, but to create a coalition and symbiosis between societal needs and the environment:

“From space, we can see and study the Earth as an organism whose health depends on the health of all its parts. We have the power to reconcile human affairs with natural laws and to thrive in the process. In this our cultural and spiritual heritages can reinforce our economic interests and survival imperatives.
This Commission believes that people can build a future that is more prosperous, more just and more secure. Our report *Our Common Future*, is not a prediction of ever increasing environmental decay, poverty and hardship in an ever more polluted world among ever decreasing resources. We see instead the possibility for a new era of economic growth, one that must be based on policies that sustain and expand the environmental resource base.”

This report set the path towards creating an international discourse on sustainability: a discourse that is still primary in the international vocabulary.

**What is “Sustainable” and How Does it Apply to Development?**

The basic tenets of sustainability can be derived from analysis of the multiple efforts put forth by the United Nations in establishing a worldwide dialogue on the subject. An objective review of the major United Nations documents addressing sustainability put forth beginning with *Our Common Future* in 1987, creates a simplified matrix of the basic tenets of sustainable practice (Table 1). These basic principles will form the boundaries for which we will examine sustainable development practices.

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3 World Commission on Environment and Development, sect 4, par 2,3.
Table 1.1

<table>
<thead>
<tr>
<th>Natural Resource System</th>
<th>Desired Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy</strong></td>
<td>Generate clean and efficient energy to meet the needs of humanity with a focus on developing and implementing economically viable, non impacting alternative sources and reducing emissions of green house gasses (GHG’s)</td>
</tr>
<tr>
<td><strong>Air</strong></td>
<td>Sustain clean and healthy air. Alter industrial patterns to reduce and eliminate harmful emissions.</td>
</tr>
<tr>
<td><strong>Water</strong></td>
<td>Sustain water resources ensuring quality and availability.</td>
</tr>
<tr>
<td><strong>Materials (Natural Resources)</strong></td>
<td>Do more with less. Alter industrial patterns to reduce and eliminate unsustainable patterns of production and consumption. Promote resource efficiency and renewable resource systems.</td>
</tr>
<tr>
<td><strong>Land</strong></td>
<td>Support ecologically sensitive land management and development. Eliminate practices that promote undue taxation to the land and incite deforestation, desertification and loss of biodiversity.</td>
</tr>
<tr>
<td><strong>Ecosystems</strong></td>
<td>Protect and restore ecosystem functions, goods and services. Support biodiversity.</td>
</tr>
</tbody>
</table>

The 2005 World Summit Outcome (WSO), drafted by the General Assembly of the United Nations identified three interdependent components of sustainable development:

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5 United Nations General Assembly; United Nations General Assembly; World Commission on Environment and Development
economic development, social development and environmental protection. John Elkington translated this idea, as the oft-quoted phrase: “planet, people and profit” which defines the triple bottom line of greening society. This holy trinity of incorporating ecological stewardship, societal interests and the needs of business for profitable enterprise will be the basis for defining realistic sustainable development boundaries.

The United Nations, the EPA and the United States Government all support this symbiotic binding of economy and ecology. The Federal government defines the term ‘sustainable’, as “…create[ing] and maintain[ing] conditions, under which humans and nature can exist in productive harmony, that permit fulfilling the social, economic, and other requirements of the present and future generations of Americans.” Efforts to reverse negative environmental impacts will never be practicable without economic incentive to business, meeting the needs for profit and growth and stirring commitment by the public.

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7 United Nations General Assembly, 12.
8 Elkington, np.
9 The President (George W. Bush), 3922, The President (Barak H. Obama), 52126.
The impacts of residential housing on the environment and consumption of natural resources are tangible. Over 7.1 million new housing units were built in the United States between the years of 2005 and 2009.\(^\text{10}\) Residential buildings accounted for almost twenty-one percent (21\%) of total U.S. energy consumption in 2005: surpassing commercial buildings.\(^\text{11}\) In 2006, residential structures expended over one-half of the overall electricity consumed by buildings in the U.S.\(^\text{12}\) Water consumption numbers are similar, as residential use accounts for over seventy-four percent (74\%) of the total building water usage in the U.S.\(^\text{13}\) Landscaping alone accounts for thirty percent (30\%) of this water consumption. The U.S. Environmental Protection Agency cites: “A typical suburban lawn consumes ten thousand (10,000) gallons of water above and beyond rainwater each year”.\(^\text{14}\) Residential buildings account for approximately twenty-one-percent (21\%) of total U.S. carbon dioxide emissions, surpassing emissions of the commercial sector.\(^\text{15}\) Building related construction, demolition and use are responsible

\(^{10}\) United States Environmental Protection Agency, 2.
\(^{11}\) United States Environmental Protection Agency, 2.
\(^{12}\) United States Environmental Protection Agency, 2.
\(^{13}\) United States Environmental Protection Agency, 3.
\(^{14}\) United States Environmental Protection Agency, 3.
\(^{15}\) United States Environmental Protection Agency, 2.
for about two-thirds of all non-industrial solid waste in the U.S.\textsuperscript{16} The negative
impacts on the environment, consumption of natural resources and produced emissions
are clearly evident.

The average family in the US moves every ten years.\textsuperscript{17} Homes may be renovated
frequently in their lifetimes, or demolished and replaced with new structures. Architects
and builders do not plan and build with a mind to renovation and deconstruction.\textsuperscript{18} The
practical lifecycle of a residential building is limited. Without building with these
practices in mind, the negative impacts of housing are amplified. Sustainable
development practices attempt to reverse or negate these trends.

Some groups, such as Earth First, take the stance that mankind and the planet cannot exist
in harmony with each other while we promote an industrialized society. As stated in their
article “No Compromise in Defense of Mother Earth”:

“…industrial civilization and its philosophy are anti-earth…”\textsuperscript{19}

\textsuperscript{16} United States Environmental Protection Agency, 6.
\textsuperscript{17} United States Environmental Protection Agency, 6.
\textsuperscript{18} United States Environmental Protection Agency, 6.
\textsuperscript{19} Earth First!, par 5.
Their belief relies on the hypothesis that natural resources should no longer be extracted for any reason. This obviously is an extremist stance, as mankind does not desire to regress to its primal tendencies and live in caves. Their argument is countered in Gro Harlem Brundtland’s foreword to Our Common Future:

“The environment does not exist as a sphere separate from human actions, ambitions and needs and attempts to defend it in isolation from human concerns have given the very word “environment” a connotation of naivety in some political circles. The word “development” has also been narrowed by some into a very limited focus along the lines of “what poor nations should do to become richer”, and thus gain is automatically dismissed by many in the international arena as being a concern of specialists. But the “environment” is where we all live; and “development” is what we all do in attempting to improve our lot within that abode. The two are inseparable.”

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20 Brundtland, par 13.
However the argument against the current systems of industrialization cannot be ignored: if production systems, utility and resource use are not completely self-sustaining, can it ever truly be “sustainable”?

So, how do we coalesce ecology, economy and society in a healthy, practical and sustainable manner? Many attempts have been made to create a formulation for achieving equilibrium between stewardship and the industry of building. Venturing to comprehensively define sustainable development is much like trying to hold water in your hands: just when you believe you have it within your grasp, it seeps through your fingers. Unless we eliminate production and progress in all forms, or develop systems, which are forever cyclical as proposed by McDonough and Braungart in their Cradle-to-Cradle theory, there can never be true-to-definition cycle of industrial sustainability. At this point in our technological development, the best that can be achieved is a concerted effort toward improving levels of sustainability, and reducing negative environmental impacts, while balancing needs, budget, function and practicality.
In wise reflection of the factors, which impact sustainability worldwide, the Brundtland Commission report notes that no single format of sustainable practice will be achievable which can address the varied economic, social and ecological conditions which occur throughout the world.\textsuperscript{21} This can be further interpreted to consider that there can be no true mechanism for standardization that will holistically address sustainability throughout the varied regions of the United States. Geographic, climactic and economic variations alone could be impacting enough to deter such a reality. Development of a fully functional sustainable template can only be feasibly implemented if created as a regional mechanism.

This attempt to define will identify the primary logical system of sustainability through its applicability and impacts to the residential homebuilding sector, most specifically to the greater Rochester, New York area where the follow up study will be conducted.

\textsuperscript{21} World Commission on Environment and Development, 1.51.
Chapter 2: Sustainable Development Practices

An evaluation of sustainable development practices determined by the United Nations, the U.S. Federal Government agencies, and individual certification programs have been used to create a broad identity of how these elements function within the built environment. These varied resources have been used to identify ten distinct systems to consider when defining sustainable development: energy efficiency, air quality, water, land use, ecosystems, natural resources, materials production and consumption, chemical waste, material waste and finally spatial interaction (universal design). It is impractical when considering these facets of sustainability to address them as separate individual entities when discussing the applicability to residential construction practices, as in reality; many facets integrate or overlay multiple systems of building development. The factors of sustainability must be considered as a whole, each element coalescing with the other to create a cohesive sustainable development system. Any applications of individual features, without considering the whole system, are admirable in their intent, but ineffective in their goals of sustainability.
It is not within the bounds of this study to express specific prescriptive practices, which can be emulated as each incidence of development has its own compendium of needs. Regional culture, sites, materials, practices and geography all fuse to create a new problem set for each project, therefore a broad template will be created which may serve as a model for other regions.

**Environmental Stewardship: the Macro Environment**

“Environment and development are not separate challenges; they are inexorably linked”

-World Commission on Environment and Development.22

The world focus on sustainability evolved from concerns of man’s negative impact on the environment. *Our Common Future* emphatically stated that first priority of international efforts should be focused on threatened ecosystems and conservation of species. This is the foundation for the sustainable development movement and has directed the establishment of international strategies.

22 World Commission on Environment and Development Sect 2.40.
In the document *Agenda 21*, the United Nations Commission on Sustainable Development has reported that: “The current decline in biodiversity is largely the result of human activity and represents a serious threat to human development.” With continued expansion of industrialization and urbanization, ecosystems are being heavily impacted: flora and fauna are displaced undermining the ability of these biologic systems to provide their critical goods and services. Declines in biotic diversity result in increased air, water and soil degradation as biota constantly engage in absorbing and breaking down pollutants (often rendering them harmless), as well as controlling natural environmental impacts such as erosion.\(^{23}\) Although these systems demonstrate resilience, tolerating some levels of disruption, loss of biologic diversity may reduce this resilience and result in a loss of systemic equilibrium.\(^{24}\) Where natural systems are compromised, the health, economic and social well being of the people is threatened, as we are dependent on the services they provide.\(^{25}\) The U.S. Environmental Protection Agency (EPA) has noted that: “Achieving sustainability in managing natural systems therefore

\(^{23}\) Office of Research and Development, 30.

\(^{24}\) Agenda 21, 9.19.

\(^{25}\) Office of Research and Development, 27.
requires a better understanding of the complexity of these systems, including their critical thresholds, resilience, and adaptability.”

The inability of biota to effectively filter air pollutants created through increased industrialization and development have brought the negative impacts of green house gasses (GHG) and the debate over global warming to the forefront of international dialogues. Although many sources of GHG emissions are created naturally, human activities such as consumption of fossil fuels, farming and industrial production cause additional quantities to be produced changing the balance and increasing atmospheric concentrations. Landfill wastes accounted for twenty-two percent (22%) of U.S. methane emissions in 2008. Deforestation practices reduce the natural filtration cycles causing these build ups to remain. These concentrations result in climactic change and are the basis for the global warming debate. Even though the concept of global warming is still being debated in some sectors, no matter what side of the argument the resulting science lands on, the need to minimize negative impacts to the atmosphere is not in question.

26 Office of Research and Development, 27.

27 United States Environmental Protection Agency, 8.
The understanding of this broad spectrum of stewardship can be more readily realized when considering residential building practices: the impacts on ecosystems are widespread. The current practices of deforestation through clear cutting building sites, severe geographic re-contouring, and stripping the topsoil for resale, not only strip the land of its ecosystems, increase fractalization of remaining ecosystems, but also force biotic compliance within an unnatural setting. Biota are removed and replaced with an artificial substitution in the forms of manicured gardens and lawns. The habitual integration of these selective biota, which must be maintained regularly in an artificial manner may be seen as “natural” to residents and homebuilders, but in reality do not designate a functioning bio-system.

This destruction of functioning biosystems in the residential landscape results in the need for maintenance, through chemical additions to the soil, to maintain the perfect desired aesthetic. Lawns require additives as the system lacks the prerequisite diversity to allow production of these normally, naturally occurring elements. These artificial amendments not only serve to offset chemical imbalances within the soil, but also contain toxins used to control undesirable species such as weeds and insects. The impacts on the ecosystem
become cyclical, as these toxins and chemicals seep into the water sources through storm water runoff, and ground source permeation. Many of these materials do not biodegrade, and become persistent contaminants to the environment. The EPA notes that persistent or bio-accumulative toxins in natural organisms, including human beings, have yet to be fully assessed but are assumed to pose the highest risk to the health of both humans and the environment.28 These practices not only hold nature as something that must be controlled, but perpetuates a psychology of embattlement between man and nature.

The continuous expansion of urbanization results in increased application of impervious surfaces. Roadways, rooftops, and parking lots abound creating the proverbial asphalt jungle. Spread of these applications increase runoff water volume and further degrade water quality as oils, chemicals, and other toxins are washed from them.29 The ability of aquifers to recharge is reduced as water is redirected.30 Application of permeable

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28 Office of Research and Development, 30.
29 Office of Research and Development, 32.
30 Office of Research and Development, 32.
surfacing products can alleviate some of these effects, but not all: pollutant sources must also be controlled.

The concerns over environmental stewardship, and the protection of the functions of the biosphere set the stage for determining the evolution of sustainable development practices. Each tenet must keep these considerations on task and ultimately result in an enhancement of the macro environment: diminishing human impacts. The growth of urbanization and the built environment displace both flora and fauna and compromise biological systems’ ability to provide their vital goods and services.\(^\text{31}\) The definition of environmental stewardship is no longer simply interpreted as a need to control pollution, as was the focus during the early years of the movement: its identity has expanded.

**Energy: Efficiency and Embodiment**

According to the EPA, residential buildings account for almost twenty-one percent (21%) of total U.S. energy consumption (2005): surpassing that of the commercial building sector.\(^\text{32}\) Over one-half of the electricity consumed by buildings in the US (2006) was

\[^{31}\text{Office of Research and Development, 7.}\]
\[^{32}\text{1United States Environmental Protection Agency, np.}\]
attributed to residential structures. Historically, the production of energy resources has resulted in the increased consumption of fossil fuels: a well-known source of GHG emissions, as well as other negative impacts on air, soil and water qualities. Sustainable development seeks to diminish these impacts. With energy costs skyrocketing in recent years, the turn to energy efficient systems and alternative sources have taken center stage in the growth of the sustainable development industry. The economic benefits are tangible to both the builder and the consumer: the builder can create a highly marketable product that appeals to the wallet of the consumer through lowered energy bills. Stewardship is forwarded, for economic, not environmentally philanthropic reasons but the end result remains the same.

The general public has become well versed in the ideas of energy efficiency since the energy crisis in the 70’s when society was faced with the realities of the limitations of fossil fuels. Political turmoil in the Middle East and price controls established by the Organization of Petroleum Exporting Countries (OPEC) resulted in severe oil shortages. This promoted a turn to more fuel-efficient vehicles and efforts to minimize energy

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33 United States Environmental Protection Agency, np.
consumption. By 1992, this ideal of increased efficiency was fostered within the home through the U.S. Environmental Protection Agency and the U.S. Department of Energy’s introduction of ENERGY STAR standards. Energy efficiency and increased weatherization standards have been further promoted through current governmental tax rebates and credits. Energy efficient appliances, lighting systems and other mechanicals have gained widespread acceptance with ratings such as ENERGY STAR leading the movement. Energy efficiency has assumed a primary role in the marketplace.

Within the homebuilding industry, the adherence to ENERGY STAR standards has become predominant. The industry is now turning to the consideration of integrating alternative energy sources such as solar and wind, and the use of more efficient HVAC systems such as geothermal heat pumps. These alternative systems have yet to be mainstreamed, but the focus on efficiency stands firm.

Energy consumption considerations cannot be restricted to the structure itself: a holistic approach must be applied to this evaluation. According to the World Business Council for Sustainable Development (WBCSD), about 84% of a building’s, lifecycle energy
(considering a 50-year cycle) is typically consumed during use.\textsuperscript{34} Materials, construction and renovation account for approximately 16% of this total.\textsuperscript{35} The impacts of overall embodied energy of the structure and development must be considered. The energy consumed in the harvesting of resources, manufacture, transport, and installation of materials becomes the first element of embodied energy. However, measures of future energy consumption for disassembly, deconstruction and disposal must also be considered in this equation. As there are currently no viable widespread mechanisms for evaluation, embodied energy is a difficult factor to determine. Design professionals must rely on manufacturers’ calculations, which can be skewed.

**Materials: Doing More with Less**

*Our Common Future* addressed humanity’s needs as being inexorably tied to industry:

“Many essential human needs can be met only through goods and services provided by industry, and the shift to sustainable development must be powered by a continuing flow of wealth from industry.”\textsuperscript{34} The needs for a progressive economy to spark sustainable practices are key to the successful spread of resource conservation.

\textsuperscript{34} WBCSD, 2007, 27.
\textsuperscript{35} WBCSD, 2007, 27.
The conservation of environmental resources includes both the minimization of consumptive practices and protection of quality, of both non-renewable and renewable natural resources: doing more with less. Minimizing usage of valuable natural resources is an obvious element of sustainable practices. The mantra of “reduce, reuse, recycle,” can be interpreted for this idea as: reduce consumption, reuse existing resources (salvage, recycled content or recyclable materials), and recycle waste produced.

**Reduce:**

In this new environment of sustainable practices, industry must meet the call for reduction of materials; manufacturing products containing fewer materials, which are able to achieve the same end-use requirements as conventional. The homebuilding industry has embraced many of these lower material content products such as engineered wood, roof and floor trusses and cored brick. The reduction of materials content (and packaging) not only serves to diminish the usage of renewable and nonrenewable resources physically, but through reduction in overall embodied energy. Local and regional resourcing and manufacturing of materials must be considered in this turn to embodied energy. The LEED certification program has established a benchmark of a 500 miles radius for materials resourcing and product manufacturing from the final
installation site as the ideal for minimizing embodied energy from transportation. This consideration not only reduces overall embodied energy of these materials, but also promotes local and regional industry and commerce.

The use of renewable resources, considered ideal materials as they are readily replenishable, adds further complexity to the sustainable development conundrum. ASTM E2114-2004 defines renewable resources as a “resource that is grown, naturally replenished, or cleansed at a rate which exceeds a depletion of the usable supply of that resource.” Resources such as lumber may be renewable, but the impacts of the industry on the environment are far more intensive than this: harvesting and impact on bio-cycles, embodied energy, as well as industrial production impacts through energy, waste, and consumption of non-renewables. Evaluation of the sustainability of materials must take all these factors into account, therefore minimization of application and usage of all materials, renewable and non-renewable must be considered. There is no argument that non-renewable resources are limited in their availability, and should be replaced with renewable mechanisms, but until these mechanisms become readily available to industry,

reuse and recycling of these often environmentally adverse elements are the best alternative.

**Reuse:**

Government policies for Federal construction standards as well as sustainable certification programs have promoted the use of biobased and recycled content materials.\(^{37}\) The use of these products can be a great substitution for traditionally more impacting materials, but a holistic view of these materials must be considered before qualification as being environmentally responsible to use. Although the inclusion of recycled content seems ideal to the goal of sustainability, it cannot be seen as a utopian solution to the problem. Often, the processes used to create functional recycled products can have more negative impacts than disposal of the original product. As elements such as plastics are recovered, more hazardous chemicals are added for stabilization. As a result, many materials such as plastic may contain more toxic additives and have a larger negative environmental impact than the original product derived from virgin raw materials.\(^{38}\)

\(^{37}\) National Institute of Building Sciences, Executive Order 13423, Executive Order 13514.

\(^{38}\) McDonough, 58.
Recycle:

Home building produces large quantities of waste, both hazardous and nonhazardous materials. The Connecticut Department of Environmental Protection estimates total home construction waste calculations at approx 3 - 5.2 pounds per square foot (lbs/sqft).\(^{39}\) These numbers infer totals approximating 9430 lbs of waste for an average 2300 sqft home (considering a mean 4.1 lbs/sqft estimation). Collection and separation of construction waste on site can result in a potential reduction of 60-80% of this total through the reclamation of wood, drywall and cardboard (Table 2.1).\(^{40}\)

\(^{39}\) Department of Environmental Protection, np.

\(^{40}\) Department of Environmental Protection, np.
Table 2.1

<table>
<thead>
<tr>
<th>Predominant Materials</th>
<th>Rough %</th>
<th>Estimates: Lbs./Sq. Ft.</th>
<th>Recyclable?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood (1)</td>
<td>20-35%</td>
<td>1.3-2.1</td>
<td>✓</td>
</tr>
<tr>
<td>Drywall</td>
<td>10-20%</td>
<td>1.0-2.1</td>
<td>✓</td>
</tr>
<tr>
<td>Corrugated Cardboard (2)</td>
<td>5-15%</td>
<td>0.1-0.5</td>
<td>✓</td>
</tr>
</tbody>
</table>

(1) Range for wood waste depends on material used for wall sheathing, siding, trim, and roofing.
(2) Range for cardboard depends on type of siding and whether windows, doors, and cabinetry are locally manufactured

Waste reduction can initially be achieved through efficient use of materials, and specifying materials that use minimal packaging. In the homebuilding industry, the primary sources of hazardous wastes are generated from painting, sealing, staining and caulking.\(^{42}\) Using products that minimize the inclusion of hazardous elements is recommended, and appropriate disposal methods should be observed.

**Lifecycle Analysis:**

Resource efficiency will further be improved within the design and construction field if practices are implemented so as to increase materials’ durability and reduce future

\(^{41}\) Information obtained from Department of Environmental Protection, State of Connecticut, notes are direct citations from this site.

\(^{42}\) Department of Environmental Protection, np
maintenance therefore maximizing materials lifecycles. Life cycle assessment tools are available online which help to evaluate the total environmental impacts of materials. They can be complex and time consuming to implement. Lifecycle assessment must become integrated into the standardized information base shared by manufacturers under the guidance and purview of an overseeing agency (governmental or third party) in order to simplify this process and ensure its quality.

**Land Use: Where We Live**

We have already discussed the consideration of protecting ecosystems and the need to reestablish and restore these systems when impacted to promote their important functions, goods and services. Sustainable land use goes beyond the implications of overtaking flora and fauna and invading ecosystems for development purposes. The question of ‘where’ and ‘how’, come into play: where are we placing our living environments, and how do we best plan with the least impacts on environment and promoting sustainability?

A large portion of the literature denotes that sustainable standards promote the tenets of compact urban environments and planning forms such as New Urbanism. In the early
1980s, architects Andres Duany and Elizabeth Platner-Zyberk (DPZ) designed the New Urbanist model as a response to the homogenous suburban sprawl that lacked a sense of community, social interaction and overly relied on automobiles for transportation. The town of Seaside, Florida served as their model where small single-family residential lots surrounded the town center that featured shops and stores. The sustainable aspects of these communities center on reducing the inhabitants’ overall carbon footprint by creating high-density, walkable living environments that integrates housing with commercial infrastructure. High density, livable neighborhoods have been further shown to promote sense of community and social cohesion. There are many positive social aspects to these proposed communal forms. Decreased energy use is the core of the stance promoting the sustainability of urban living: less energy intensive activity patterns, reduced reliance on automobiles, and shared wall living which minimizes heat energy losses.

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43 Harwood et al, 768.
44 Kats, xix.
45 Holden, 2148.
Although much of the literature is in agreement that the New Urbanist format is an ideal method of implementing sustainable living, some studies question the reality of lowering carbon footprints through this type of planning. Housing, transportation and food account for as much as eighty-percent (80%) of the direct and indirect environmental impacts caused by households.\textsuperscript{46} With greater concentration of population farther away from industrial and agricultural sources, embodied energy and material costs are increased. In addition, studies have shown that with increased population densities, consumption patterns may be altered.\textsuperscript{47} A study conducted by Holden and Norland examined the relationship between land use characteristics and household consumption of energy and transport in high-density urban areas. The study findings denote that although daily commutes are minimized, therefore reducing consumption, there is a noted increase in leisure-time travel by plane, and automobile: two extremely high energy consumptive practices. These findings are of notable enough significance to question whether the energy savings perceived from high-density urban environments in fact exist when considering an increase in high consumptive practices such as these. Further study is

\textsuperscript{46} Holden, 2145.

\textsuperscript{47} Holden and Norland, 2145
required in this area, which incorporate consideration of human interactions within these environments.

The market for high-density urban environments meets with further resistance from the home buying marketplace. A study conducted by Senior et al, suggests a preference for low-density, suburban, detached or partially detached dwellings with a yard:

“Evidence indicates… that many households seem to aspire to more land consumption per capita and tend not to regard central city amenities as sufficient compensation for living at higher densities.”

Erving Goffman in his 1959 sociological study, *The Presence of Self in Everyday Life*, determined that a sense of crowding is translated by the psyche as a feeling of having no personal control. Private space lends to the feeling of control and regulation of interpersonal contract. These psychological factors must be considered in efforts to attain the ideal balance between ecology and societal needs.

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48 Senior et al, 338.
There can realistically be no singular solution to such a daunting subject as creating the “ideal” sustainable community plan, which will meet the needs of all people, and reflect regional, cultural geographic influences holistically. Living in high-density environments is a unique experience for each individual and consumption patterns vary. The market demand for higher density urbanism will require time to develop if it is determined that this is unequivocally the best method for reaching sustainable goals.

Mankind has long regarded land ownership as being representative of status and wealth: this psychology will not be easily changed. Turning the consumer away from this draw will be difficult. In the interim, a focus on promoting high-density suburbanism may be a more practical goal.

**Factoring Livability: the Micro Environment**

In reviewing academic and industry discussions on sustainability, energy efficiency and the building shell seem to be the primary focus; little attention is given to the impacts of materials, interior finishes and human interaction within the built environment. These aspects which address the livability of space and its function of supporting the inhabitants’ physical experience, ease of use, productivity and physical health, all culminate in a level of satisfaction with the built environment which improves quality of
life and longevity of usefulness of the structure. Factoring the indoor environment into the equation is integral to true sustainable practice. As we will discuss later in this paper, this aspect is ignored in some of the more high profile sustainable developments, which are flagged as leaders in the field of green construction such as LEED projects.

**Indoor Air Quality:**

The focus on air quality does not end with the macro environment: the microenvironment of the building interior is equally impacting. Indoor air quality (IAQ) is one of the more difficult issues to comprehend when trying to understand sustainable development. Effects are not immediately tangible, do not have monetary payback cycles, and often go unknown as public education is lacking. With increased focus on energy efficiency in residential construction, thermal barriers and weatherization have been improved to minimize heating or cooling losses. But with this increased efficiency a new conflict arises: reduced air quality.

Early construction standards set forth by the America Society of Heating, Refrigerating and Air-Conditioning (ASHRAE) called for 15 cubic feet per meter (cfm) of indoor/outdoor air transference for each occupant of the household. Primarily intended to
offset and dilute offensive odors, this standard held until the 1970’s. The 1973, Arab oil embargo created a new call for energy efficient measures to be implemented. This reduced the standard infiltration of air from 15 cfm to 5 cfm per occupant.49 These tightened air infiltration standards resulted in notable impacts to the health of the inhabitants. The World Health Organization suggested that up to 30% of new and remodeled buildings worldwide resulted in indoor air quality complaints ranging from mild to severe.50 In response to this issue, in 2004, ASHRAE Engineers revised its energy standard (ANSI/ASHRAE Standard 62.1-2004) to return to the 15 cfm minimum in residential applications.

**Volatile Organic Compounds**

Most indoor air pollution comes from sources within or part of the building shell. Volatile organic compounds (VOC) are organically based chemical compounds with high vapor pressure and low water solubility levels, which under normal conditions (standard indoor temperatures and air pressurization) allow vaporization and atmospheric contamination. These include many chemicals, which may have short or long term adverse health effects. According to the EPA, indoor concentrations of VOC’s can be up

49 Indoor Air Facts, np.
50 Indoor Air Facts, np.
to ten times higher than outdoors. A wide array of products are responsible for VOC emissions including but not limited to the following: paints, lacquers, paint strippers, cleaning products, pesticides, building materials, furnishings, computer printers, glues, adhesives, fuels, cosmetics, tobacco and public water (chlorine).\textsuperscript{51} Formaldehyde, a known carcinogen and common airborne pollutant is commonly found in residential construction materials.\textsuperscript{52}

An industry trend to reduce VOC’s from building products and consumables has led to an increased availability of low emitting products. Although their testing standards denote low emissions, the methodology of testing may negate these findings, as they would apply to real life installations. The resulting science is misleading the consumer and the building trade. True evaluation of indoor air quality must consider both the primary and secondary reactions of these chemicals.

\textsuperscript{51} Indoor Air Facts, np.
\textsuperscript{52} Wong, 4.
Although the inhalant qualities of VOCs are known, other reactions may be occurring within the interior environment creating unknown toxic elements. In their article “Impact of Reaction Products from Building Materials and Furnishings on Indoor Air Quality”, E. Uhde and Dr. Tunga Salthammer address the building as being a “reactionary vessel” in which secondary chemical reactions may be occurring. Factors, which stimulate these secondary reactions, can include light, ozone, presence of reactive gases, and degradation of materials. In essence, the volatile compounds contained within the enclosed space can and will interact changing their metabolisms and creating new negative impact compounds.

Industry testing of materials is done in singular applications: floor covering is tested separately from adhesives. Each may be determined to be a low emitting material, a testing process that does not take into account the actual installation conditions. In reality, these materials are directly interacting and the combination of the two may create a highly emitting toxin. Should this installation be done on concrete, further interactions may occur. The reactivity and secondary compounds created from the chemicals found
within these materials can result in adverse health effects within human inhabitants even at low concentrations.\textsuperscript{53}

**Ground Contaminants**

Naturally occurring substances from the building geography can also affect inhabitants. Radon is an odorless, tasteless gas which is a naturally occurring contaminant found in decaying earth and granite that can leach into the home through the ground. According to the U.S. Environmental Protection Agency (EPA), radon is the leading cause of lung cancer for non-smokers. The EPA has determined that reduction of radon would aid in the prevention of lung cancer and respiratory related diseases such as asthma. It is estimated that through 2003, 1.7 million homes had implemented radon reduction mechanisms preventing a potential 470 future annual cancer deaths.\textsuperscript{54}

**Biological Contaminants:**

Along with VOC’s, moisture can be trapped and build up within these tighter building shells. Appliances such as refrigerators and air conditioners also contribute to increased levels of moisture. High levels of humidity within the residential environment can create conditions where biological contaminants thrive. Warm, moist environments nurture

\textsuperscript{53} Uhde, 3112.

\textsuperscript{54} Jacobs, 979.
biological contaminants like bacteria, molds, mildew, viruses, fungi, dust mites and other insect infestations. According to the EPA, biological contaminants may also breed in areas where water has accumulated such as insulation, carpeting, ceiling tiles and air ducts. Biologic contamination can be minimized in part through the control of relative humidity levels. The EPA suggests a relative humidity of thirty to fifty percent (30-50%) for homes. Standing water, water-damaged materials or wet surfaces should be cleaned, treated, or disposed of in order to reduce growth of biologic contaminants.

The U.S. EPA lists indoor air pollution as one of the top four environmental health risks. Thousands of cancer deaths and hundreds of thousands of respiratory health problems each year are attributed to indoor air pollution. Health effects of biological contaminants may include physical symptoms such as cough, chest tightness, fever, chills, muscle aches, and allergic responses such as upper respiratory congestion. Approximately 23 million people, including 6.8 million children have asthma in the US. Asthma accounts for nearly 17 million physician and hospital visits per year. The

55 Jacobs, 977.
56 Indoor Air Facts, np.
57 Indoor Air Facts, np.
58 Indoor Air Facts, np.
Center for Disease Control (CDC) has noted a seventy-five percent (75%) increase in diagnosed asthma between 1980 and 1994. Very young children have suffered a one hundred and sixty percent (160%) increase in asthma. Studies have related these increased asthma occurrences directly to the living environment. Biologic contaminants and VOC’s within the home have been pointed to as causes.

The literature focuses on ventilation as the primary remediation for negative impacts of IAQ, but a primary consideration should be the elimination of high VOC content materials, other toxins and moisture control within the home. Full remediation cannot be achieved by simply venting these contaminants out of doors: indoor and outdoor air quality must be equally considered. Combining these three factors into a holistic remedy will create living environments that promote productivity, satisfaction and physical health of the inhabitants as well as integrating environmental stewardship practices.

The true impacts of chemical interactions and biologic contamination with real life installation have yet to be examined thoroughly. It will take further research to determine the long-term impacts of these processes on the health of the inhabitants.
Studies on this subject must continue as construction methods and new technologies advance. As public knowledge of the issues related to indoor air quality increases, new materials, construction methods and technologies are being developed to minimize environmental toxicity.

Spatial Interaction: Universal Design

Ron Mace, the originator of the term, defines universal design (UD) as follows:

“Universal design is the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design.”

In order to more comprehensively discuss the inherent requirement for sustainable design in residential architecture, the standards of universal design must be incorporated.

A primary factor in sustainable development is the reuse of existing structures and building for longevity and lifecycle management. A 2008 study conducted by Smith et al. cites that ninety percent (90%) of current housing stocks in the U.S. are inaccessible to people with disabilities. Further, the study determined that by 2050, almost ninety-one percent (91%) of new American housing will be required to either permanently house or

59 The Center for Universal Design, np.
accommodate the visitation of disabled persons in some manner. There is a substantial gap between the availability of universally accessible housing in the U.S. and the needs of the inhabitants. Universally inclusive design incorporates functionality for the long term, reducing the potential for required alteration, materials waste, and therefore increased embodied energy. Creation of prescriptive construction practices must consider the structures long-term usefulness for the inhabitants.

A study by Gossett et al. factors barriers within the living environment as exacerbating the disablement of inhabitants: freedom of movement, functionality and safety are impeded causing conflict between inhabitant and dwelling. UD focuses on the functionality and accessibility for everyone: not just those with disabilities. It denotes construction that does not inhibit access or freedom of movement for individuals with limited ambulatory function. Universal design takes into consideration age, gender, culture and ability as part of creating a home, which is transformable, adaptable and functional for a lifetime of use.

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60 Alonso, 2
The elderly population in the US is growing exponentially with the 79 million baby-boomers rapidly reaching retirement. The AARP (AARP.org) has studied the needs of the aging population and determined that more than 8 in 10 individuals over the age of 45 and more than 9 in 10 of those over age 65 would prefer to age in place: the ability to remain living in a non-healthcare environment. Eighty-two percent (82%) of these individuals would prefer to stay in their current homes. With the population aging at such a rapid rate, accessible housing will be in increased demand.

The 2000 Census showed that approximately 20.9 million American families had at least one member with a disability. The prevalence of disabled persons living in standardized housing which does not cater to their needs can have many adverse effects from increased incidence of injury due to forced navigation of barriers to diminished independence, increased medical care costs or the inability to engage socially within the community. The inability to interact freely with others increases the likelihood of

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61 Haga, Np.
62 Bayer, Np.
63 United States Census Bureau, 1.
64 Ho, 903.
suffering from social isolation and loneliness, which further impairs health, happiness and self-esteem, often resulting in forced early transition to long-term facilities for care.\textsuperscript{65}

Disabilities affect everyone. At some point, most people experience a limitation of mobility whether from accident, injury or illness. Those with temporary injury, pregnant women and the obese also experience mobility challenges. Studies have shown that 82\% of households recognize existing barriers within their living environments.\textsuperscript{66} Whether or not a disability affects a family directly, visitability of homes by the disabled must also to be considered. Disabled individuals are limited in their ability to access the “standardized” home without some form of assistance. Creating such limitations further impedes social interaction, further precipitating the progression of debilitation.

Implementing sustainable construction practices must take into account the needs for the inhabitants over the long term. Construction practices, which cater immediately to these needs allow for a more profitable and practical interaction between user and structure. If housing stocks do not take this factor into consideration, the need for renovation and

\textsuperscript{65} Smith, 290.
\textsuperscript{66} Alfonso, 39.
retrofitting will be increased, therefore increasing the embodied energy, depletion of natural resources, and increasing waste associated with the home. Even a home that is built to all the other sustainable standards, may potentially nullify those aspects by altering these important values.

**Conclusion:**

The tenets of sustainability cannot be perceived as individual elements to be selectively used at whim: they must be cohesively applied in order to achieve full impact and best environmentally responsible practices. Although each individual principle establishes goals with positive impacts, the neglect of others can result in impacts which can offset any benefits of those implemented.

There can never be one singular fully prescriptive solution to building sustainably. Regional variations alone offset this potential. As this industry is relatively in its infancy, many issues still remain associated with understanding how to fully work within the boundaries of the principles of sustainable development. But those active in the residential housing industry must make efforts towards creating a functional prescriptive
plan for more universal compliance. No system can fully reverse the negative impacts of housing on the environment, but diminishing these negative trends may be feasible.
Part II: Determining the Barriers to Sustainable Development
Chapter 3: Defining Market Barriers:

In order to promote and propel the homebuilding industry to implement the basic aspects of sustainable development, the barriers that impede these practices must be identified.

An examination of existing literature on barriers to implementing sustainable construction has resulted in a delineation of four primary categories: market perceptions, information gaps, infrastructure issues and implementation issues.

**Market Perceptions:**

One of the major impediments to furthering the sustainable homebuilding marketplace is misplaced perception that there is no consumer demand for such a product. The construction industry is ultimately a business, and like any other, it aims to satisfy user demand. If there is no perceived demand, builders are not motivated to supply the product, unless perhaps, out of a desire for environmental philanthropy.

Robert Charles Lesser & Co. (RCLCO) conducted a study which examined factors that drive consumer demand for green homes. RCLCO divides these motivational factors into

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67 Choi 110.
three main categories: environmental stewardship, energy savings, and health benefits.

This research showed that more than 36% of potential homebuyers currently connect to one of these categories as a primary factor in home purchase decisions.\(^{68}\) Currently, the category of energy savings is the highest motivator for sustainable buying decisions as these benefits are tangible. It is projected that although energy savings currently has the highest market pull (almost 22% of all homebuyers), the segment of the market with the highest growth potential lies in the health benefit sector.\(^{69}\) As education on the effects of IAQ, and the potential health benefits of sustainable practices becomes more widely perceived by the public, this demand is expected to rise exponentially.

The RCLCO study further showed that 70% of homeowners do not believe their homes negatively impact the environment.\(^{70}\) But of the remaining environmentally aware portion of the population (approximately 20%), almost all wished to reduce their impact and would factor it into future purchases.\(^{71}\) This study further demonstrated that almost 29% of homebuyers who were seeking sustainable features found they were not

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\(^{68}\) RCLCO, 3.
\(^{69}\) RCLCO, 4.
\(^{70}\) RCLCO, 8.
\(^{71}\) RCLCO, 8.
available. Though consumer education, this marketplace has the potential for substantial growth.

The perceived additional costs of building green have further impacted the potential marketability of the “green” product. Studies conducted on the “costs” of going green show increased cost ranges from 0-18%. But, as we have already discovered, with no industry wide definition of sustainable construction practices, how can a realistic “apples-to-apples” comparative be formed? Practices which attempt to do direct feature-for-feature comparisons with sustainable versus conventional housing will always result in a higher up front cost. As systems are still evolving, they have not yet become standard solutions, which are in the end always less costly. The additional “cost” or value of the structure must consider the costs of its external environmental impacts and the improved function, which in the end may give a quantifiable payback: the inherent return on investment must be considered.

72 RCLCO, 8
73 Kats 8, Jackson 92.
74 Choi, 116.
75 Choi, 110.
As the literature seems in conflict with the actual cost of construction increases, or lack thereof, this is an area that requires more in-depth study. No substantial study has been found on the increased costs of residential housing or the payback cycles of alternative technologies. Research into the cost of implementation must be undertaken which compare like structures, fully consider the inherent value of sustainable features, and incorporate built-in payback cycles, and how these integrate with regional materials and utility costs.

Although the initial construction costs may in the end be shown to be higher than standard construction methods, studies have found that buyers are willing to pay an increased premium for potential end savings benefits. Energy efficiency becomes the easiest marketable element in this discussion. Nevins and Watson demonstrated that for every one-dollar ($1.00) reduction in annual fuel bills, an increased home sales price of ten to twenty dollars ($10.00-$20.00) is gained.76 With the added costs of energy skyrocketing of late, this value could be more pronounced.

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76 Nevin and Watson, 401, 409.
Dr. Barbara Fahar and Prof. Timothy Coburn studied high-performance residential developments in southern California. This study demonstrated that if builders take advantage of bulk purchasing, government incentives and build up their profit percentages incrementally, green home sales prices are both competitive and profitable.\textsuperscript{77}

Contrary to traditional practices, if sustainable systems are offered as standard, rather than optional equipment, buyers are more amenable to purchase them.\textsuperscript{78}

Typical homebuyers are new to the vocabulary of sustainable development and technologies. The key to successful marketing of the sustainable home relies on educating the consumer, through clear strategies and simplified messages.\textsuperscript{79} Once the industry opens up to standardization of practices, it is reasonable to expect that the buying public will be more responsive to buying into these products. Studies have shown that sustainable neighborhoods have higher levels of owner satisfaction, less turnover and greater longevity of use.\textsuperscript{80} The greening of the industry beyond energy efficiency will

\textsuperscript{77} Fahar, 25.
\textsuperscript{78} Fahar, 31.
\textsuperscript{79} Fahar, 31.
\textsuperscript{80} Fahar, 31; Kats, xix.
not only create a method of branding for developers, but also allow them to embrace the fuller market potential of sustainable development.

The presence of a market for sustainable residential product can further be derived from the current trend towards “greening” within the broader consumer marketplace. It has become the mantra of the advertising industry: if you can delineate sustainable features, the market will buy your product. This is also the primary reason that greenwashing has become so prevalent. Corporations are turning a new eye to the marketplace as demand pushes for alterations in strategic planning towards sustainability.\textsuperscript{81} Man’s negative impact on the environment has come to the forefront of the general consumer marketplace and the media.

For the construction industry, the green building market (both non-residential and residential) is expected to more than double in the next few years from $36-49 billion in 2010 to $96-$140 billion in 2013.\textsuperscript{82} The energy efficient home improvement market

\textsuperscript{81} Vandermerwe, 10
\textsuperscript{82} U.S. Green Building Council, np
alone is expected to grow from $38.3 billion in 2009 to $50.2 billion in 2014.\textsuperscript{83} Unprecedented levels of government initiatives and the widespread availability of quality sustainable materials will further spark the market. According to the U.S. Department Bureau of Labor Statistics, “Extensive knowledge of green design is expected to be in demand…The public’s growing awareness of environmental quality and the growing number of individuals with allergies and asthma are expected to increase the demand for green design.”\textsuperscript{84} Many consider the trend towards green construction and sustainability to be just that: a trend. But the statistics show that in reality, green construction will become mainstream. The American Institute of Architects (AIA) has noted that the trend in residential construction is veering away from the “McMansion” to smaller energy efficient dwellings.\textsuperscript{85}

In the US, total green construction comprises of 13.4% of the gross domestic product.\textsuperscript{86} As the US government furthers its promotion of sustainable construction through fostering tax rebates and incentive programs such as Energy Star, this trend is slated to

\textsuperscript{83} M2Presswire, np
\textsuperscript{84} Bureau of Labor Statistics, np.
\textsuperscript{85} American Institute of Architects, np.
\textsuperscript{86} U.S. Green Building Council, np.
continue. Builders, who do not evolve sustainability into their development practices, risk losing out on the vast potential of this marketplace inherently jeopardizing the viability of their business.

**Information Gaps**

This evaluation began as case studies demonstrated a lack of clarity of the direction or meaning of sustainable development practices. If academia has a conflict of clarification, and studies do not clearly relate the true meaning of sustainable development, what is the message that reaches the homebuilder? The green building industry has failed not only to get the message to the consumer as to the impacts of their living environments, but to the homebuilding industry as well.\(^{87}\)

**Energy Cost Comparisons**

“There are two wrong conclusions. Building professionals tend to underestimate the contribution of buildings’ energy to climate change and to overestimate the cost of saving energy.”\(^{88}\)

– World Business Council for Sustainable Development

\(^{87}\) RICS

\(^{88}\) WBCSD, 2007, 16
Comparisons of energy savings are dependent on the energy intensities used within each dwelling. Homes have varied consumption rates depending on design, features and use. Comparisons must consider these factors as well as standard regional infrastructures and their cost basis. Within the Rochester demographic, there are select municipalities that supply low cost electricity to their residents, and regionally although prices are higher than the national average, they are not considered extreme. This makes it difficult to engage buyers and builders to implement alternative energy systems such as solar, wind or geothermal. Without tangible payback cycles, and the economic incentive of established and guaranteed lowered monthly costs, these systems become justifiable only for their social and environmental benefit which, according to the Lesser study, will only motivate 18% of buyers. Even with viable payback cycles, the economic motivation may not be relevant in areas where there is a high transient population unless there is a quantifiable increase in housing value.

Tangible energy savings valuations are far more easily discerned in areas where zoning requires lower density and larger lot single-family dwellings. In these more rural areas, natural gas availability is limited and heating systems focus on other fossil fuels:
primarily oil and/or propane systems. In these areas, alternative systems are beginning to take a foothold as demonstrated by the recent proliferation of contractors providing alternative energy and heating systems. Payback cycles are short and easily demonstrated with the skyrocketing costs of heating oil and propane that have been noted in recent years. Without quantifiable payback, builders and homeowners are reticent to invest in these more costly systems.

**Reliable Datasets**

There is a demonstrable need for reliable data sets on the costs, benefits, performance and health data for green features. The literature is conflicting on the actual added costs for inclusion of sustainable features and payback cycles vary. Without established information addressing these elements, commitment to implementation may wane and instances of application will be more heavily motivated by environmental stewardship, which is not strong enough to promote widespread adoption of sustainable development practices.

In order to appropriately obtain quantifiable datasets that establish the performance of sustainable homes, an apples-to-apples comparison must be undertaken that considers not
only the structure, but also human interaction within. A lifecycle assessment must be conducted. For a relevant review of these high efficiency environmentally responsible homes to occur, collation with standardized housing must be undertaken which considers the regional impacts of the housing market, market cycles, energy rates, materials and construction costs. These valuations should be done over time in order to perceive the full life span benefits of energy efficiency and systems efficiency. Valuation of reliable performance and cost benefit information relies on datasets that at this point in time, may be difficult to obtain, as there are few widespread applications of sustainable housing throughout the varied regions of the U.S.

These information gaps also extend to individual materials and products. Manufacturers are still lacking information establishing the true costs of their products and their impacts on both the macro and microenvironment. This evaluation must include life cycle costs and overall embodied energy. Manufacturers’ testing, as we have discussed can be misleading as these are not conducted in situ, and further, they do not consider the full lifespan. Determining what products are environmentally responsible and meet the standards of “greening” can be an arduous task, and in the end essentially comes down to
a best guess. There is no control over the term “green” and companies can consign that label to their products freely with minimal adherence to any standard. Databases that have been instituted to certify products like the Cradle-to-Cradle™ label are still being established and there is no third party oversight.

Unless the information gaps are filled, and firm datasets are developed, the homebuilding industry will remain reticent to implement these practices: proof must be had. The conservative home construction industry responds to uncertainty by adhering to tradition. Without a full understanding as to “why” these systems work, their cost, and tangible benefits to the builder and the end user, these potentially beneficial systems may continue to be considered as little more than a trend. Individuals change their behavior where there is a perception that the benefits outweigh their natural inclination to remain within their established habits. The conservative homebuilding industry does not yet see this benefit.

**Infrastructure Issues:**

The infrastructure of the homebuilding industry caters primarily to standardized light-frame construction. This has been the principal construction method for decades, and
systems have developed that coordinate with this process. With the infrastructure focused on existing standardized systems, conflicts with permits, code compliance, appraisal and financing impede alternative sustainable building methods.

**Land Use: Study Locale Barriers**

In the greater Rochester area, large expanses of affordable land within a 40-minute commute of downtown and the prevalence of outlying suburban business districts impede the support of urbanism for sustainable practices. Existing zoning ordinances create a barrier to multi-use higher density development in the townships that make up the greater Rochester area. Many surrounding towns, in an attempt to protect against overdevelopment and maintain the “small town” aesthetic, have instilled “green print” plans which allow existing farmland and naturalized areas to be protected from potential development by purchasing their building rights. These same suburban towns and others have established zoning areas where lot size minimums ostensibly further protect the naturalistic aesthetic. Lot minimums require anywhere from 2-5 acres for each single-family dwelling. The townships see this as a method of protecting the

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89 Behen 1.22.
environment, but according to the literature, this extravagant use of land becomes the antithesis of sustainable.

The inclusion of multi-use high-density New Urbanist type communities within this market is incurring a “not in my back yard” (NIMBY) response from homeowners. As the recent decline in the housing market has hit this region later than other parts of the nation, homeowners have become much more concerned with protecting the value and marketability of their homes. Although Rochester’s real estate market was late to absorb the hit of the mortgage crisis, in the third quarter of 2010, when the crisis was perceived to be diminishing in many parts of the nation, sales of homes were down 11.4%.90

Studies show that investment risk is a high factor in keeping homeowners out of major urban centers and high-density living.91 In the Rochester region this is no different. In Pittsford, a mid-sized suburb and the most affluent of the suburban townships, zoning plans have delegated multi-family housing to less desirable neighborhoods adjacent to industrial and commercially zoned areas (Appendix A, Map 1).92 On the other end of the

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90 GRAR np.
91 Senior, 339.
92 Behan, 1.12.
spectrum, Greece, a blue-collar suburb which has the largest population of the suburban townships, has integrated multi-family living units within its single-family areas (Appendix A, Map 2). The incidence of multi-family housing within this town still remains at a slight 2% of the total land area while 42.5% is delegated to single family.\textsuperscript{93}

Single-family detached homes constitute the preponderance of residential stocks at a hefty 75%.\textsuperscript{94} Although both towns are reaching build-out status, only Greece has shifted development towards multi-family housing as a solution to its land crisis.\textsuperscript{95}

It could be argued that the NIMBY mindset arises in areas with higher property values, but in reality, even within mixed-use areas, residents often respond to any alteration in zoning with protest. Change is rarely embraced. If this pattern holds, then the future for New Urbanist and high density living environments may be restricted to lower income, commercial and industrial areas. This further impedes the implementation and viability of sustainable high-density development.

\textsuperscript{93} Clough 2.3, 2.4.
\textsuperscript{94} Clough 2.8.
\textsuperscript{95} Clough 2.4.
**Code conflicts**

A functional conflict arises when alternative systems, methods of construction and design elements are integrated into home designs. The current system of construction codes can inhibit ingenuity and innovation. These codes, which are intended to safeguard the health, safety and welfare of the public, also serve to inhibit the more comprehensive definition of “societal welfare” by discouraging sustainable construction solutions. Codes, which are often prescriptive in form, discourage variation from standard construction methods. The codes were written to consider substitution of alternative materials as stated in the Residential Code of New York State:

*R103.3 Alternate materials, design and methods of construction equipment:*

“This code is not intended to prevent the use of any material or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been approved by the code enforcement official or, the State Fire Prevention and Building Code Council.”

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96 New York State, Department of State, 1.
Code officials will argue that this clause initiates an open process for acceptance of alternative methods. Although this is formatted to be overtly accepting of substitution, the reality of implementation becomes far more complex for the applicant, especially when considering alternative construction techniques such as rammed earth and straw bale. Requirements for acceptance of alternative systems rely on inclusion of supporting documentation of how alternative systems and materials meet the standards set forth in the code, documents which are often not readily available. Overwhelmingly, this puts an undue onus on the developer, builder or individual, to educate officials in sustainable practices. The lack of available supporting documentation, likelihood of additional time commitments, and the perceived additional costs necessary to pursue approval can inhibit applicants from pursuing beneficial change.

A 2002 study conducted by David Eisenberg, Robert Done and Loretta Ishida of the Development Center for Appropriate Technology demonstrated that sixty-five percent (65%) of those seeking code approval stated that they chose not to specify green systems over concerns that they would not be approved.\textsuperscript{97} The study further determined that

\textsuperscript{97}The Development Center for Appropriate Technology is a non-profit organization that works towards overcoming the institutional barriers to sustainable building and development; Eisenberg, et al. 16.
primary reasons for denial of alternative green systems were: code incompatibility (due to letter or spirit of the code), knowledge deficits on the part of the code enforcement official, and insufficient time to acquire knowledge. The opposite effect was also shown. When code officials had a sufficient knowledge base, were presented with supporting documentation through product training and research, code passage was supported.

The REScheck system is intended to simplify planning compliance with state and national energy codes. This system, which is intended to clarify and ease the compliance certification process, instead complicates efforts of builders to permit sustainable homes. These evaluations do not allow for alternative HVAC system trade-offs. Often this causes issues with the local permitting officials as they may not denote compliance when in reality, if the increased efficiency of these systems were incorporated, compliance would far exceed standards. Builders rely on the knowledge base of the permitting official to understand the differences of these systems. Without a heightened understanding, the REScheck system becomes the antithesis of simplicity.

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98 Eisenberg, et al. 12.
99 Eisenberg, et al. 12.
Codes are currently aimed at construction methodologies that have been practiced for generations. Regulations must turn away from prescriptive solutions, and open the path for structural, systematic and design innovation by integrating performance-based criterion. Code officials’ lack of knowledge of alternative systems, outdated standards and complexity of compliance systems combine to create a perfect storm for most developers pushing sustainable development out of the mainstream. A synergy between developers and codes enforcement must be created that integrates all parties into the design process.

**Appraisal and Assessment and Valuation:**

Building sustainable infers using minimal quantities of materials, (further minimizing embodied energy), and often alternative construction methods (those other than stick-built: rammed earth, straw bale, earthworks and so on). This also entails consideration of smaller dwellings. The implementation of alternative systems, and downsized homes raises an issue with appraisal and assessment by the banking industry, the real estate industry and local tax assessors.
The questionable viability of financing impedes builders and homeowner’s commitment to constructing alternative non-stick built systems. As most financing systems are tied to code compliance, if town officials are stretching codes for applicability and compliance, the bank appraiser may disagree with the level of compliance and deny loans.\textsuperscript{100}

With the mortgage crisis of recent years, banks have become more conservative in their lending practices; the viable recovery of investment must be established. Assessment systems require viable comparatives of sales in order to establish the market value of properties: how do you establish the value of a straw bale or rammed earth home under these standards if comparable stocks do not exist? More recent changes in real estate appraisal standards within the Rochester locality require comparatives from a twelve-month cycle. This further impedes the availability of reasonable assessment and creates a barrier to financing.

\textsuperscript{100} Henderson, 267
Appraisal systems based on valuing a home by its square footage and lot size do not take into consideration features which may give added market value to the property such as energy efficient systems that reduce monthly bills. This results in tax assessments and bank appraisals that rarely meet construction costs. Unless worth is given to green features such as energy efficient systems, which have a verifiable value, added initial costs may be impossible to integrate when financing options are limited.

**Implementation Issues**

Traditional practices in residential housing focus on repetitive use of architectural plans and quick construction; the commitment of architects and builders is unfortunately short-term. Their aim is to reduce initial costs and make a fast profit. With limited architectural involvement, the integration of whole design practices and teaming required for a full implementation of sustainable development becomes improbable. Additionally, it becomes difficult to develop a communal knowledge base, which extends beyond individual properties.\(^{101}\) This is the nature of the home construction industry as it exists today.

\(^{101}\) Pinske, 3
Certification Programs:

Certification programs are intended to ease the implementation and guide trade professionals through the complexities of building functional, efficient, healthy and sustainable structures. But integrating these systems into the design and construction process requires hours of training: time, effort and investment to gain the prerequisite knowledge base. These prerequisites increase according to the complexity of the system used. This may be a venture beyond the means of many trade professionals. There are a myriad of systems in place, but few are regularly implemented in the homebuilding industry as extensively as ENERGY STAR (Table 3.1).
Table 3.1

<table>
<thead>
<tr>
<th></th>
<th>ENERGY STAR for Homes</th>
<th>LEED for Homes</th>
<th>National Green Building Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year Launched</td>
<td>1995</td>
<td>2006</td>
<td>2009</td>
</tr>
<tr>
<td>Number of Homes Certified</td>
<td>1,142,247 (1)</td>
<td>3820 (2)</td>
<td>598 (3)</td>
</tr>
</tbody>
</table>

(1) As of November 6, 2010
(2) As of October 5, 2010
(3) As of November 8, 2010. If NAHB Green Building Guidelines are included (which predates the standard, this number totals 1709

ENERGY STAR:

Homebuilders and homeowners alike have embraced ENERGY STAR standards as they cater to traditional construction methodologies, follow a simplified format and the cost of evaluation is minimal. The conservative homebuilding industry has perceived this to be a viable marketing tool that feeds their need for quick turn around and minimal commitment to innovation. This singular goal of energy efficiency is an admirable

102 Reeder, 4: modified from Table 1-2
103 EPA,DOE np.
104 Leed for Homes Program, np.
105 Email correspondence between author and Michelle Desiderio, NAHB Research Center, November 8, 2010
target, but it is based on exceeding a seventeen-year old standard too easily achieved, setting a low benchmark for energy efficiency. ENERGY STAR, which also rates lighting, HVAC systems, water heaters and other home appliances for energy efficiency, has been in question as to the credibility of its labeling process. In 2009, the U.S. Department of Energy conducted an audit of the ENERGY STAR program and found: “the Department had not developed a consistent, comprehensive testing program for all of its Energy Star product categories.”¹⁰⁶ An evaluation of currently qualified appliances demonstrated a failure to meet ENERGY STAR criteria.¹⁰⁷ No independent evaluation system is in place to watchdog the misuse of the label.

Although there are imperfections in this program that must be addressed, ENERGY STAR’s success is based on its simplicity, approachability and minimal cost of implementation. Referencing the qualities of this program will lead to a more comprehensive viable system for rank and certification of sustainable homes which industry can rapidly embrace and mainstream.

LEED for Homes:

One of the most prominent sustainable building programs, the U.S. Green Building Council’s Leadership in Energy and Environmental Design (LEED) program, has gained popularity in the commercial and institutional sectors. The U.S. Government requires LEED certification for general administration buildings enhancing its credibility.\textsuperscript{108} Several states also require government projects to meet this standard, including California, Pennsylvania, Maryland, Massachusetts, New Jersey, New York and Oregon.\textsuperscript{109} The system is widely lauded for comprehensively approaching sustainable development in its perceived inclusion of macro and microenvironmental impacts, efficiencies of natural resources and materials, and promotion of whole building design and innovation. But the merit of LEED as a fully sustainable system has been brought into question: specifically, in its lack of focus on the buildings’ interior environmental health.

Environment & Human Health Inc. (E&HH), a non-profit organization dedicated to research and education to protect human health from environmental harms, released a

\textsuperscript{108} Horvat, 14
\textsuperscript{109} Horvat, 14.
report examining the LEED program for its health benefit in defraying environmental health risks.\textsuperscript{110} The report found that LEED’s focus on energy efficiency neglects to consider the impacts on overall human health.

“The Green Building Council’s award of “platinum”, “gold”, and “silver” status conveys the false impression of a healthy and safe building environment even when well-recognized hazardous chemicals exist in building products.”\textsuperscript{111}

An examination of the LEED for homes program backs up their assertion. There is no section in the LEED program that addresses the impacts of VOC’s and chemical/biologic air impacts. The systems’ category, which addresses indoor environmental quality (IEQ), is articulated as intending to improve “indoor air quality by reducing the creation of and exposure to pollutants.”\textsuperscript{112} The focus of this category is on ventilating combustion sources, spot ventilation and air filtration: important aspects that should not be ignored. But no attention is given to source pollutants within the structure. The LEED system awards maximum one point credit for moisture control, which is integral to controlling

\textsuperscript{110} Energy & Environmental Health, Mission Statement.
\textsuperscript{111} Energy & Environmental Health, 50.
\textsuperscript{112} -USGBC, iv.
biologic contaminants. Considering the 136 potential points for LEED Platinum certification (Table 3.2), this seems an egregious oversight.

**Table 3.2**

<table>
<thead>
<tr>
<th>LEED for Home Certification Levels[^113]</th>
<th>Number of LEED Homes points Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Certified</td>
<td>45-59</td>
</tr>
<tr>
<td>Silver</td>
<td>60-74</td>
</tr>
<tr>
<td>Gold</td>
<td>75-89</td>
</tr>
<tr>
<td>Platinum</td>
<td>90-136</td>
</tr>
<tr>
<td>Total available points</td>
<td>136</td>
</tr>
</tbody>
</table>

Lead author of the E&HH report, John Wargo, professor and chair of Environmental Studies at the Yale School of Forestry & Environmental Studies firmly argues that:

“This fact points up a serious flaw in the program: The job of setting standards for new construction – particularly health standards- should not be left to a private-sector organization dominated by members who profit form the sale of goods and services to the building sector.”[^114]

This argument has recurred throughout the literature.

[^113]: USGBC, iv, direct reproduction of matrix.
[^114]: Wargo, np
The complexities of the LEED system have further made it unapproachable by all but niche homebuilders or those who work in both commercial and residential sectors. Builders and homeowners alike perceive the added costs of certifying LEED for home building to be a barrier to usage. In email correspondence with Maureen Mahle, of Steven Winter Associates, an architectural, engineering and research firm which has worked LEED for homes projects in western NY, she denotes that a standard added cost for LEED certification (both hard and soft included) ranges between 0.5-3% increase over ‘original’ or ‘standard’ design and construction.115 Although this percentage may seem small, this equates to a potential $7,500 on a $250,000 home. With the conservatism of the Rochester real estate market, and the recent downturn in the home building marketplace, this would translate as an excessive amount for a non-aesthetic enhancement. In the greater Rochester area, no LEED for Homes certified projects have been constructed as of November 2010.116

116 LEED for Homes Program, np.
National Green Building Standard:

In 2007, the National Association of Home Builders (NAHB) and the International Code Council (ICC) teamed to format a standard for green development. The resulting publication of the 2008, *National Green Building Standard*TM (NGBS) was based on the NAHB Model Green Home Building Guidelines developed in 2008. The NGBS has since replaced the retired Model Green Building Guidelines (as of September 2010). Having received approval from the American National Standards Institute (ANSI) in 2009, this standard is intended to be a format for local, state or federal adoption of green regulation in new residential construction, development and renovation. The standard goes beyond the International Building Codes and although both NGBS and LEED for Homes work on a points system, the support of ANSI gives it greater credibility to the trade. The NGBS can be used as an independent rating system, or as intended, as the basis for governmental regulations. Further, should governing bodies adopt this code, requiring compliance to be standardized, this significant barrier to the trade will be in essence eliminated.
Creating a new vocabulary:

There are a myriad of programs in the market, but no one stands as the leader having obtained broad acceptance in the residential industry. Each system offers different standards and focuses on sustainable features (Table 3.3).

Table 3.3

<table>
<thead>
<tr>
<th>Category Types Considered in Rating Building Performance¹¹⁷</th>
<th>Energy Star for Homes</th>
<th>LEED for Homes</th>
<th>National Green Building Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Selection</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Site Development</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Energy Efficiency</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Water Conservation</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Material and Resource Efficiency</td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Indoor Environmental Quality (IEQ)</td>
<td>✓ (1)</td>
<td>✓ but no points for source pollutants</td>
<td>✓</td>
</tr>
<tr>
<td>Owner/Tenant Education</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Other</td>
<td>Innovation and Design</td>
<td>VOC’s and chemical impacts on IEQ</td>
<td></td>
</tr>
</tbody>
</table>

¹¹⁷ Reeder, 5 modified from Table 1-3

(1) Optional for homes permitted before January 1, 2011
With the intricacies of existing systems, the industry is reticent to consider innovation and exploration that implementing sustainable methods require. The lack of expertise and resources can create an environment of increased costs due to extended construction schedules.\textsuperscript{118} The time, cost and increased involvement required by architects and builders to implement these systems become a deterrent to their broad acceptance within the homebuilding industry.

ENERGY STAR and LEED have benefitted the industry firmly with their presence, albeit an imperfect interaction, through bringing sustainability to the forefront of the trades vocabulary. Although the general understanding may be unclear, the dialogue has begun: from there change can happen. The trade must open up to creating a vocabulary of sustainable solutions, which can be quickly and efficiently implemented. The turn to sustainability in the residential sector is still in its infancy, and it is hoped that with time, a system will evolve to take the lead role as an approachable, viable framework, which will gain acceptance within the industry.

\textsuperscript{118} Choi, 111.
Conclusion:

In their publication “Overcoming Barriers to Innovation in the Home Building Industry”, the U.S. Department of Housing and Urban Development Office of Policy Development Research has stated that:

“The best time to advance innovation is during a housing recession when builders are looking for something to make their product distinctive. When the housing market is booming, builders are likely to be resistant to innovations that might slow down their standardized processes. To be successful, innovations must be sensitive to market timing.”\(^{119}\)

The homebuilding industry has come a long way in the last decade towards bettering practices of energy efficiency. Although construction methodologies in the broad spectrum remain staid, as they have for over a century, some areas have improved. It is within the reach of the homebuilding industry to make the shift to standardizing sustainable practices but this can only occur with widespread commitment. In this era where the homebuilder has been hit hard by a downed economy, increased energy costs

\(^{119}\) U.S. Department of Housing and Urban Development, vi.
and a collapse in the real estate market, the turn to sustainability can potentially be a saving grace.
Part III: Evaluating the Homebuilding Industry in Rochester, NY.
Chapter 4: Survey Mechanism

Research Aims:

This study began with a literature review addressing the conceptual problem of holistically evaluating sustainability and its key elements. These elements were then used to establish the known barriers to sustainable development defined by academia in order to ascertain how these determined barriers are directly affecting the greater Rochester area. This information was used to collectively coordinate and direct a survey of primary decision makers in the homebuilding industry to evaluate their understanding and application of sustainable practices, their attitudes towards the field and how the defined barriers are affecting the Rochester, New York marketplace.

The intent of this research is to establish the veracity of the materials and information found in the literature review and to expand the informational base. To date, there has been no evaluation of the residential builder which examines attitudes, or practices of holistic sustainable construction. Most queries of the industry are focused on energy efficiency and alternative energy systems. This study will fill some of these information gaps.
The research is focused on study of the greater metropolitan area of Rochester, New York. Rochester’s conservative marketplace has quickly embraced the standardization of energy efficiency, such as ENERGY STAR products for the new home market. Many newly built mid-to-upper level homes are constructed to this standard, but no residential homebuilders have endeavored to implement more broadly defined sustainable construction practices. As New York’s third largest city, Rochester has long been renowned as being among the top ten cities (ranking second), considered representative of consumers as a whole: an ideal consumer test market. This makes it an ideal subject for study of builders’ attitudes towards sustainable practices and can be indicative of similar patterns in other American cities.

The greater Rochester area lies primarily within Monroe County, in western New York State. The surrounding counties, Wayne, Ontario, Livingston, Genesee, Wyoming, Orleans, Seneca and Yates are also considered part of this demographic. The greater Rochester area has a population of approximately 1.1 million people. The area’s

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120 Business Editors, np.
121 GRE, np.
largest population densities are situated within the boundaries of Monroe County, which hosts the urban city center of Rochester and its adjacent suburbs, with the surrounding counties being more rurally based. Housing values range between counties with the higher values in the more populated areas of Monroe and Ontario Counties. Monroe County’s median housing value is established at $134,500 with neighboring Ontario County having the highest median values at $136,600.\footnote{122}  

**Survey Mechanics**

The survey was divided into three parts: establishing the builders’ professional knowledge base, frequency of practical implementation and determining their attitudes towards sustainable development. Survey participants were examined for demographic purposes: defining elements such as price range, mean home size and amount of homes built yearly in order to establish the sample. Participants were categorized by their level of knowledge of sustainable practices through certification, professional development seminar, self-education and other methods using a nominal scale of measure.

Builders were presented with the basic category types to be considered in rating a buildings’ performance as noted in Table 3.3. These elements were derived from the evaluation of the three most often implemented programs: ENERGY STAR, LEED and the NGBS (previously known as the National Association of Homebuilders Green Building Guidelines). Builders’ levels of confidence in applying these aspects of sustainable development to their residential construction projects were evaluated using semantic differential scales of measure ranging from “very confident” to “not confident at all”. If the builders demonstrated a high level of confidence in their ability to apply specific sustainable practices then it can be surmised that they have either increased experience implementing the practice or a sufficient knowledge base on the topic. Builders were given follow up questions using ordinal scales to establish their frequency of application of these standards and determine if knowledge coalesced with practice.

Finally, questions ascertained builders’ perceptions of market presence, costs, property valuation, benefits and impacts. Further, attitudes and perceptions of the barriers created by codes and zoning were evaluated.
Sampling

The Rochester Home Builders Association (RHBA) was contacted and presented with the proposed research in order to gain broad support for the study. For over 70 years, the RHBA has worked to improve the quality and professionalism of the homebuilding industry in the greater Rochester area. Their goal is to support local builders though offering educational seminars, workshops and training programs to keep builders up to date on the latest industry trends, new technologies and innovations. The RHBA’s endorsement of the survey increased the credibility of the research to the local trade and promoted builder participation. The information drawn from the study will also serve to aid the RHBA in their endeavors to educate and promote sustainable practices within the area.

A Web-based survey mechanism published, gathered and filtered responses. Publicly accessible RHBA membership directories and local phone listings established the builder sampling as these were deemed the most prevalent resourcing of builders by the average homeowner. RHBA affiliated trade professionals (non-homebuilders) were excluded from the sample. The RHBA listings produced one-hundred-and-fourteen (114) candidates for the survey. Sixty-eight (68) additional homebuilders were identified from
phone directory listings and contacted directly in order to gain their email contact
information. Only 28 of these candidates were willing to share their contact information
for potential participation. Builders were contacted twice weekly by email with requests
to participate in the survey while it was open. The survey remained open for four weeks
in order to give ample opportunity for participation. A larger response rate was noted by
the phone directory contacts than the RHBA. Participation values ranged from 46% of
those contacted through the phone directories, to only 26% of RHBA members. The
reasons for a stronger response by non-members are unknown.

Final respondents demographics varied as would be expected. All homebuilders
surveyed built single-family dwellings with just over 21% having experience building
multi-family, apartments and condominiums. Housing values ranged primarily in the
moderate value range as follows in Figure 4.1.
Almost 77% of respondents were small volume builders producing 10 home units or less per year. 17% produced 10-25 units and 4.3% were large production builders producing 50 or more units per year. This sample range coalesces with variations within the original population.

The majority of builders surveyed had some exposure to sustainable development education through their participation in training, seminars or other professional development focused on sustainable building practices (Figure 4.2).
Survey respondents represented a suitable mix of experience and knowledge levels on the topic of sustainability. Ten-percent (10%) of respondents employed individuals with LEED credentials, and thirty-one-percent (31%) employed NAHB Certified Green Professionals. The presence of many survey participants with green certification denotes a high population of individuals educated in the field of sustainable development.

Figure 4. 2: Demographic of Builders Participation in Professional Development Focused on Sustainable Practices.
Chapter 5: Survey Results

**Information Gaps**

The largest barrier to sustainable residential development identified was the lack of affirmed respect and widespread understanding of sustainability as a whole. The resulting study demonstrated significant problematic areas that should direct future research focus towards the quality of education in both green certifications and professional development seminars.

Builders were evaluated for their confidence levels in their ability to apply certain basic sustainable features to their residential construction projects. This worked under the hypothesis that if builders had ample understanding of sustainable building practices and methods, their confidence in their professional abilities to implement these features would be notably higher. Builders were then queried on their consistency of practice of the basic elements of sustainability to determine if implementation coalesced with their knowledge base. This should result in fairly equal proportion of consistency. Hypothetically, builders with lower levels of confidence should be exhibiting little or no application of these methods in their construction practices. Inversely, those with higher
levels of confidence would be expected to demonstrate higher application rates. If there were variations of this dynamic due to other factors such as cost, market demand or negative attitudes towards the field of sustainability, it would be expected to err with lower consistency of practice and varied levels of confidence in their abilities to apply these practices.

**Sustainable Construction Practices: Land and Ecosystems**

The survey evaluated three basic environmental systems: geography, ecosystems and natural waters. Respondents were questioned as to their confidence in ability to implement basic practices including: minimizing impacts to the geography, protection and restoration of ecosystems and protection of natural waters on site.

Builders’ responses to this portion of the survey demonstrated an anomalous rift between their confidence and their consistency of application. 62.5% of respondents (47.5% confident, 15% very confident) exhibited confidence in their abilities to minimize impacts to the geography during the construction process (Figure 5.1).
Figure 5.1: Builders’ Confidence in their Ability to Minimize Geographic Impacts

This number was contrasted by an 82.5% consistency of practice (60% often, 22.5% always) response rate (Figure 5.2). The builders expressed considerably less self-assurance (over 20% variant) in their knowledge base than is demonstrated in their portrayal of actual practices. If they are effectively and consistently practicing these standards regularly as they represented in their responses, the confidence levels should coalesce more appropriately with their conduct.

Figure 5.2: Builders’ Consistency Minimizing Geographic Impact on Site
This rift between confidence and consistency of application is even more notable when evaluating the protection of ecosystems and natural waters. 53.8% of homebuilders demonstrated a high level of confidence (17.9% very confident, 35.9% confident) in their ability to protect and restore ecosystems (Figure 5.3).

![Confidence in Ability to Protect and Restore Ecosystems](image)

**Figure 5.3 : Builders’ Confidence in Protecting and Restoring Ecosystems on Site**

Almost ninety percent (43.6% always, 46.2% often) responded that they consistently protect ecosystems on site during construction (Figure 5.4). This is an extraordinary proportion when considering that a little over half of builders exhibited confidence in their abilities to apply this practice to residential construction.
The question of protecting ecosystems was then broken down into individual elements in order to discern which elements were of primary focus and understanding. The responses demonstrate overwhelming unbalances between protecting waters on site rather than the restoration of native plants in the land based ecosystems. Over 50% of respondents denote that they “always” protect natural waters on site (Figure 5.5), and appropriately dispose of wastewater, while only 15% (Figure 5.6) practice this same consistency in restoring ecosystems with natural plants.
Builders seem clear in their awareness of their impacts on water quality, yet do not perceive a similar impact on the land, soil and associated biota. A major lapse of understanding of these systems and appropriate methods of practice is demonstrated by these imbalances between confidence and consistency of application. They stand in stark contrast to objective observation of development in the area.
Standards of practice locally have changed little if at all during the past two decades. Lot clearing begins with land re-contouring in order to maintain a uniform flat profile readily accepting of standardized house plans. Few homes are designed to suit the natural forms and undulations of the topography including many of the custom homes and large mansions whose owners could feasibly afford custom designs to accommodate these unique settings. The humus-rich topsoil is then sold and only small amounts are retained. Trees and other biota are removed during this process. An occasional large tree will remain if it is distant enough from dig sites and deemed viable to survive the construction process. After construction is complete, one to two inches of topsoil is reapplied to the lots. Regeneration of ecosystems in these instances rely on seeding lawns and installation of manicured landscape materials that infrequently consider locally indigenous plant life.

The only major alteration to lot preparation practices in the last decade is the widespread requirement “green spaces” by towns for subdivision approval. These green spaces usually consist of a certain percentage of the total subdivision acreage (dependent on
town requirements) including storm water runoff control systems and retention ponds that are fed by neighborhood storm drains. Most townships and builders consider these to be a naturalizing element to the neighborhoods. Restoration of flora in these areas consists of field seeding to minimize maintenance costs and accommodation of biannual mowing and installation of inexpensive shrubs or trees that are not locally indigenous.

Years later, indigenous biota and natural systems will evolve in these controlled areas but the conditions limit these systems. The flora and fauna that survive are those able to sustain the harsh increases in toxins in the soil and water due to chemical applications to lawns, storm drain dumping and high levels of seasonal salination due to winter road salting practices. No focus is made to re-establish viable, balanced ecosystems producing valuable goods and services. “Naturalization” is translated by being any specimen of plant life present.

It would be expected for builders’ confidence levels to increase when evaluating respondents who had higher levels of green education such as professional certifications, frequent training and seminars. Although their consistency of application raised
somewhat in these areas, their confidence levels were in alignment with the broad sample responses. Inversely, respondents who have “never” participated in training, seminars or other professional development focused on sustainable development practices had confidence numbers that also coalesced with the broad sample. Their consistency of application waned only slightly.

This data strongly enforces the known presence of information gaps throughout the industry including those who have pursued green certifications and frequent training on the subject. The educational focus is neglecting the impacts of residential construction on the macroenvironment. This suggests a serious issue with the educational system in both professional development training and seminars and green certification programs.

**Sustainable Construction Practices: Building**

While builders surveyed seemed unclear on the environmental practices of sustainable development, their confidence and practice in certain aspects of the physical structure exhibited more clarity. Responses of confidence in their ability to implement and
consistency of practice coalesced more appropriately with procedures that deal directly with the physical building and associated construction processes.

Energy

As the literature expressed, energy efficiency was by far the most accepted and seemingly understood of all the sustainable building practices. Among the broad spectrum of respondents, 89.7% (33.33% confident, 56.4% very confident) were exhibiting high levels of confidence in their abilities to apply energy efficient standards to their residential construction projects (Figure 5.7). These numbers were reinforced with a consistent implementation of energy efficiency to meet or exceed ENERGY STAR standards (Figure 5.8). These numbers are not to infer that ENERGY STAR certification is being pursued, simply that builders use this standard as a baseline.

Figure 5.7; Builders’ Confidence in their Ability to Implement Energy Efficiency to Meet or Exceed ENERGY STAR Standards
Builders do not broadly understand alternative energy systems as would be expected at this stage in the development of the industry. There seemed to be an awareness of the topic but no strong feelings one way or the other (42% neither confident or not confident) as to their abilities to implement these systems. Although the majority of builders (45%) rarely or (17.5%) never implement these practices, 37.5 % of the broad sample sometimes or often implemented alternative energy systems. These respondents were notably building in more rural areas where natural gas infrastructures do not exist and the payback cycles are readily defined as an alternative to more costly to oil or propane systems. Confidence levels were distinctly higher with those trained in LEED certification with entirety of this group expressing high levels of confidence in their ability to implement alternative energy systems.
The high confidence levels and consistent application of energy efficiency standards by all portions of the sample demonstrates the impacts of communication and intensive industry focus on the subject. Even those who “never” participate in green professional development applied these standards regularly. Energy efficiency has become part of the common societal vocabulary. Through consistent industry support, focused programs such as ENERGY STAR and government-sponsored incentives, it has gained acceptance and become assimilated as an industry standard. Although alternative systems have not taken hold to the extent of standard energy efficient systems, education in this area is notably being communicated effectively. With the increased application of alternative energy systems in rural areas, where costs would most profoundly be deferred by payback cycles due to the lack of natural gas infrastructures in the area, it is clear that this segment of the sustainable development industry is in the process of becoming standardized in these rural regions.

**Materials**

The most simplistic aspect of practicing sustainability involves the use of materials which are more “green friendly”: Forestry Stewardship Council (FSC) certified woods, biobased and recycled content materials as well as locally resourced products (within the 500 mile...
supply radius). Although product awareness is essential to propelling the adoption
these materials, no special education is required to implement use; simply substitute
materials.

Respondents had lower levels of confidence in the areas that dealt specifically with green
certified materials (Figure 5.9). The majority demonstrated ambivalence in their
confidence levels on all materials. Distinctly higher levels of unease exist with FSC
certified and biobased products. The highest confidence levels are reflected with
recycled content materials. The majority of builders did not integrate use of any of these
materials on a regular basis (Figure 5.10). The largest frequency involved recycled
content materials.

Figure 5. 9: Builders’ Confidence in Using Sustainable Materials
Recycled content materials have taken a notable role in the broad consumer marketplace.

As with energy efficiency, the topic of recycling has become integral to the broad societal dialogue on sustainability and “greening”. FSC and biobased products are still not as widely recognized in the marketplace. While the focus on recycled content materials is admirable, they hold far less value as a sustainable material than other potential options such as biobased products.

FSC certified materials have become readily available in greater Rochester area, and throughout the country. Big box home improvement retailers are now carrying their
products for consumer purchase. Although FSC certified products are becoming prevalent throughout the marketplace, their definition and purpose is still unknown to most. It would be expected that awareness of these materials would increase with professional training or certification. This was not the case. Respondents with frequent green training and professional development had lower rates of confidence in their ability to use these products. This stands as a further indication that educational systems are ignoring the more holistic aspects of sustainability.

Biobased products are also not making their mark on the broad professional and societal dialogue on sustainability. The notable decrease in confidence in using these materials (22.5% not confident at all) infers a distinct misunderstanding in their material properties or definition of the term within the industry.

This knowledge gap in product usage is distinctly remarkable when evaluating the responses of builders who have built LEED certified projects. LEED confidence levels with biobased materials are significantly less than the sample as a whole (Figure 5.11). This disparity was not observed with FSC certified or recycled content materials. This
may be due the way the LEED system is written which creates a rift between actual sustainable materials and how they becomes relevant to the LEED rating system.

![LEED Experienced Builders' Confidence in Using Biobased Materials](image)

**Figure 5.11: LEED Experienced Builders’ Confidence in Using Biobased Materials**

Meredith Chambers and Mikesch Muecke at the Center for Industrial Research and Service at Iowa State University examined the disconnect between LEED systems and biobased materials and determined their absence within the system as a major oversight of the program and an impediment to the growth of the biobased materials industry.\(^{123}\) These materials are not categorically promoted within the LEED system with the exception of the single point available for MR 6, Rapidly Renewable Materials.\(^{124}\) Otherwise, these elements had to be translated into use in their low emitting material

\(^{123}\) Chambers and Muecke, 104.

\(^{124}\) Chambers and Muecke, 104.
points categories. This is an inherent flaw in LEED education as biobased materials are ignored. Further it emphasizes the complexity of the program and its point systems causing a rift of understanding between actual material application and credits.

The United States Department of Agriculture (USDA) has recently created an online database that will aid the industry in gaining more easy accessibility to information on biobased materials and products. The USDA BioPreferred program seeks to promote and increase the purchasing of biobased products. As of February 21, 2011, USDA certified biobased product labeling is available to industry for certification of products and materials. With increased awareness of products, it is hoped that increased usage may permeate the residential construction industry in the near future.

The specification of locally resourced materials (within a 500 mile radius) demonstrated an extremely low rate of application (33.5% never, 12.8% rarely and 38.5% sometimes responses). These numbers are surprising considering the centralized location of the greater Rochester area. The radial 500 mile map (Appendix B, Map 3) includes almost

all of New England, extends into large portions of Ontario Province, ranges westward to Chicago, Illinois and south to North Carolina: a large industrial portion of the United States. Builders may be using local materials without realizing, but without intent behind specification, green standards are not being addressed.

It can be concluded that the limited rates of builders’ confidence in sustainable materials specification is due to a lack of education and materials awareness. Sustainable materials are readily available in the region. No special skill is required to use these materials, but products must be sought out. A large portion of the consistency of application of some products such as FSC certified and biobased materials may rest in added costs. There are currently increased costs associated with many of these products but with the introduction of these products to large home improvement retailers, this disparity will rapidly minimize.

**Waste**

One of the most well-known and basic tenets of sustainability is the reduction of waste. The concept of ‘reduce, reuse, recycle’ has been integrated to the broad vocabulary of society and has taken firm hold in the greater Rochester area. Monroe County has been
progressive in continually expanding their recycling programs for over 20 years.

Although homeowners have embraced recycling, the residential building industry has not yet assimilated these practices.

Waste on building sites can be extreme. Overstock lumber, gypsum, paints and other materials are often not returned to vendors unless there is sufficient quantity to justify shipment. Often, these usable materials end up in the dumpster. Recyclable construction scrap is being discarded without regard for potential of reuse. Few builders are implementing recycling practices on site. 53.8% of builders surveyed responded that they rarely or never implement recycling practices (41% rarely, 12.8% never). Only 23% responded that they often recycle on site.

Annual materials audits allow builders to review levels of material waste in order to minimize cost overruns. This not only meets sustainability standards but also stands as a beneficial business practice. Few builders exhibited any level of confidence (less than 16%) in their ability to conduct annual materials audits. Only 12.8% of builders regularly implement this practice. This is a surprising result as this practice not only addresses
sustainability, but also serves as an important potential cost cutting measure for builders during these harsh economic times.

**Sustainable Construction Practices: Interior Environment**

Indoor air quality and livability are primary elements of sustainability that directly affect the health and well-being of the inhabitant. In the field of sustainability, this is addressed through the awareness, reduction and control of VOC’s and implementation of UD standards.

 Builders exhibited high levels of confidence with their ability to implement UD standards with 22.5% rating in the “very confident” category and the largest proportion answering “confident” at 35.0%. Only 15% rated any unease with the topic. ADA and its tenets have become a part of the public consciousness and has gained widespread acceptance in practice in the building industry. Since the passage of the ADA in 1990, the industry has had time to evolve a level of comfort with these standards with defined guidelines that are easily referenced.
Figure 5. 12: Frequency of Applying Basic Universal Design Features

Consistency of application varies with the most common elements being the installation of lever door handles and comfort height toilets, simple acts which does not require alteration of design and negligible expense increases (Figure 5.12). Roll in entries and showers are less often implemented, as these are more costly, planning intensive and may require alteration of site, and home plans.

Although UD has become prevalent throughout the commercial and institutional construction sectors, little has been gained towards promoting the implementation of UD in residential settings. The average homeowner does not see the applicability of UD
standards to their homes as relevant. It remains restricted to individual occurrences of customizing homes for clients with specific physical needs. Further focus needs to be made in communicating the importance of these practices in all built environments.

Where UD standards are more easily graspable by homebuilders, the impacts of indoor air quality are less immediately tangible. Although professional development seminars in the field of sustainability and green building do give some focus to indoor air quality standards, the reasons behind these requirements may be vague to many. Almost 58% of builders stated an understanding of the health benefits of sustainable building. Yet few builders consistently reviewed their materials for VOC emissions (Figure 5.13). The most common practice in controlling VOC’s within the homebuilding industry is the application of low or no VOC paints (30.8% sometimes, 33.3% often).
Figure 5.13: Frequency of Applying Basic VOC Controls

Over 50% of builders sometimes or often installed whole house ventilation systems. It can be assumed that this trend has taken hold due to the standardization of radon testing for new and existing home inspections in the region. With the frequent implementation of these systems, which may incur added costs, it becomes apparent that builders are aware of some of the impacts of IAQ on the inhabitants yet instead of eliminating source contaminants they are opting to ventilate. This remediation may temporarily improve the homes microenvironment, but displaces the contaminants to the greater macroenvironment to further their negative impacts.
Sustainable Construction Practices: Infrastructure Barriers

The survey evaluated how the infrastructure barriers identified in the literature translated to the greater Rochester area. Many of the barriers identified in the literature were not translated as hindering practices in this region.

Building codes were not perceived as a major barrier to sustainable development within this market. Although builders expressed a belief that code officials had insufficient knowledge of alternative products and designs, they did not demonstrate this as being a sufficient barrier to specifying alternative systems. With low frequency of practice of sustainable development in the region, it can be surmised that these potential impediments have not come to the forefront of focus for the homebuilder.

The primary infrastructure barriers identified within the greater Rochester marketplace are zoning laws that notably discourage high density building in suburban areas. Respondents overwhelmingly agreed (42.1% strongly agree, 26.3% agree, 15.8% somewhat agree) with this contention. Builders have expressed a desire to build with higher density as it increases their profitability by offsetting exorbitant land costs, but
planning boards and zoning ordinances discourage these practices. The townships claim these practices to be necessary to support housing values and the naturalized aesthetic of the area.

**Educational Failures**

The residential construction industry has a long way to go towards integrating sustainability into their development practices. It is clear that education is the key. The disparities between confidence and consistency of practice clearly demonstrate a high level of doubt by builders that their practices are truly meeting sustainable standards. Professional development seminars, and training, as well as green credentials have been shown to aid in the communication of some aspects of sustainable development to the profession but these systems are not producing the knowledge base in practical implementation that should be expected.

The most significant finding of this study is the extent of the knowledge gaps within the homebuilding industry. 62.3% of builders surveyed agree that the primary concern of sustainable development is energy efficiency. This emphasized focus on energy
efficiency may ultimately become a barrier to holistically communicating sustainability. As builders gain their confidence in this area, they believe that they are addressing sustainable issues in their business. Without a more comprehensive dialogue the move towards sustainability will never be fully realized. The Rochester homebuilder does not have a clear understanding of what practices denote true sustainable development. A post survey comment made by a local homebuilder who holds NAHB Certified Green Builder credentials and frequents professional development seminars on sustainability summarized this thinking:

“I think that there is not a clear understanding in the industry of what sustainable building techniques are. Energy efficiency seems to be the primary factor that is discussed and implemented.”

-Survey Respondent

It has been demonstrated that residential housing has significant negative impacts on the environment, from construction practices, housing densities, materials usage, natural resource consumption and biosystem damage; to the inherent risks to human health and welfare through indoor air contaminants. The extreme lapse in education is more fully
understood when considering how respondents received the statement “Residential housing negatively impacts the environment.” Almost 87% of builders surveyed disagreed with this statement (Figure 5.14) with the largest proportion (almost 37%) strongly disagreeing. This is a most notable finding as across the board, builders were strong in their negative attitudes towards this statement.

**Figure 5.14: Builders’ Attitudes Towards the Impacts of Residential Housing on the Environment**

These numbers become even more extreme when examining the responses of those who frequently participate in training, seminars or other professional development focused on sustainable development practices. 71% of these builders strongly disagreed that housing has negative impacts on the environment (Figure 5.15). Educational systems are not
communicating the impacts, therefore the reasons for the industry to move towards standardizing sustainable development practices.

Figure 5. 15: Builders Who Frequently Participate in Professional Development:

Attitudes Towards the Impacts of Residential Housing

Although it is clear that there is a severe lapse in knowledge, and educational efforts are not improving this disparity, builders believe they have a true comprehension of sustainability. Only 37% of builders surveyed admitted a lack of understanding of the practices of sustainable development (Figure 5.16).
It is clear that builders have not assimilated the reasons and ultimately the motivations for embracing sustainable development practices and building sustainable homes. If this information gap is not addressed fully by the trade, affiliated industries and the certification programs tasked with educating the building professional, the homebuilding industry will never forward its practices towards addressing sustainability in its holistic form.

**Market Perceptions**

The homebuilding industry, like many is driven by its bottom line. In order for the industry to be motivated to overcome informational barriers and strive to integrate sustainable development practices into their methodologies, they must perceive the presence and profitability of a viable market. It has been shown that the consumer
marketplace, if appropriately educated is motivated to purchase sustainable home inventories. The majority of builders surveyed stated that increased sales and marketing stands as the best motivation for their companies to integrate sustainability into their construction practices.

Builders surveyed were notably split (48.8% perceive market presence, 51.3% see no market presence) on the existence of a viable market for sustainable homes in the greater Rochester area. Market studies have not been conducted specifically in this region, but it can be assumed that this market is commonplace with the greater population of the United States and would stand in alignment with the results of the RCLCO study.

A large production low-to-mid priced homebuilder made a notable comment in his post survey response:

“…in the past 5 years I have had only 1 person out of 500 even inquire about "green" products. Our clients are just not asking for it.”

-Survey Respondent
It should not be surprising that the broad consumer base is not asking the questions concerning green building. According to the RCLCO study, 70% of homebuyers do not believe their homes negatively impact the environment.\textsuperscript{126} If in the Rochester area, 87% of trade professionals do not perceive a negative impact of housing on the environment, it can be assumed that the knowledge base of the areas homebuyers is similar, raising the levels of environmental ignorance in the locality to exceed that noted in the RCLCO study.

This ambivalence towards the presence of a marketplace hinges upon the lack of education with both the consumer and the trade professional. Almost 70% of builders surveyed expressed belief that buyers are aware of the benefits of sustainable homes. If they are under the misconception that there is awareness within the consumer marketplace, yet demand has not taken hold, their motivations to alter practices are negligible.

Many builders remain wary that sustainable development may be a temporary trend

\textsuperscript{126} RCLCO, 8
(Figure 5.17). However, 61.5% of builders perceive this as a permanent turn within the industry.

![Bar chart showing attitudes towards sustainability as a temporary market trend]

**Figure 5.17: Builders’ Attitudes Towards Sustainability as a Temporary Market Trend**

Although the majority of builders are aware of the potential permanence of this market shift, only 42% of builders saw any potential to grow their business by building sustainable homes.

**Cost**

Builders perceive increased construction costs as the greatest barrier to implementing sustainability in the residential homebuilding industry. Several post survey comments emphasized this fact:
“Most buyers will buy sustainable homes as long as they don't cost any more than traditional homes. This economic environment will not support additional home cost. People can barely afford to purchase a new home much less a home with the added expense of being leed [sic] certified. Good idea, terrible timing.”

-Survey Respondent

In contrast to the RCLCO study, builders surveyed did not express a firm belief that consumers are willing to pay more for sustainable features in their homes. Almost 62% expressed that buyers would not absorb the cost increases.

Two-thirds of builders surveyed did not believe there was sufficient information available on the added costs of building sustainable homes. The academic research supported this view, demonstrating broad variations in the literature. Although actual increased cost additions have yet to be established there is a perception within the industry that the increases are excessive. Almost 77% of builders agreed that sustainable homes are too expensive. Post survey comments emphasized their concerns over costs:
“In my experience cost seems to be the biggest deterrent to customers. Even those that are interested in "going green" typically opt not to because of the expense and longer lead times for sustainable products.”

-Survey Respondent

“Everything will revolve around costs...at the end of the day a person who has $185000 to spend on a house will try to get as much as they can for their money. The return on investment on alot [sic] of these items will never fly in the marketplace.”

-Survey Respondent

The cost basis of sustainable homes has not been established to consider the lifecycle costs of building and how it in the end financially impacts the consumer. The market for energy efficiency has taken hold, as it has a demonstrated realizable value. The increased costs basis and asset value of holistically sustainable homes must be established or consumer demand will be minimal. Without firm documentation the ability of builders to sell these products will be severely limited.
Conclusion and Recommendations

Information gaps stand as the largest barrier to the standardization of sustainable development practices in the residential homebuilding industry today. Although the building trade has introduced many certification programs, training and professional development seminars to educate the builder in sustainable practices, the impacts of these programs on the residential trade are negligible.

In order for the industry to shift their practices, two major elements must be clarified. First and foremost, the builder must understand the reasons behind the need to shift to sustainable development practices. This would include the impacts of residential housing on both the macro and microenvironments. 87% of building professionals do not believe residential housing negatively impacts the environment. This is an alarming statistic. Without a clear understanding of the impacts, builders and consumers will not be motivated to seek out further information or be open to seeking further education. Green certifications, training and professional development programs have failed to communicate this message to the industry. This points to a major systemic failure in sustainable development education.
The successful widespread integration of energy efficiency into the everyday practices of the homebuilder demonstrates the impacts of clear communication and focused education. Builders clearly perceive the necessity, benefits and marketability of this practice. Energy efficiency has been enforced by firm science: the cost basis, benefits and value to the consumer established. This same focused attention must be given to other aspects of sustainable development.

The industry must reassess all aspects of communicating sustainable development. From concept, to benefits and methods of simplified practical application, the industry has failed in its efforts to clearly communicate sustainable development practices. This disjoining of the symbiotic relationship between information and practice has obstructed the industry shift to sustainability.

The second clarification that must be addressed is the need to firmly establish a market presence for sustainable homes. The aspects of sustainable development currently given priority within the Rochester, NY marketplace, such as energy efficiency and
environmental considerations through implementation of green spaces are regulated by code or town ordinance. However, governmental regulation cannot drive demand nor increase asset value for a product. Consumer demand must propel the market.

The research shows a high potential for this market presence but without the effective communication of value and benefit to the consumer, this demand will not be realized. The informational systems are not in place to educate either the builder or consumer as to the benefits of sustainable homes, both economically or to their health either personally, or to the greater environment. Without clarification of the lifecycle costs, health benefits and added value of to the residential asset, the market will remain within the limited niche of environmental philanthropy and fail to establish in the mainstream.

Research must be conducted to establish and justify the added capital investment in sustainable homes. A firm cost basis must be established for the builder to viably market the product. Further, apples-to-apples comparisons must be made between current standardized housing, and comparable sustainable homes in order to ascertain definitive benefits integrating regional, geographic, climactic and economic impact considerations.
It is the current societal evolution of the spirit of ecological stewardship, which will over time alter our technology, methods and implementation resulting in a paradigm shift within the industry. It is hoped that this will culminate into a condition of complete knowledge that will better connect the built world with the natural environment. Will we ever achieve that perfect balance? No one can be sure. But as history has proved: man has the capacity for change, and the power to create wondrous things.

In the book *Silent Spring*, Rachael Carson articulated the need to integrate sustainable practices into our society:

“\textquote{We stand now where two roads diverge. But unlike the roads in Robert Frost’s familiar poem, they are not equally fair. The road we have long been traveling is deceptively easy, a smooth superhighway on which we progress with great speed, but at its end lies disaster. The other fork of the}”
road- the one “less traveled by”- offers our last, our only chance to reach a destination that assures the preservation of our earth.”

This last chance destination, the path less traveled today is the path to standardized sustainable development. The negative impacts of housing on the environment are widespread. Unless the barriers to sustainable homebuilding becoming a standardized practice are addressed, these negative impacts will remain.

127 Carson, 277.
References:


Chambers, Meredith and Mikesch Muecke. “Biobased Products and the LEED Rating System.” *Journal of Green Building* 5 no 4 (Fall); 91-107.


Appendices A: MAPS

Map 1: Land Use Patterns in the Town of Pittsford, NY.

Map 1
Land Use Patterns

Data Sources:
- Town of Pittsford GIS, May 2009
- Monroe County Real Property Tax Service, January 2009

The information depicted on this map is representative and should be used for general reference purposes only. No warranties, expressed or implied, are provided for the data or its use or interpretation.
Map 2: Existing Land Use in the Town of Greece, NY.  

Source: Master Plan, Town of Greece figure 2.
Map 3: 500 mile Radius around Rochester, New York

http://www.freemaptools.com/radius-around-point.htm
Appendix B: Survey Questionnaire

The attached questionnaire shows the basic format of the questioning, optimized for printing and attachment into this document. It does not show the headers, or color layouts or exact page breaks of the actual survey device.

Due to improper online formatting, the question pertaining to “…what do you believe is the most marketable aspect of sustainable home construction” was disregarded in the final results evaluation. The survey mechanism inadvertently allowed respondents to give more than one numeric response to the options thus negating the findings.
This survey is for ACADEMIC PURPOSES ONLY. Data collected will be used as part of a case study of sustainable homebuilding in the greater Rochester area. Information will be kept PRIVATE and WILL NOT be used commercially.

Please limit responses to construction done in the greater Rochester area, which includes Monroe, Wayne, Ontario, Livingston, Genesee and Orleans Counties.

Respondents to this survey must be the decision maker for your company's RESIDENTIAL construction methods and practices.

Are you the primary decision maker for your company's RESIDENTIAL construction methods and practices?

☐ Yes
☐ No

* Please enter your email address (Email will only be used for tracking participation only.)
* Which type(s) of projects has your company built in the last five (5) years? (please choose all that apply)
  
  □ Residential
  □ Commercial
  □ Institutional

If your company has built COMMERCIAL or INSTITUTIONAL projects, have any been LEED certified?
  
  □ Yes
  □ No
  □ Does not apply

* Which type(s) of RESIDENTIAL projects has your company built in the last five (5) years? (please choose all that apply)
  
  □ Single family
  □ Condominium
  □ Apartments
  □ Multi-Family

* Considering the last five (5) years, what is the average price range of your company’s individual RESIDENTIAL units?
  
  □ Under $150,000
  □ $150,000 - $250,000
  □ $250,000 - $500,000
  □ $500,000 - $750,000
  □ $750,000 and up

* On average, how many RESIDENTIAL units per year does your company build?
  
  □ Less than 10
  □ 10-25
  □ 25-50
  □ 50 or more.
Does your company permanently employ individuals with credentials in any of the following:

☐ LEED Professional Credentials
☐ NAHB Certified Green Professional
☐ Other Sustainable/Green Professional Credential (please specify) 

* Have your company employees participated in training, seminars or other professional development focused on SUSTAINABLE development practices?

☐ Frequently
☐ Occasionally
☐ Never
The remainder of this survey will address RESIDENTIAL building practices only. Please answer to the best of your ability.

For the purposes of this survey the terms "green" and "sustainable" will be interchangeable.

In the last five years, how frequently have you gained ENERGY STAR certification for your RESIDENTIAL Projects

- Never
- fewer than 10% of the time
- 10-24% of the time
- 25-49% of the time
- 50-74% of the time
- 75-100% of the time

In the last five (5) years have you gained green certification for your residential projects? Please input the number of certifications for each.

- LEED for Homes
- National Green Building Standard/NAHB Green Building Guidelines

Which of the following features of sustainable development do you feel confident in your ability to apply to your residential construction projects

Please rate on a scale of 1 to 5, with 5 being "very confident", and 1 being "not confident at all”

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<tr>
<td>Energy efficiency</td>
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</tbody>
</table>
Which of the listed elements of sustainable development does your firm CONSISTENTLY PRACTICE for residential construction projects?

Please select all that apply:

<table>
<thead>
<tr>
<th>Element</th>
<th>Never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Often</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimize impacts to the geography</td>
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<tr>
<td>Protect ecosystems during construction</td>
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<tr>
<td>Restore ecosystems with native plants</td>
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<tr>
<td>Protect natural waters on site</td>
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<tr>
<td>Appropriately dispose of wastewater on site</td>
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<tr>
<td>Energy efficiency to meet or exceed ENERGYSTAR</td>
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<tr>
<td>Using alternative energy supplies</td>
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<tr>
<td>Conduct annual materials audits</td>
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<tr>
<td>Recycle on site</td>
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<tr>
<td>Specify materials sourced and manufactured within a 500 mile radius</td>
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<tr>
<td>Use products or materials with recycled content</td>
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<tr>
<td>Use bio-based products or materials</td>
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<tr>
<td>Use FSC certified wood products</td>
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<tr>
<td>Evaluate materials for VOC emissions</td>
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<tr>
<td>Use low or no VOC emitting paints</td>
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<tr>
<td>Use of low or no VOC emitting adhesives</td>
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<tr>
<td>Minimize use of PVC based products or materials</td>
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<tr>
<td>Install whole house ventilation systems</td>
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<tr>
<td>Install water efficient fixtures</td>
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<tr>
<td>Include single roll in home entry</td>
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<tr>
<td>Install lever door handles throughout the home</td>
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<tr>
<td>Install widened interior doorways throughout for accessibility</td>
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<tr>
<td>Include a single accessible roll in shower</td>
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<tr>
<td>Include comfort height toilets</td>
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</tbody>
</table>


<table>
<thead>
<tr>
<th>Item</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental stewardship</td>
<td></td>
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</tr>
<tr>
<td>Energy efficiency</td>
<td></td>
<td></td>
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<tr>
<td>Health benefits for homeowners</td>
<td></td>
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<tr>
<td>Reduced monthly bills/payback cycles</td>
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</tr>
</tbody>
</table>
Which describes the BEST motivation for your company to implement sustainable construction practices:

- [ ] Increased Sales
- [ ] Enhancing Corporate Identity
- [ ] Marketing
- [ ] Environmental Stewardship
- [ ] I do not foresee our company entering into this field
- [ ] Other (please specify)
Please read each statement and indicate your level of agreement or disagreement with each:

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Somewhat Agree</th>
<th>Somewhat Disagree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>There is no market for sustainable homes in the greater Rochester area.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Buyers are aware of the benefits of sustainable homes.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>There is sufficient information available on the added costs of building sustainable homes.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Sustainable homes are too expensive.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
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</tr>
<tr>
<td>Buyers are willing to pay more for sustainable features.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
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</tr>
<tr>
<td>I can grow my business by building sustainable homes.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Sustainable development is a temporary market trend.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
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</table>
Please read each statement and indicate your level of agreement or disagreement with each:

<table>
<thead>
<tr>
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<th>Somewhat Disagree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustainable development is primarily concerned with energy efficiency.</td>
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<tr>
<td>Residential housing negatively impacts the environment.</td>
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<tr>
<td>There is sufficient information on the additional costs of sustainable building.</td>
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<tr>
<td>The health benefits of sustainable building are clear to me.</td>
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<tr>
<td>Sustainable homes have superior energy performance.</td>
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<tr>
<td>There is insufficient proof to the benefits of sustainable buildings.</td>
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<tr>
<td>Recycled content makes a product sustainable.</td>
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<tr>
<td>Building materials can negatively affect human health.</td>
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<tr>
<td>I have a clear understanding of sustainable development practices.</td>
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</tbody>
</table>
Please read each statement and indicate your level of agreement or disagreement with each:

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<th>Somewhat Disagree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zoning laws discourage high density building in suburban areas.</td>
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<tr>
<td>Codes discourage the use of alternative materials, products or designs.</td>
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<tr>
<td>Code officials have sufficient knowledge of alternative materials,</td>
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<tr>
<td>products or designs.</td>
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<tr>
<td>I do not specify alternative systems as they may not meet code.</td>
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<tr>
<td>It is difficult to finance homes with alternative materials, products or</td>
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<tr>
<td>designs.</td>
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<tr>
<td>I am concerned that sustainable homes may not meet bank appraisal.</td>
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<tr>
<td>Sustainable homes do not have added value for resale.</td>
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</tbody>
</table>
Thank you for your time and participation!

If you have any further questions or wish to discuss the survey, or the study at large, please feel free to contact:

Heidi Tomkiewicz
HTomkiewicz@MonroeCC.edu

Please feel free to add any additional thoughts or comments you may have: