GETTING BACK ON *TRACT*:

Developer Housing Re-energized

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ABSTRACT

The problems of the suburban condition have been documented over the past few decades by urban planners and architects alike. However it is clear that demand for car-oriented developments remains high, and expansion of the suburbs with single family houses continues. Given this reality, this thesis focuses on the importance of developing a comprehensive design approach to tract housing that is more responsive to site, more energy efficient and less damaging to the environment. The work builds upon research that is being conducted through the Carleton Research & Innovation in Sustainable Energy Project (C-RISE). In collaboration with Urbandale Developers, C-RISE is studying the potential for making single family houses more energy efficient through passive solar design, building envelope, seasonal storage of solar thermal energy, hybrid passive-active storage of solar thermal energy, and passive and solar cooling. In light of this work, this thesis proposes a series of single family house designs that incorporate the C-RISE energy technologies and also address larger architectural issues around tract house and lot design.

The Suburban House:

“It’s basically a box hooked up to life-support systems that supply warm and cool air, water, light and power. Its materials have been transported from many miles away. Its features allow this same building to be constructed in a variety of climates without concern for site-specific variables such as the path of sun.” (Snell and Callahan 18)

TABLE OF CONTENTS

ABSTRACT:	ii
INTRODUCTION:	1
CHAPTER 1:	
Importance of DESIGN	
(Style/ Materials/ Architectural Details)	6
CHAPTER 2:	
Relationship between HOUSE AND SOCIETY	
(Architect/ Dweller/ Developer/ City).....	19
CHAPTER 3:	
Relationship between <i>HOUSE AND SITE</i>	
(Orientation/ Land/ Streetscape).....	25
CHAPTER 4:	
Relationship between <i>HOUSE AND CAR</i>	33
CHAPTER 5:	
Relationship between <i>HOUSE AND ENERGY</i>	39
CHAPTER 6:	
Relationship between <i>HOUSE AND WATER</i>	51
DRAWINGS	56
CONCLUSION	63
ACKNOWLEDGEMENTS:	65
BIBLIOGRAPHY	66
LIST OF IMAGES	69

INTRODUCTION:

"Today's suburban reality finds its origins in the pastoral dream of the autonomous homestead in the countryside." "However, this equation seems to have its limits, as only a small number of people can achieve that dream without compromising it for all involved. As the middle class rushes to build its countryside cottages at the same time on the same land, the resulting environment is inevitably unsatisfying, its objective self-contradictory: isolation en masse." (Duany, Plater-Zyberk, and Speck 40)

The historic ideal behind the suburbs, bringing together the best of city and country lifestyles, has resulted in an outcome, which certainly from an environmental perspective has created the worst of both worlds. The development of the suburban lifestyle has an extensive history that is rooted in an elaborate and interconnected set of social, economic and cultural influences and it is clear that despite the negative impact on the environment, demand for this lifestyle continues strong. The problems of the suburban condition as a whole have been widely addressed for the past few decades by urban planners and architects alike. Popular movements such as New Urbanism, Smart Growth, and Neo-Traditional Main Street developments have emerged in response to critiques of suburbia.¹ Appropriately, these design strategies address the need for a fundamental shift in the focus and scale of

¹ **New Urbanism** "promotes the creation and restoration of diverse, walkable, compact, vibrant, mixed-use communities composed of the same components as conventional development, but assembled in a more integrated fashion, in the form of complete communities. These contain housing, work places, shops, entertainment, schools, parks, and civic facilities essential to the daily lives of the residents, all within easy walking distance of each other." ("New Urbanism," New Urbanism. Web. 2011. <<http://www.newurbanism.org/>>.)

Smart Growth "is a collection of land use and development principles that aim to enhance our quality of life, preserve the natural environment, and save money over time." ("Creating More Livable Communities," About Us. Web. 2011. <<http://www.smartgrowth.bc.ca/AboutUs/tabid/56/Default.aspx>>.)

Neo-Traditional Main Streets or "Traditional Neighbourhoods by New Urbanist designers often resemble historic villages with homes and shops clustered together along quaint, tree-line streets." ("What Is Neotraditional Architecture?" About.com Architecture. Web. 2011. <<http://architecture.about.com/od/housestyles/g/neotraditional.htm>>.)

the suburbs from car-oriented and isolated streets to active and pedestrian focused multi-use: live, work, and play communities. This thesis acknowledges that to have the greatest impact on energy use, densification is the preferred strategy. However it is clear that demand for car-oriented developments remains high, and expansion of the suburbs with single family houses continues. American architect Aaron Chang outlines in his article *Beyond Foreclosure: The Future of Suburban Housing*, that “suburban reformers, focusing almost always on the scale of systems, have rarely paid sustained attention to suburbia's essential component, its irreducible unit — the freestanding single-family house.”² The consumer demand for single-family homes cannot be ignored and the City of Ottawa outlined in its Residential Land Strategy for 2006-2031 that 40% of new construction dwellings would be single-family detached homes.³ The projected development of new builds for single-family detached units is 94% for rural dwellings and 35% for urban dwellings, which shows that this style of house design will continue to be built for the next few decades as urban infill projects and in suburban developments.⁴

With this in mind, the C-RISE project (Carleton Research & Innovation in Sustainable Energy), in collaboration with Urbandale Developers, is studying the potential for making single

² Chang, Aron. "Beyond Foreclosure: The Future of Suburban Housing." *The Design Observer Group*. 14 Sept. 2011. Web. 04 Apr. 2012. <<http://places.designobserver.com/feature/beyond-foreclosure-the-future-of-suburban-housing/29438/>>.

³ City of Ottawa, Department of Infrastructure Services and Community Sustainability Planning Branch Research and Forecasting Section. *Residential Land Strategy for Ottawa, ON 2006-2031*. Rep. *Www.ottawa.ca*. Feb. 2009. Web. <http://ottawa.ca/doc_repository/reports/residential_land_strategy_en.pdf>. Pg.17.

⁴ Ibid. Pg.18.

family houses more energy efficient. Multiple energy strategies and environmental design techniques are currently being explored in preparation for the building of a full scale Urbandale model home on the north end of Carleton University campus, which will be used as a research facility for future projects. The leading elements being explored in the C-RISE design are the architectural and passive solar design, building envelope, seasonal storage of solar thermal energy, hybrid passive-active storage of solar thermal energy, and passive and solar cooling. “The Carleton Research and Innovation in Sustainable Energy house will support a multifaceted research programme aimed at discovering and critically evaluating novel concepts to increase energy efficiency and maximize the use of solar energy in Canadian single-family detached housing.”⁵ I have had the unique opportunity to be a member of the C-RISE team and in light of this work, this thesis looks at a more comprehensive redesign of the single family developer model house, with the intention of improving individual house design standards.

The opening quotation for this thesis describes the suburban home as “basically a box hooked up to life-support systems that supply warm and cool air, water, light and power”.⁶ With few exceptions, the average modern-day suburban house can be heavily criticised for providing an environment to its inhabitants that has questionable air quality, is not particularly energy efficient and

C-RISE Project

Team members:

Carleton Engineering Program:

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Associate Professor in the Department of
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Progress: The C-RISE project is currently in the research and design phase of the program with a projected schedule to start building in the spring of 2013.

⁵ Beausoleil-Morrison, Ian D. Project Module: The Carleton Research and Innovation in Sustainable Energy (C-RISE) Funding Report. Rep. 2011. Print. Pg. 2.1.

⁶ Snell, Clarke, and Tim Callahan. Building Green: A Complete How-to Guide to Alternative Building Methods: Earth Plaster, Straw Bale, Cordwood, Cob, Living Roofs. New York: Lark, 2005. Print. Pg. 18.

destroys natural ecosystems. American Architect Frank Lloyd Wright explains that architecture should be appropriate to time, place and to man. “Appropriate to time means a building that belongs to the era in which it is created, addresses contemporary life-styles, social patterns and conditions, and employs available materials and new technological methods resourcefully and honestly. Appropriate to place means a building in harmony with its natural environment – a building that in its proportions, materials and design, belongs to its site. Appropriate to man means a humane architecture, in human scale.”⁷ Suburban housing denies all three of these imperatives set out by one of the greatest modern residential architects. Moreover, typical subdivision houses are not designed or built to last. The workmanship is poor and decisions are made based on minimum standards. Profit margins and marketability are the real driving forces of the design of most suburban homes.

Given the demand for single family houses and a lifestyle that is fundamentally dependent on the car, this thesis has accepted that the proposed reimagining of the single family tract house must follow certain expected suburban norms, particularly the requirement of on-site parking that is accessible from the street. The lot dimensions and proportions, rough house size and proportions, and street layout are the guidelines and constraints for this thesis that were developed from the current Ottawa developer model and the regulations from the C-RISE project.

⁷ Rattenbury, John. *A Living Architecture: Frank Lloyd Wright and Taliesin Architects*. San Francisco, CA: Pomegranate, 2000. Print. Pg. 27.

This thesis focuses on the importance of a more comprehensive design approach to tract housing and is structured around the relationships that exist between the house design and the socio-economic environment, the house and the site, the house and the car, and the design of the house with respect to energy and water. The goal is to propose a series of single family house designs that are more responsive to their sites, and therefore more capable of being self-sufficient and less damaging to the environment. In addition, the objective is to design a house that could accommodate a variety of family structures that would allow it to be seen as a longer term investment, and not simply as a starter home that ignores life cycle costs. Finally, the thesis will explore the potential of the architectural detail to enhance the quality of life of the inhabitant, both on the interior and with respect to façade treatment and its impact on the streetscape.

CHAPTER 1:

The Importance of DESIGN

(Style/ Materials/ Architectural Details)

Importance of the Home

The health and happiness of the inhabitants is fundamentally what should drive the design for residential architecture. Frank Lloyd Wright stated our home should be, “our own little world within the great world – for every man’s home should be that to him.”⁸ A large percentage of one’s life is spent in the home and as French philosopher Gaston Bachelard eloquently describes in *The Poetics of Space*, the home, “is a resting place for daydreaming” and “is our corner of the world”. The attention to detail of a design, the connection to the unusual and originality of a space, and the pure admiration and pleasure of the closest extension of space from one’s own body has been lost in contemporary tract housing. Children spend a great deal of time and first learn the ways of the world from inside their home. It is their “first world.”⁹ The current bland, repetitive house types, the generally poor quality of construction (often using toxic building materials), and the inattention to

*“Benefit of the house: the house shelters daydreaming, the house protects the dreamer, the house allows one to dream in peace.”
(Gaston Bachelard 6)*

⁸ Wright, Frank Lloyd, Andrew Devane, and Frederick Albert Gutheim. *In the Cause of Architecture, Frank Lloyd Wright: Essays*. New York: Architectural Record, 1975. Print.

⁹ Bachelard, Gaston, and M. Jolas. *The Poetics of Space*. Boston: Beacon, 1994. Print. Pg. 7.

detail is slowly affecting the health of the inhabitants and negatively altering their connection to the home.

Importance of Green Design

The current residential design fabric is ethically and aesthetically flawed. One of the most important drivers of tract house design should be the environmental impact. Canadians spend roughly 90% of their time inside the built environment so healthy buildings are incredibly important for the health of society.¹⁰ It is estimated that buildings in Canada account for one third of Canada's energy production, half of the extracted natural resources, 25% of landfill waste, 10% of airborne particles and 35% of greenhouse gases.¹¹ "The creation and operation of buildings accounts for some 50 percent of all energy resources consumed across the planet, making the construction industry the least sustainable industry in the world."¹² The built environment has moved well past a sustainable and healthy state of being, and the shift towards green design needs to be made in all building industries. "We intended merely to be prosperous and healthy but have inadvertently triggered a mass extinction of other species, spread pollution throughout the world, and triggered climatic change – all of which undermines our prosperity and health. Environmental problems, then, are mostly the result

¹⁰ Lucuik, Mark. A Business Case of Green Buildings in Canada. Presented to Industry Canada. Rep. no. 2052223.00. March 31, 2005. Print. Pg 3.

¹¹ Ibid. Pg 3.

¹² Abley, Ian and James Heartfield. *Sustaining Architecture in the Anti-Machine Age*. West Sussex: Wiley-Academy, 2001. Print. Pg 24.

of a miscalibration between human intentions and ecological results, which is to say that they are a kind of design failure.”¹³ Polluting and environmentally damaging designs affect everyone negatively and tract subdivision housing is currently one of the worst contributors to damaging precious ecosystems.

The economics related to green building are extremely complicated. Industry Canada developed “*A Business Case for Green Buildings in Canada Report*” and broke down the economic considerations of building green into the following categories: Direct capital costs; direct operating costs; life cycle costing; productivity effects; property values and absorption rates; other indirect or intangible benefits; and external or tertiary economic effects. The direct capital costs of building a green structure are believed to be substantially more expensive than conventional buildings, while in fact numerous studies conclude that green buildings can cost only around 2% more or can be equivalent to standard building costs.¹⁴ However green designs can earn this percentage of initial cost increase back with reduced energy and water prices which lower direct operational costs, improved indoor air quality and natural lighting, which results in productivity gains (or in the case of housing, happier inhabitants), superior occupant comfort and health from sensitive designs and materials, and increased property value.

¹³ Orr, David W. *The Nature of Design: Ecology, Culture, and Human Intention*. New York: Oxford University Press, 2002. Print. Pg 14.

¹⁴ Lucuik, Mark. *A Business Case of Green Buildings in Canada*. Presented to Industry Canada. Rep. no. 2052223.00. March 31, 2005. Print. Pg 16.

There are numerous scales of green and sustainable design approaches. Many green designs tend to focus only on the mechanics of the design or energy consumption and neglect the beauty and importance of architectural details.

Suburban Style

The architecture of the suburban tract house is uninspiring, wasteful and unsophisticated. The houses are clad with different replicated and repeated “styles” that fall short while trying to mask the uniform overall design and interior space. The design of the suburban house has evolved from the early Levittown style, Sitcom Suburbs, Mass Suburbs, or Automobile Suburbs of post-war-time housing, to the American Foursquare style, to the Bungalow style, to the Ranch styles, to the Neo-eclectic style, Builder’s Colonial / Neocolonial style, and the Snout House styles that dominate today’s suburbs. The energy standards have progressed in keeping with the minimum environmental standards of the times. The lot sizes and room layouts have changed to reflect changes in the socio-economic fabric and in the structure of family relationships, but the importance of and dependence on the car has remained more or less static. The latest design catastrophe is the development of the completely garage dominated Snout House. The Snout House was designed as an affordable housing option but has taken the garage domination of the house to an extreme level with the garage as virtually the only visible element of the home.

Figure 1: Levittown

Figure 2: Canadian War-time Housing

Figure 3: Typical Modern-day Suburban Tract Housing Neighbourhood

Suburban houses are being built in the same style and with the same techniques and materials all over North America. Little accommodation is made for the local climate or the use of local resources. A clear case in point is the fact that the Canadian tract housing industry does not reflect or considerably protect Canada's precious resources (forestry; fresh water; clean and fresh air) nor does it showcase the skill, craft, and education that this country has to offer. Canada has the largest area of certified forest in the world, with 142 million hectares, which is approximately 40 percent of the world's certified forest area.¹⁵ The Canadian Wood Council has created a sustainable and efficient system for harvesting this important resource and all of Canadian tract housing should embrace and reflect this. Similarly, one of the most precious natural resources that Ottawa and Canada as a whole has to offer is the access to fresh water, and the mass polluting of this resource needs to stop. Canadian residential architecture should be reflecting and highlighting these natural resources that, if harvested efficiently, are readily and abundantly available.

Importance of Architectural Details and Beauty in Design:

"Careful detailing is the most important means for avoiding building failure, on both dimensions of the architectural profession – the ethical and the aesthetic. The art of detailing is really the joining of materials, elements, components, and building arts in a functional aesthetic manner. The complexity of this art of joining is such that a detail performing satisfactorily in one building may fail in another for very subtle reasons." (Frascati 2)

¹⁵ "Canadian Forest Service," *Canadian Forest Service*, Web, 04 Dec. 2011. <<http://cfs.nrcan.gc.ca/>>.

Figure 4: Bungalow Style

Figure 5: American Foursquare Style

Figure 6: Ranch Style

Figure 7: Raised Ranch Style

Figure 8: Split-Level Ranch Style

Figure 9: Builder's Colonial / Neocolonial Style/ Neo-Eclectic Style

Architectural details are defined in many different forms and over history the meaning and importance of details has transformed dramatically. The issue of what architectural details actually are has been addressed by many architects through the ages, but this thesis subscribes to the definitions outlined by Italian architect, architectural theorist and director of the Azrieli School of Architecture & Urbanism at Carleton University, Marco Frascari. He defines architectural details as “much more than subordinate elements; they can be regarded as the minimal units of signification in the architectural production of meanings. These units have been singled out in spatial cells or in elements of composition, in modules or in measures, in the alternating of void and solid, or in the relationship between inside and outside.”¹⁶ The design of a home should have an overall connectivity that is reflected through these smallest elements of detail. Details are revealed through the ways that spaces flow from one to the next as well as the way that materials and surfaces organically flow from one skin to the next.

Frank Lloyd Wright celebrated the details in his residential designs through the intricate designing of the light fixtures, window details, and furniture. His geometric and organic forms were derived from his admiration for the natural environment. (Examples of his projects are shown in Figures 11 and 12). Another organic designer, Spanish architect Antonio Gaudi, carefully planned every last detail of his extremely unconventional creations down to the smallest venting system in the

Figure 10: McMansion / Tract Mansion: "A large, expensive house constructed among homes that are very similar by a subdivider who builds on speculation is a tract mansion. Architecture critic Ada Louise Huxtable names them McMansions, where the 'preferred style is Grotesquely Grandiose. Unencumbered by architects or accuracy, developers offer a mind-boggling mix of Rapunzel towers and pretend Palladian. ...'" "A tract mansion may also be called a twenty-minute house since a realtor shows it quickly – all of the builder's energy has been focused on the front." (Hayden 110)

Figure 11: Snout House: is a house that is constructed with an attached front entry garage that is closer to the street than any other part of the house. They have been criticized for looking like a storage shed with an attached house. (Hayden 92)

¹⁶ Frascari, Marco. "The Tell-The-Tale Detail." *VLA 7: The Building of Architecture*: 23-37(1984). Print. Pg. 1.

bottom of the window frames (as shown in Figure 13). Frascari describes the importance of true architectural designs and details: "Architecture is an art because it is interested not only in the original need of shelter but also in putting together spaces and materials in a meaningful manner. This occurs through formal and actual joints." "In architecture, feeling a handrail, walking up steps or between walls, turning a corner, and noting the sitting of a beam in a wall, are coordinated elements of visual and tactile sensations."¹⁷ The architectural beauty lies in the uniqueness of a space. The beauty reveals itself where the pattern or the regularity is disrupted and goes in a different direction than one had anticipated. The normality of suburban houses and constant repetition of the same system is where the beauty is lost. A visually appealing built environment is very important and recognizes "that when our buildings delight our senses, architecture can help inspire us to dwell more lightly on our beautiful Earth."¹⁸

Materials

Suburban neighbourhoods are becoming biogeochemical hotspots that are created from the array of toxic materials and technologies that are being used to build these communities. Historically with the scarcity and high expense of materials the act of using locally available sources,

¹⁷ Frascari, Marco. "The Tell-The-Tale Detail." *VLA 7: The Building of Architecture*: 23-37(1984). Print. Pg. 7.

¹⁸ Guzowski, Mary. *Towards Zero Energy Architecture: New Solar Design*. London: Laurence King, 2010. Print. Pg. 9.

Figure 12: Carlo Scarpa's Details

Figure 13: Carlo Scarpa's Brion Cemetery Detail

*In the work of Carlo Scarpa,
Beauty
the first sense
Art
the first word
then wonder
then the inner realization of
Form
the sense of wholeness of
inseparable elements.
Design consults Nature
to give presence to the elements.
A work of art makes manifest
the wholeness of Form of the
symphony of the selected shapes
of the elements. In the elements
the joint inspires ornament, its
celebration.
By Louis Kahn
(Frascari 7)*

re-using and recycling products and resources was very common. Globalization and the disposable mentality of today's consumerist society has created unnecessarily damaging and wasteful designs and products. The material choices for typical suburban houses are mainly based on economics with little regard for sustainable, native, or regional products. The International Living Future Institute outlines in their Living Building Challenge how material conservation management is important at every stage of building. In the Design Phase the evaluation of the appropriate durability in product specification is needed and in the Construction Phase product optimization and the collection of waste materials is very important. The Operation Phase and End of Life Phases need a collection plan for consumables and durables while an adaptive re-use or deconstruction plan is needed for the future demise of the structure. The life-cycle result of products is responsible for many adverse environmental problems and every phase of a product's life needs to be addressed from the extraction, manufacturing, fabrication, construction, operation, demolition, transportation, and the end-of-life deconstruction. "Each material has an environmental burden associated with it due to the environmental effects associated with each phase of its life cycle."¹⁹ The Athena Sustainable Materials Institute developed life cycle assessment data and software tools to evaluate the life-cycle of building materials to allow for environmentally positive and informed material choices to be made. The Living Building

*Figure 14: FLW
Lighting Details*

*Figure 15: FLW
Furniture Details*

*Figure 16: Gaudi
Window Detail
air vents*

¹⁹ The International Living Future Institute. Web. Nov. 2011. < <https://ilbi.org/> >.

Challenge delineates the red-list materials that are toxic or harmful and should not continue to be used in building practices.²⁰

Sustainable House Design Precedents:

In preparation for the design portion of this thesis, a number of sustainable houses were studied. Kingspan Lighthouse is a sustainable house that was designed by Alan Shingler and Martin Rose for the Building Research Establishment Ltd. (BRE) Innovation Park, in the United Kingdom. "The quality of space, relationship to place, thermal and luminous comfort as well as the experience of light were thoughtfully reconciled with the strictest of standards for zero-energy and net zero-carbon design."²¹ This project is architecturally and visually appealing and was classified as the first net zero-carbon house in the United Kingdom. This design unfortunately has been criticized for being overly complicated for contractors to build and cannot be built on the mass scale for tract housing that it was intended to be. The problems for this design surfaced in the details and the material choices. "The BRE is more interested about the press hype about achieving exemplar "sustainable homes" than about making 300,000 homes a reality. They struggle to prototype single homes, let alone offer the mass

Figure 17:
Kingspan Lighthouse
Section

Figure 18:
Kingspan Lighthouse

²⁰ Red-list Materials:

Asbestos, Cadmium, Chlorinated Polyethylene and Chlorosulfonated Polyethylene⁴³, Chlorofluorocarbons (CFCs), Chloroprene (Neoprene), Formaldehyde (added), Halogenated Flame Retardants⁴⁴, Hydrochlorofluorocarbons (HCFCs), Lead (added), Mercury, Petrochemical Fertilizers and Pesticides⁴⁵, Phthalates, Polyvinyl Chloride (PVC), Wood treatments containing Creosote, Arsenic or Pentachlorophenol

²¹ Guzowski, Mary. *Towards Zero Energy Architecture*. New Solar Design. London: Laurence King, 2010. Print. Pg. 31.

housing solutions that are needed today.”²² This project is a successful sustainable one-off design but unfortunately not a successful model to replace the suburban home.

Local examples of sustainable suburban house designs tend to incorporate environmental features as add-ons rather than integrating them in a holistic way into the design. The Urbandale model house represented in Figure 19, was developed as a solar model by basically taking a standard house design, manipulating it, and adding two thermal solar collectors to the roof. Not only are these houses unpopular from a market standpoint, but it would appear that because the add-ons are visually awkward and unresolved, they actually contribute to a sense of mistrust of new technologies. This Urbandale Solar Model will be discussed in further sections of this thesis. The Equilibrium Housing Project developed by the Canada Mortgage and Housing Corporation (CMHC) has developed a number of models to educate the public and the building industry on sustainable technology. However, many of the projects only focus on single environmental issues rather than addressing a more comprehensive attitude toward the suburban lot as a whole. The Ottawa Minto Ecohome house, built by Minto Developments Ltd., successfully added multiple energy saving and environmentally conscious improvements to its standard house, but, like the Urbandale model, the add-on design approach created a similarly incoherent looking design by failing to re-interpret the suburban house materials, layout and aesthetics.

Figure 19: Urbandale Solar Model

Figure 20: Minto Ecohome Model

²² Abley, Ian. "Gummer Might Gloat, but He Made the Building Research Establishment What It Is Today." *Audacity*. Web. Jan. 2012. <<http://www.audacity.org/1A-11-11-07.htm>>.

Finally, the LivingHome Model is an example of a residential project that combines the notions of celebrated architectural details with a design that treads lightly on the environment and is the First LEED Platinum residence in the United States. It was built in Santa Monica, California with the collaborative effort of the developer LivingHomes, and the modernist and environmental architect Ray Kappe. The design goals of this project were to meet the Six Zeros: zero waste, zero water, zero energy, zero carbon, zero emissions, and zero ignorance. This project is particularly successful at integrating environmental strategies with striking spatial design and detailing. The project boasts dramatic sectional development with thoughtful changes in room heights created through a series of elevated or recessed intersecting horizontal platforms, a flexible relationship between indoor and outdoor living spaces, and honest use of materiality. Architectural critic Greg Goldin described the architectural elements of this home in *The Architects Newspaper* in 2007: “The drama is in the cascade of shifting levels, ceiling heights, sight lines, and the light that pours in, even on a gloomy gray day.”²³ The environmental elements incorporated into this design are a passive solar system designed for heating and cooling with the use of optimal natural cross and stack ventilation, exposed concrete floors, thermal chimney and a green roof. “Ray Kappe has designed a prefabricated house that is still intimately and dramatically shaped by the particularities of site, sun, and wind.”²⁴ The six zeros were not formally met by this design but often the locally available technology and the existing city

Figure 21: LivingHome Model Home – Ray Kappe, Santa Monica, California, USA

Figure 22: LivingHome Model Home

²³ Guzowski, Mary. *Towards Zero Energy Architecture: New Solar Design*. London: Laurence King, 2010. Print. Pg 19.

²⁴ Ibid. Pg.17.

regulations make it extremely difficult, if not impossible to propose a tract house design to that high of a standard.

Elements for Design:

The interior layout of the design proposal for this thesis is an open concept plan that revolves around a central core space that is built up of the fireplace, staircases, and a living wall. The open spaces allow for natural cross and stack ventilation which is controlled by the large operable windows and access to the roof. The bold central hearth is in dialogue with the positive exterior space of the courtyard and grounds the house into the site. The courtyard creates a visual and fluid connection to the outdoors. The use of the central hearth, open concept and organic flow of spaces was inspired by Frank Lloyd Wright's house designs. Certain elements of the shelving and furniture are built into the core of the house to establish their importance and create a fluid holistic design. The main portion of the house is intended to be fairly consistent from lot to lot, with different interior layout options, while the garage design is more flexible with multiple options and configurations. On the exterior of the house the horizontal planes are highlighted and extended to create large overhangs to control the direct sunlight. The material choices for this design are to be durable with the evaluation of the life cycle of products to be used as the main determining factor. No materials or

Sketch showing the site orientation

Sketch of interior living wall

Working model showing courtyard space

building techniques will be incorporated into this design that uses any of the red list materials that are outlined by the Living Building Challenge. Inspired by Ray Kappe's approach to materials in his house designs the materials are to be used in their honest form and exposed where possible to reduce excess material layering.

Vignette of Core

Detail of Plan (Celebrated core space)

Figures 23: House Designs

CHAPTER 2:

Relationship between HOUSE AND SOCIETY

(Architect/ Dweller/ Developer/ City)

"Culturally, we tend to think that downtowns should be dynamic, and we expect that. But we seem to have an expectation that the suburbs should forever remain frozen in whatever adolescent form they were first given birth to. It's time to let them grow up"²⁵ (Ellen Dunham-Jones)

The formulaic designs of suburban houses leave few opportunities for a house to evolve with its dwellers. Although intended to maintain design standards, the Municipal regulations and Zoning Bylaws often constrain the implementation of innovative ideas and actually restrict subdivisions from developing organically to become dynamic and flexible places. The homogeneous and overly-synchronized neighbourhoods of contemporary suburban housing are static, isolated, and outdated. The lack of integration and the isolation of housing districts create dull, car dependent communities. The City of Ottawa is starting to envision a more dynamic urban environment, by encouraging urban infill projects, but is still overlooking the rapidly developing suburban areas. Restrictive suburban zoning classifications need to be challenged. Multi-use communities are dynamic and lively regions. Municipalities need to encourage the incorporation of Accessory Dwelling Units (ADU), office space

²⁵"Speakers Ellen Dunham-Jones: Architect." *Ellen Dunham-Jones*. Web. 01 Apr. 2012.
- http://www.ted.com/speakers/ellen_dunham_jones.html".

and retail space into the suburban streetscape. An ADU is a self-contained apartment that is either attached to the principal dwelling on the lot or a separate structure on the same property. These building types have been studied at UCLA in their CityLAB's Backyard Homes project as an innovative approach for infilling California's single-family residential neighbourhoods with flexible, environmentally sensitive, and affordable architectural prototypes. This project rejects the top-down planning attempts of many movements such as New Urbanism and suggests that smaller scale projects need to evolve from the local context to transform underutilized space within suburbia. The Backyard Homes project demonstrates ways to challenge the current city regulations, setbacks and zoning classifications to add more options to tract houses. The incorporation of this mixed-use concept into the thesis design proposal is explored further in the chapter on the relationship between *the house and the car*.

The guidelines for zoning classifications, setbacks, lot regulations, building height and area coverage also need to be revisited to eliminate wasted land and provide more flexibility to allow these neighbourhoods to respond to our fast changing world. Zero lot lines, zipper lots and alternative lot layouts, displayed in Figures 24, 25 and 26 are different siting alternatives for the suburban context. These dynamic arrangements allow for the re-interpretation of the standard lot and challenge the relationships that can exist between tract houses.

Figure 24: Example of possible Accessory Dwelling Unit

Figure 25: Prototype of Accessory Dwelling Unit

Figure 26: CityLAB's Backyard Homes Prototype

At the scale of the lot, historically, people had a more intense connection to their homes. Often they had a hand in the design and building process, but more importantly, they tended to remain in a single house for many years, if not for their entire adult lives. The modern attitude that considers a house as an investment rather than a home has dramatically changed the relationship that one has to one's place of residence. Development companies and consumer demands have framed the standards for suburban house designs; the home buyers have very little control over the design of their future home. This lost connection between the dweller and the design of the home has created monotonous options for housing.

Developers dominate the creation of residential architecture. The majority of architects avoid this important form of building altogether. "Architects have a larger share of responsibility for the world's consumption of fossil fuel and global warming gain than any other professional group."²⁶ With housing being a significant part of the built environment, it is crucial that architects take back the responsibility for and address the sustainability of domestic architecture (and not just commercial and institutional building).

The involvement of architects in the suburban residential context is minimal. "In a comprehensive global history of the twentieth-century house, the individual architect-designed house

Figure 27: Zipper Lot- City of Ottawa

Figure 28: Zero Lot Lines - City of Ottawa

Figure 29: Alternate Lots - City of Ottawa

²⁶ Hyde, Richard, et al. *The Environmental Brief, Pathways for Green Design*. New York, NY: Taylor & Francis, 2007. Print. Pg 35.

would be hardly more than a footnote.”²⁷ This quotation outlines the small role that architects have in the development of residential architecture. “The individual, architect-designed house is a distinct category of artistic and cultural production...”²⁸ The attention to detail and dedication to the quality of design, that architects are trained to focus on, is a stark contradiction to the economic focus of a typical development company. The architect, in a traditional build is the lead facilitator and is hired directly by the client. In a developer’s model, the architect is hired by and works within the development company. The architect’s loyalty switches from an obligation to the ultimate user, to an obligation to the developer’s objectives and values. Development companies typically care more about the bottom line than the architectural integrity and environmental impact.

Designing for sustainability typically uses an integrated design process (IDP), which incorporates a multi-disciplinary team of many different building professionals that work together from the pre-design brainstorming phase to the post-occupancy review stage. This collaborative design approach changes the traditional building system by creating an environment for everyone to work collectively for the same end result, as opposed to disjointedly working with separate intentions. This approach needs to be applied to suburban housing and involve engineers, architects, city officials,

²⁷ Davies, Colin. *Key Houses of the Twentieth Century: Plans, Sections and Elevations*. New York: W.W. Norton, 2006. Print. Pg. 10.

²⁸ Ibid. Pg. 10.

urban planners, contractors, community representatives, as well as the developers, to change the current developer dominate system.

Similarly, the attitudes of the occupants need to change to reflect a greater awareness of their impact on the environment. The idea of zero ignorance was developed by American Architect Ray Kappe and LivingHomes Builders to encourage everyone involved in the project, especially the occupant, to act responsibly to create an active house design. "If we are going to live in the house, it has to be intuitive. It has to respect the local environment. With passive energy, occupants have to be able to intuitively adjust the house. Active systems need to be low tech with simple controls. Design can encourage behavioral changes."²⁹ A project in Ottawa, the Minto Ecohome is designed with a master off-switch that allows the dwellers to turn off all lights, computers, cable boxes, and any other phantom-load power consumers as they leave the house.³⁰ The act of educating the occupants and allowing the platform for them to actively participate in the system of their home will encourage the dwellers to adjust their lifestyles accordingly.

²⁹ Guzowski, Mary. *Towards Zero Energy Architecture: New Solar Design*. London: Laurence King, 2010. Print. pg. 31.

³⁰ "Inspiration --- The Minto Ecohome." *Canada and Mortgage and Housing Corporation*. Web. Dec. 2011.

<<http://www.cmhc-schl.gc.ca/en/inpr/su/cqho/inmicc/index.cfm>>.

Elements for Design:

The municipal By-law regulations need to change to allow for Accessory Dwelling Units on individual suburban lots for small business opportunities, offices, apartments, studios, granny flats, or multi-purpose space. This design proposes that the garage space can be used for these desired additional functions to the house. The opportunity for homeowners to work from home, increase monthly revenue by renting out apartment space, accommodate family members on existing property, or have a store front business space, all within their garage area, allows suburban dwellers more financial and social freedom.

The experience gained from the process of working with a multi-disciplinary team for the C-RISE project has shaped the design for this proposal. The roof angle and size for the optimal solar collection are the main design features that have emerged from the round table discussions. The interaction and knowledge acquired from the collective process of working with the Carleton Engineering Program and a local Ottawa Developer has given me an invaluable collaborative perspective. This experience supports the importance of a multi-disciplinary team for the shaping of the next generation of suburban landscapes.

CHAPTER 3:

Relationship between *HOUSE AND SITE*

(Orientation/ Land/ Streetscape)

The developer house ignores orientation with respect to the sun. Neighbourhoods are developed with no reflection of the character, history, and environmental circumstances of the site or surrounding area. Developers regularly build subdivisions by clear-cutting green space, wetlands, forests, farmland, and flood plains, and in the process destroy precious ecosystems.

The orientation of a house to the site is one of the fundamental foundations to creating a successful design and a healthy residence. This element has been eliminated from contemporary housing. In an interview with Matthew Sachs, the General Manager of Ottawa Urbandale Developers, the message was very clear. Economics drive the decision for tract housing not to have alternative options for home layouts that reflect the orientation of the house on the lot. The current system of selling tract homes allows the home buyers to choose their lot and house design separately. Due to this system of mixing and matching, Sachs claimed that it is too expensive to have multiple house layouts to harmonize with the direction of the site. In addition, if multiple plans were indeed an option, then more site supervision would be needed and more attention would be required by the

trades. It is important to keep things simple for the construction workers who typically do not read the drawings but simply build what they are used to building. Secondly, when Urbandale did build a “solar” version of one of their models, appropriately oriented on its site, it discovered that this was the last house to sell. These past solar model attempts will be outlined further in the chapter focused on *the house and energy*. According to Sachs, there simply is not a large enough demand for a different kind of house.

Nevertheless, for housing to become healthy and sustainable, it is crucial that such market driven practices and societal prejudices change. This is another argument for why architects should be involved in suburban house design. As professionals, architects should be visionaries and take a leadership role in moving society towards more sustainable practices. It is unreasonable to expect a developer to take on such an altruistic role.

One of the foremost critiques of the contemporary suburban lifestyle is the lost connection to the human scale. The streetscape of a typical Ottawa subdivision is a dull vista dominated by garages, the large paved surfaces of driveways and streets, with one awkwardly planted tree and strips of greenery. Privacy is achieved through two meter high fences; the relationship between the houses seems to restrict the interaction between neighbours rather than encourage it.

The repetitive nature of suburban housing is fundamental in the economics of these developments with the material choices and designs. The issue of lacklustre streetscapes can be addressed by incorporating flexible facades and challenging by-law restrictions to create multi-purpose and dynamic neighbourhoods.

The yards of grass that are currently framing suburban houses all over North America are not as “green” or healthy as suburban dwellers think. “Homeowners are happily fussing over expanses of bright green grass – watering, fertilising, applying herbicides and insecticides, and, of course, pushing or riding a lawnmower around to keep it all under control. It’s so perfectly normal. And it doesn’t make the least bit of sense.”³¹ Native species, by definition, survive without supplementary watering and maintenance. Sheep fescue grass is just one of many turf alternatives, which does not require fertilizing, extra watering or even mowing since it only grows to be 5 inches tall.³² Native ground cover and drought-tolerant species that are promoted by The City of Ottawa are Common Bugle or Ajuga (*Ajuga reptans*), Lesser Periwinkle (*Vinca Minor*), Large or Greater Periwinkle (*Vinca Major*), Siberian Bugloss (*Brunnera macrophylla*) or Woolly Thyme (*Thymus pseudolanuginosus*).³³ The incorporation of these native species can give the appearance of typical grass that suburbanites are attracted to, while saving water, energy, time and creating a healthy ecosystem.

*“Collectively, Americans spend 25 billion on lawn care a year, according to the EPA. One acre of lawn costs from \$400 to \$700 a year to maintain, and the average American will spend the equivalent of a full workweek, 40 hours, cutting the grass.”
(Johnston and Gibson 311)*

31 Johnston, David, and Scott Gibson. *Green from the Ground Up: A Builder's Guide : Sustainable, Healthy, and Energy-efficient Home Construction*. Newtown, CT: Taunton, 2008. Print.. Pg. 311.

32 Ibid. Pg. 312.

33 "Native Plants." *The City of Ottawa*. Web. Jan. 2012.

· http://ottawa.ca/en/env_water/tlg/lawn_garden/garden_care/native_plants/index.html.

“In today’s conventional suburbs, man’s relationship to nature is represented by engineered drainage pits surrounded by chain-link fences, exaggerated building setbacks at road frontages, useless buffers of green between compatible land uses, and a tree requirement for parking lots.”³⁴ This quotation, from the book *Sprawl Nation: The Rise of Suburban and the Decline of the American Dream*, outlines the lost relationship between nature and the modern-day suburban lifestyle. The awkward slivers of land that are created from the standard setback regulations and the siting of tract houses make a mockery of the relationship to the natural world. Yards are covered with manicured grass that is not self-sustainable; rather the grass “consumes an alarming amount of water, energy and time, and pollutes both air and water in the process”³⁵. These patches of land give the appearance of natural spaces but are anything but natural.

A more holistic approach to design suggests that we deal with both interior and exterior environments as inhabited landscapes. Wright outlines the importance of including natural elements into architectural designs:

“In the matter of decoration, the tendency has been to indulge it less and less, in many cases merely providing certain architectural preparation for natural foliage or flowers, as it is managed in the entrance to the Dana House at Springfield. This use of natural foliage and flowers for decoration is carried to quite an extent in all

³⁴ Duany, Andres, Elizabeth Plater-Zyberk, and Jeff Speck. *Suburban Nation: The Rise of Sprawl and the Decline of the American Dream*. New York: North Point, 2010. Print. Pg. 31.

³⁵ Johnston, David, and Scott Gibson. *Green from the Ground Up: A Builder's Guide : Sustainable, Healthy, and Energy-efficient Home Construction*. Newtown, CT: Taunton, 2008. Print. Pg. 312.

Figure 30: Green Roofs

Figure 31: Interior Living Walls

Figure 32: Exterior wall and fence options. Rammed earth, living walls, and shrubs

the designs and, although the buildings are complete without this efflorescence, they may be said to blossom with the seasons."³⁶ (Wright)

The incorporation of living features into the house can have psychological and environmentally pleasing effects. Interior living walls improve the indoor air quality, help to moderate building temperatures, capture airborne pollution, contribute to carbon dioxide and oxygen exchange, act as a sound barrier, and are aesthetically stimulating. Green roofs have many environmental benefits and also create celebrated exterior spaces that would otherwise not be accessible. Adding landscaping to the roof of a building has the same positive effects as living walls, while also helping to absorb the sun's heat and insulate the roof, soak up rainwater thereby decreasing storm water run-off, and create an environment for wildlife to help sustain biodiversity. Exterior living walls and rammed earth walls have the benefits of using natural materials, re-using excavated land from the house foundation, naturally integrating into the environment, filtering pollution, absorbing carbon dioxide and creating sound, wind and snow breaks between the houses.

Elements for Design:

The proposed house designs are intended to be developed in Ottawa on brownfield sites or as suburban infill. The house designs have been shaped by the sun patterns and micro-climate of the Ottawa suburban context. Two directionally developed house plans have been designed for a North

Figure 33: Rammed Earth Wall: "What occurs is layers of prepared dirt (optimally 70% sand and 30% clay) are layered and packed in succession with either man power or machine help. When completed the rammed earth walls are as strong as concrete, fire proof, of course weather proof, rot proof, and also minimize temperature swings on the interior. Great benefits with rammed earth construction are some of the tweaks that can be added. Concrete, steel bars, and veneers can be added to the appropriate parts of the wall for strength and appearance." (Gunzelmann)

Figure 34: First Rammed Earth House in Ontario Castleton, ON. Aerecura builders and architect Terrell Wong

³⁶ Frank Lloyd Wright and the Prairie School, 29:12 Min. Web. Dec. 2011.
<<http://digital.films.com.proxy.library.carleton.ca/PortalViewVideo.aspx?xtid=10013>>.

and South facing façade. This proposal works with the orientation of the site rather than against it. The positioning of the house on the lot was experimented with to re-define the strips of “yards” and the connection between the houses. The houses were shifted closer together on one side, using a zero lot line strategy, which opens up the other side of the house for the courtyard space. This positioning allows the houses to appear from the street as a single detached house, but utilize the yards around the house more effectively. The ‘dead’ space between houses is designed to be used for bike storage, a rainwater cistern and the water tanks needed for the solar thermal collection system.

The central celebrated space of the house has a large two story living wall that runs parallel to the courtyard. The staircase wraps around and at points breaks through the living wall which leads up to the open-air rooftop garden. The front yard is designed as tiered landscaping space that leads up to a large front porch space. Fences and gated communities do not allow wildlife to move freely throughout the neighbourhood. The proposed development uses living walls, trees, shrubs, and rammed earth walls to separate lots rather than typical fencing techniques. The courtyard area and roof gardens are the more private exterior spaces, which allow the backyards to be open and shared if desired. The goal of this neighbourhood is to create a healthy ecosystem for all species of inhabitants. Only native species and drought resistant vegetation is planted in the lawns, living walls and green roofs. This design proposes to create a more overall self-sufficient home through the design of the lot and house. The re-claiming of suburban land and roof space, with natural and native plantings will

create the perfect environment for each household to grow its own food. The open backyard system would allow for neighbours to choose to work together to grow food and potentially make a business of it. The integration of edible landscaping elements into the site benefits people, birds, and all kinds of wildlife.

The streetscape of this development is designed to be flexible with options for developing the garage space and the third level of the house. As stated earlier, the garage space will be used for many functions adding new life to the suburban fabric. The integration of store fronts, businesses, and working/studio space create a new face for the suburban street and break up the pattern of the typical neighbourhood.

View of rooftop green roof

Sketch of street view

Site Plans

Figures 35: House and Site Designs

CHAPTER 4:

Relationship between *HOUSE AND CAR*

Suburban housing has developed and evolved around the need to accommodate the automobile. While the car is celebrated and used as one of the major driving design forces in suburbia, these communities have lost the importance of human interaction that grows out of a pedestrian focused lifestyle. In the mid-twentieth century the widespread use of the automobile helped to shape and develop suburban sprawl, intertwining the designs of the car and the suburban home. The cheaply made and simply designed garage continues to be the focal point and façade for tract housing. The sightlines of a typical subdivision street allow you to only see a wall of garages, strips of asphalt, and small slivers of grass, rather than viewing human scaled facades, porches or main entrances. The scale of the garage has grown with the escalation of the size of vehicles, which has also impacted the interaction between houses. Impermeable paved driveways cover the majority of the front yard of a tract house site and create unnecessary water run-off problems and water pollution. Dr. Richard Jackson, a UCLA scientist, is one of the leading experts that has connected urban design of suburbs with many public health issues such as: “asthma caused by particulates from cars and trucks, water contamination from excessive runoff, lead poisoning from contaminated houses and soil, and obesity, heart conditions, and depression exacerbated by stressful living conditions, long commutes, lack of

access to fresh food, and isolating, car-oriented communities.”³⁷ Alternative transportation options, public transportation connections, and transportation issues at the urban design scale of suburbia are very important matters that many urban planners and urban design guidelines are addressing. This thesis acknowledges the importance of these issues but for the purpose of this thesis is focusing on the subject of the car’s effect on the individual site and design of the single-family home.

The location allocated to park one’s car, as well as its importance to the house design has transformed over time from back-lane parking, side-lane parking, detached garages, carport structures, side of the house structures to dominating front façade garages. Back-lane parking used to be very popular for separating the utilitarian elements of the house and car from the pedestrian focused front street facade. “There’s no pretence. You can let it all hang out in the back lane. If you want to get Freudian, the front of the house is the ego, the back lane is the id”³⁸ New Urbanism, Smart Growth and Neotraditional styles are promoting the re-orientation of the garage back to the back-lane system. The back lane parking option was explored for this thesis but ultimately requires a re-orientation of the street layout and was deemed outside the scope of this project. The suburban design style of the Snout House, which was discussed in the earlier chapter about design, has removed the human scale from the façade of the house, effectively hiding the main entrance beyond the garage. The assumption is that

“Asphalt Nation: The asphalt nation is the paved-over United States, according to architectural critic Jane Holtz Kay.”
“An extensive paved area of the built environment forms a heat island because of the rising temperatures generated by paving and structures.” (Hayden 11)

Figure 36: Examples of garage dominated “Snout” houses

³⁷ Carlson, Scott. “Research.” *A Scientist Pushes Urban Planners to Put People First*. Jan. 2012. Web. <<http://chronicle.com/article/A-Scientist-Pushes-Urban/130404/>>.

³⁸ Lahey, Anita. “Romance and Graffiti: Ottawa’s Back Alleys.” *Ottawa Magazine* Sept. 2007. Web. Pg. 34.

the average person will arrive home by car, drive into the automatic door garage, and enter the house directly from there. Many municipalities have reacted negatively to this design and have created regulations for the scale of the garage and the street appeal that a home presents. The City of Ottawa is encouraging developers and designers to “allow the front door (the public entrance) to dominate the front façade as opposed to the garage being dominant”³⁹ in their guidelines for Urban Infill but this design preference does not yet apply to suburban homes.

The problem of the relationship between the car and the architecture of the home has been experimented with by hiding, burying, recessing, elevating, or detaching the garage. Evidently the garage still remains the focus for contemporary tract houses. As shown in Figure 34, the garage space can be sunken below grade to minimize its prominence or careful material choices can help to blend this space into the overall house design. More elaborate interventions, displayed in Figure 35, playfully hide the car by lowering it underground and blending a carport-like space into the house structural system. These design attempts disconnect that garage as the house focal point; blend the garage materials and structure into the overall house design or structure; or hide the car altogether. These techniques explore ways to challenge the traditional suburban relationship between the house and the car.

Figure 37: Recessed and “hidden” garage entrances

Figure 38: Elevated and buried car structures

Figure 39: Alternative paving options

³⁹ The City of Ottawa. Urban Design Guidelines for Low-Medium Density Infill Housing. Update 2009. Rep. December 2011. Print. Pg. 16.

The garage space can also be re-invented by adding multiple functions. As discussed earlier in this thesis, the incorporation of commercial and multi-purpose spaces can bring life to the street as well as challenge the traditional garage space.

Elements for Design:

The garage design for this proposal breaks the typical barrier of using this space for only storage and automobiles. The garage is a desired component of the suburban lifestyle but is presently not being used to its full capacity. For the design for this thesis, the paved driveway area is minimized and opens directly onto the portion of the site owned by the City of Ottawa. The paving that does exist is to be made of porous materials to allow water to seep into the ground. This concept is described further in *relationship between the house and water* chapter. The house is raised up on the site, which allows the garage to be sunken and removed as the visual focus. The front lawn of the lot is a tiered landscaped area that runs along the sidewall of the garage up to the porch of the house. A zero lot line layout is used for the garages to allow for one wall to be shared with the neighbouring garage. This will encourage interaction between neighbours and allows for a more resourceful use of energy and the lot area. The garage structure is designed to function at multiple stages of development, to allow for growth in space for the changing family dynamics. The garage structure starts at phase one as an open-air space for parking. This area can be transformed into a carport

designed structurally to be easily enclosed to allow for a one or two storey structure as needed for the dwellers of the home. The roof area is an accessible green roof that is divided into individual tiles that can be raised up a level as the garage evolves with multiple stories added. The functions for this space could be: an office; studio; playroom; apartment to be rented out; a separate apartment for an extended family member or grown children; retail or service space, greenhouse to grow food; or any additional space needed for a changing family. The garage is detached at the ground level from the main house allowing for privacy for work or separate apartment space. A door is located at the lower garage level that leads into the main house. This flexibility in the garage space allows the owners to have more control over the function and operation of their property.

Elevations showing one level garage options

Elevations showing two level garage options

Section of Garage Space

Street View (Showing different types of garage spaces)

Space Planning (Second level garage options)

Figures 40: House and Car Designs

CHAPTER 5:

Relationship between *HOUSE AND ENERGY*

"The modern concept of housing is to build a strong box and hook it to adjustable life-support systems that provide temperature, light and air circulation as well as bring water in and flush waste out." (Snell and Callahan 18)

The current developer tract house is primarily reliant on external sources for energy production and lighting. This dependence makes suburban housing extremely vulnerable in disaster or extreme weather situations. The microclimate of the site is ignored despite the fact that the natural systems can provide invaluable resources. In particular the orientation of the house and the location of fenestration are essential factors in the natural heating and cooling of a dwelling. In the tract house, these issues are ignored. Current practice is for houses and lots to be selected separately resulting in the design of the house and the orientation of the lot having no relationship. This system does not allow for passive solar strategies and in many cases the solar access negatively affects the heating or cooling of the home. The window placement of a typical suburban house is in response to the interior room functions and disregards sun movement. The use of shade structures, overhangs, and terraces are rarely accurately incorporated into the overall house design. "Despite advances in building codes and regulations, equipment efficiencies, and construction practices, there has been a 13% increase in energy consumption and a 9% increase in GHG emissions due to single-family detached housing since

"many such psychological problems as anxiety, chronic tension, and eating disorders are caused by our isolation from natural settings. We spend too much time indoors in artificial, man-made environments. It's unnatural and unhealthy." (Boubekri 6)

1990.”⁴⁰ Drastic changes need to be made to the housing market to reduce the energy consumption and GHG emissions.

“...the history of architecture is the history of human beings coping with the elements, and different civilizations have applied solar principals according to their own environmental and geographical contexts and according to their own knowledge and belief systems.”⁴¹ (Boubekri 9)

The most primitive forms of architecture have always had a deep respect and connection to the patterns and the benefits of the sun. Many indigenous civilizations worshiped the sun as a god and used the sun to shape and inform the architecture and general planning of their ancient cities. Historic city centres, sites for habitat and places of worship were chosen for their relationship to the sun and were designed in harmony with the natural environment. Mass produced housing has evolved in the direction of ignoring natural environmental control systems and developing artificial replacement systems instead. This attitude needs to be shifted back towards working with the natural environment and celebrating the simple technology involved.

The connection of the house to sunlight has a direct effect on the health of the human body in two forms. The first element of light is in the form of vision where light impinges on the retina of the eye and powers the metabolism, endocrine and hormone systems. Light also interacts directly

⁴⁰ Beausoleil-Morrison, Ian D. Project Module: The Carleton Research and Innovation in Sustainable Energy (C-RISE) Funding Report. Rep. 2011. Print. Pg. 2.1.

⁴¹ Boubekri, Mohamed. *Daylighting, Architecture, and Health: Building Design Strategies*. Amsterdam: Elsevier Architectural, 2008. Print. Pg. 9.

with the skin in the form of photosynthesis and generates vitamin D.⁴² A sensitive house design with targeted access to sunlight can improve the health of the dwellers.

*"[Energy] is the single most important resource to ration and think through. Buildings use far more energy over the useful life rather than the materials to create a house. It is more critical to make the house energy efficient and to reduce the demand to generate what is needed with solar photovoltaics or geothermal."*⁴³

Solar energy is an abundant, clean, low-maintenance and reasonably simple technology.

The two leading countries in solar photovoltaic (PV) technology are Japan and Germany, despite having modest solar resources. Ontario, in fact, has a greater solar resource than these current solar leaders but the potential of Ontario's solar resource is continuously undervalued and challenged.⁴⁴ In Ontario, the low winter sun angles, reduced hours of daylight and cloudy days do limit the access to solar gain but these difficulties do not destroy the overall seasonal potential for solar gain. Outlined in the *Smart Generation Powering Ontario with Renewable Energy* by the David Suzuki Foundation "Toronto, in fact, has a better summer solar resource than the city of Miami, Florida."⁴⁵ The Canadian climate does provide challenges for solar energy production but with the advancements in the technology of seasonal solar storage, this clean and renewable resource is a viable reality. Solar

"Solar energy currently provides 8% of the average Canadian home's heating requirements (in the form of sunlight entering through windows). This proportion of 'solar thermal' energy (converting sunlight into heat) could be easily increased to 22% with minor changes in community planning, building design, and higher standards." (Etcheverry 81)

"Solar systems (PV and thermal) are generally most effective when installed on buildings that can use solar energy (either as electricity and/or heat) on site. This strategy minimizes land-use conflicts and the need for construction of stand-alone support structures, while reducing energy delivery problems (e.g. need for grid expansions and associated energy transmission losses)." (Etcheverry 88)

"Heating and cooling and other energy use in these [single-family detached] houses produces 52 Mt of greenhouse gas (GHG) emissions annually, more than 10% of Canada's total output." (Beausoleil-Morrison 2.1)

⁴² Boubekri, Mohamed. *Daylighting, Architecture, and Health: Building Design Strategies*. Amsterdam: Elsevier Architectural, 2008. Print. Pg. 53.

⁴³ Guzowski, Mary. *Towards Zero Energy Architecture: New Solar Design*. London: Laurence King, 2010. Print. Pg. 19.

⁴⁴ Etcheverry, Jose. *Smart Generation: Powering Ontario with Renewable Energy*. Vancouver, BC: David Suzuki Foundation, 2004. Print. Pg.82.

⁴⁵ Ibid. Pg.82.

energy is not the only form of clean and renewable energy. However it is the focus of the C-RISE project and therefore the primary focus for energy generation, in the design scheme for this thesis.

The three main solar technologies are photovoltaic, thermal, and passive solar energy (described in the sidebar). Building-integrated photovoltaics (BIPV) are the combination of PV modules built into the structural elements of the building. These panels can be incorporated into the roof, façade, skylights or solar shading structures and can replace typical building materials rather than being placed on top. The C-RISE project will not be using photovoltaic technology however. Instead, it is testing a thermal system that focuses on seasonal storage. In Canada, seasonal storage is an important technology to address the problem of the peak energy demand for space heating occurring when only approximately 30% of the solar energy potential is available.⁴⁶ The seasonal storage system will capture and store heat from early spring to late fall to meet the winter heating needs.

The combination of the Ontario feed-in-tariff (FIT) program with the recent drop in the price of solar power technology and equipment is making solar energy an excellent and viable option for the Ontario housing market. Solar technology has been decreasing in price rapidly and a recent article in *The Globe and Mail* recognizes that, “virtually everyone in the sector believes the time will come – likely within the next decade – when the price of solar power equipment falls to the point

⁴⁶ Beausoleil-Morrison, Ian D. Project Module: The Carleton Research and Innovation in Sustainable Energy (C-RISE) Funding Report. Rep. 2011. Print. Pg. 4.5.

Figure 41: Direct Gain System

Figure 42: Trombe Wall

Figure 43: Sun Space

Passive Solar Energy “is being used in many ways. Passive solar energy, just as the name implies uses the heat and light from the sun without using any collectors, grids, or cells. The south side of a building always gets the most sunlight. With that in mind, buildings that are designed to use passive solar energy will have large south facing windows.”
<http://www.solarenergy-solarpower.com/passive-active-solarenergy.html>

where solar is competitive with other forms of power generation”.⁴⁷ An Ontario solar panel installation company stated that the price of solar panels has decreased from about \$2.50 per watt in 2010 to \$1.50 per watt at the end of 2011.⁴⁸ These advances in solar technology are creating a strong platform for solar to become more popular for homes all over Canada.

The Drake Landing Solar Community (DLSC) is a master planned neighbourhood located in Okotoks, Alberta and is the first solar project of its kind in the world. This 52 single-family home community has integrated the solar technologies of solar thermal collection systems and seasonal borehole storage. This advanced development uses solar energy to generate electricity and captures and stores the sun’s heat for later use during the winter months when the solar gain is limited. Each house produces 5 tonnes less of greenhouse gas (GHG) emissions per year and requires 110.8 gigajoules less energy than a conventional suburban house making these homes 30 percent more efficient.⁴⁹ The solar collection systems and seasonal storage produce 90% of each home’s space heating requirements and the houses are built to the R-2000 standards developed by Natural Resources Canada.⁵⁰ This community is a landmark project that shows Canadians that solar energy is a practical and feasible option for the future of suburban housing. The DLSC is designed so that the majority of

⁴⁷ Blackwell, Richard. "Installers, Homeowners Cash in on Solar Industry Slump." *Home*, Dec. 2011. Web. <<http://www.theglobeandmail.com/report-on-business/industry-news/energy-and-resources/installers-homeowners-cash-in-on-solar-industry-slump/article2259666/>>.

⁴⁸ Ibid.

⁴⁹ "Heads Up Energy Efficiency Newsletter." *Welcome to Natural Resources Canada*, Aug. 2011. Web.

<<http://oee.nrcan.gc.ca/commercial/technical-info/heads-up-energy-efficiency/6188>>.

⁵⁰ Ibid.

Figure 44: Photovoltaic Panels

Active Solar Energy

(Photovoltaic or Thermal)

"active solar energy captures the sun's energy in order to store or convert it to thermal or electric power. In active solar energy systems, there is an active and intentional collection and redirection of energy. There are two main types of active solar energy: Thermal – used to generate heat for hot water, cooking, heating, melting, steam engines, etc. Photovoltaic used to generate electricity for both grid-tied and off-grid systems".

(<http://www.solarenergy-solarpower.com/passive-active-solarenergy.html>)

Figure 45: Solar Water Collector

the solar collection is done on the detached garages leaving the houses to be designed in the style of typical suburban homes. This design approach allows typical looking subdivision houses to be inserted into the community, which appears to be a positive feature based on the Urbandale experience of market taste. However, from a design point of view, the opportunity to showcase an alternative to the typical suburban house was lost. The DLSC system is developing important technology to blend into the current suburban housing system but is neglecting to address certain flaws of the suburban system. This thesis takes the DLSC a step further and advocates for new suburban housing that highlights and incorporates environmental features into the house design itself creating a new style of housing.

The DLSC project is a community scale system. By contrast, the C-RISE project is focusing on individual site generation and solar thermal storage. Solar energy systems are “almost exclusively an on-site generator of energy” and this individual scale system represents a need for a paradigm shift of focus from the large scale power plant generators.⁵¹ “Solar systems (PV and thermal) are generally most effective when installed on buildings that can use solar energy (either as electricity and/or heat) on site.”⁵² Working with this notion that solar energy is most efficiently generated and consumed on site supports the focus of this thesis on the individual home solar collection and seasonal storage.

⁵¹ Etcheverry, Jose. *Smart Generation: Powering Ontario with Renewable Energy*. Vancouver, BC: David Suzuki Foundation, 2004. Print. Pg.82.

⁵² Ibid. Pg.88.

Figure 46: DLSC

Figure 47: DLSC

Figure 48: DLSC Site Plan

Figure 49: Solar Seasonal Storage and District Loop

In Ottawa, Urbandale is one of the only Development companies that is trying to introduce sustainable houses. They currently build all of their homes to the 2005 R-2000 standard when according to NRCan less than 1% of all Canadian houses meet that standard. The R-2000 Standard exceeds the energy performance requirements of the Ontario Building Code and sets requirements for energy efficiency, indoor air tightness quality, and environmental responsibility in home construction.⁵³ While working directly with the Engineering Department at Carleton University and Matthew Sachs, from Urbandale Developers on the C-RISE project it was disheartening to hear from Sachs that past attempts of introducing environmentally conscious and energy conserving homes were not well received from prospective buyers in Ottawa. In one of our meetings he described the past market constraints involved in promoting and selling “green” homes. Urbandale’s first attempt to create more sustainable homes was in the 70’s and early 80’s by introducing skylight features and the use of double layers of drywall to create thermal mass walls. These houses did not sell well and turned out also not to be cost effective to build. The latest approach by this Ottawa Developer was in 2010 when they developed a partnership with Enbridge, Bullfrog Power and EnerWorks.⁵⁴ These solar houses Sachs described as “the last to sell” due to buyer concerns with the aesthetics, maintenance, and fear of the unknown. Nevertheless, they are continuing to keep an environmental focus by sponsoring The Carleton Research and Innovation in Sustainable Energy House and allowing

⁵³ "What Is R-2000?" *Welcome to Natural Resources Canada*. 2011. Web. <<http://oec.nrcan.gc.ca/residential/new-homes/r-2000/7334>>.

⁵⁴ Phone interview with Matthew Sachs. February 2012.

the C-RISE group to make drastic changes to their typical house model. Urbandale stated that the innovative ideas that are being explored for the C-RISE project “may influence the way we construct our buildings in the future” and is a way to explore novel concepts before presenting them to the Ottawa housing market.⁵⁵

This thesis is unwilling to accept the marketing constraint that suggests that “unusual” energy efficient houses do not sell. Environmental features need to be incorporated into the overall house design rather than presented to buyers as options or upgrades. PV panels, thermal solar collectors, water tanks, shading structures, and green roofs can be a visual deterrent to the general public if they are simply affixed to a conventional suburban house. This thesis attempts to integrate and highlight these elements into the overall house design.

C-RISE House:

The C-RISE project is investigating and incorporating several energy saving technologies and techniques into the research house that will be built on the Carleton University Campus. The house will be built to the 2012 R-2000 guidelines; however will significantly exceed this standard with the integration of innovative heat storage systems, insulation, and active heat management systems.⁵⁶

The flexible and integrated design of this prototype house will allow for the, “continuous study of

⁵⁵ Beausoleil-Morrison, Ian D. Project Module: The Carleton Research and Innovation in Sustainable Energy (C-RISE) Funding Report. Rep. 2011. Print. Pg. 2.2.

⁵⁶ Ibid. Pg. 2.1.

sustainable housing concepts, including solar photovoltaic (PV) and integrated PV/thermal devices, electrical storage, smart grid integration, and micro-cogeneration”⁵⁷ for future generations at Carleton University. The three major focuses, for the first stage of the program are to investigate the main energy end uses of space heating, domestic hot water (DHW) heating and space cooling. National Resources Canada outlines that in Canadian housing in 2010 these three systems accounted for 84% of the total energy use.⁵⁸ Carleton University’s Mechanical and Aerospace Engineering Professor Ian Beausoleil-Morrison, the lead facilitator of the C-RISE project outlines the importance of solar seasonal storage at the individual house scale as follows: “Numerous research and demonstration projects have evaluated the seasonal storage of solar energy at the community scale ... These large community systems enjoy some advantages due to scale. However, given the nature of the Canadian housing industry, the exploration and development of seasonal storage concepts that are applicable at the single-house scale will likely have greater impact; this is the focus of the seasonal storage research at C-RISE.”⁵⁹ The design of the C-RISE house incorporates two different seasonal heat storage systems to allow for gradual testing, critical experimentation and detailed comparisons to review the efficiency and effectiveness of each system.

⁵⁷ Ibid. Pg. 4.5.

⁵⁸ Ibid. Pg. 4.5.

⁵⁹ Ibid. Pg. 4.5.

The first form of seasonal storage is a horizontally and vertically segmented water-based storage system, which will be made of a series of 50m³ concrete insulated tanks buried in the ground adjacent to the research house.⁶⁰ “Variable height inlets and outlets will be employed, to supply and extract water at the desired height to minimize energy destruction and to maximize solar collector efficiency and solar fractions.”⁶¹ The second seasonal storage system is an insulated patch of soil, extending three meters underneath the foundation of the house, which will be used as a thermal store. This area is excavated, insulated, and to keep moisture in and out, the moist storage material is protected with a vapour barrier. “Heat transfer fluid is circulated through horizontal pipes buried in the soil. A multi-inlet flow arrangement of pipes at multiple levels will be utilized in order to achieve a degree of stratification sufficient to maximize performance as with the water-based store described above.”⁶² The detailed designs for both of these systems are the subjects of ongoing research being conducted by the C-RISE team.

Elements for Design:

The elements employed to utilize and control the light and energy arriving from the sun in the proposed designs are thermal solar collectors, PV panels, shading structures, light shelves, and

⁶⁰ Ibid. Pg. 4.5

⁶¹ Ibid. Pg. 4.5

⁶² Ibid. Pg. 4.5

thermal masses to store passive heat through the stone fireplace and exposed concrete flooring. As Ray Kappe said “Forms come out of rational decisions; this includes the solar elements such as overhangs, shading devices, and the form and section.”⁶³ The environmental features of the house design are embraced and used to shape the general layout of the house. The design incorporates all of the knowledge, research and experience that has been gained from being involved in the C-RISE project. The roof angle and area for solar collection was calculated by the C-RISE team for optimal solar gain in Ottawa, Ontario. The combination of thermal solar collectors, PV Panels and BIPV allow the sun’s energy to heat the house, heat the water and provide energy. The Masonry stove or high efficiency fireplace/wood stove provides visual and additional heating benefits. The BIPV panels are used to bring light through the roof while also generating energy. The courtyard space and skylights bring daylight deep into the house. The vital interactions between the indoor and outdoor spaces are celebrated at each level of the house with balconies, green roofs, large windows, and courtyard patio space. The interior of the house has different layout options but the main features remain throughout the designs. The house design responds to the orientation of the site and the large sloping solar roof faces south on either side of the street. This proposal shows how house designs can respond to the solar orientation while keeping a consistent layout, thus responding to the developer’s stipulation that the construction needs to be simple and uniform.

View of solar roof with skylights/BIPV visible

Early sketch of roof shaping interior space

⁶³ Guzowski, Mary. *Towards Zero Energy Architecture: New Solar Design*. London: Laurence King, 2010. Print. Pg. 19.

Solar Mapping and Light Studies

Street Section (showing south facing roof angle)

Figures 50: House and Energy Designs

CHAPTER 6:

Relationship between *HOUSE AND WATER*

Current developer and home building companies design streets and houses with rain and municipal water considered as a waste product rather than as the valuable resource that it is. Water is an easily accessible and reusable resource but home owners rely completely on potable municipal water for all their water needs. “Between 1972 and 1996, Canada's rate of water withdrawals increased by almost 90%, from 24 billion m³/yr (cubic metres per year) to 45 billion m³/yr. But, our population increased by only 33.6% over the same period, illustrating the growth in our thirsty lifestyles.”⁶⁴ This kind of wasteful usage is unsustainable. Water used to flush toilets, wash clothes and water lawns does not need to be potable. With a properly designed system, water can be reused a number of times before it is returned to the treatment plant.

The exterior of the typical suburban home is also designed poorly for embracing the natural system of the hydrologic cycle of storm water. The current standard of re-directing rainwater down paved areas, along curbs and into sewer drains removes necessary water from the site, creates water pollution, overloads the sewer system, creates poor water quality, and leaves the site needing alternative irrigation systems.

⁶⁴“Wise Water Use.” *Environment Canada*. Mar. 2011. Web. < <http://www.ec.gc.ca/eau-water/default.asp?lang=En>>.

Canadians take water for granted and undervalue this precious resource. The supplemental charts in Figure 51 and 52, produced by Environment Canada outline the drastic differences in the average daily domestic water use and typical municipal water prices in Canada, compared to other countries.

The building standards for the important relationship between house design and water towards which architects and developers should be working, is a closed-loop on-site water harvesting and filtration system. The International Living Future Institute has ambitious guidelines for their Living Building Challenge's rating system that encourages buildings to be self-sufficient and designed with a net-zero water system. "The Living Building Challenge envisions a future whereby all buildings are designed to harvest sufficient water to meet the needs of occupants, while respecting the natural hydrology of the site, the water needs of neighbors and the ecosystem it inhabits. Indeed, water can be used and purified and then used again."⁶⁵ For the purposes of this thesis however, the focus will be on the reuse of gray water. Black water treatment requires compliance with strict standards and alternative natural treatment options such as Living Machines that are best done at the neighbourhood level, and hence beyond the scope of this thesis. Grey water filtration and recycling systems can be used in residential architecture to collect and re-use rain and municipal water. These

Figure 51: Typical Municipal water prices in Canada and other countries

Figure 52: Average daily domestic water use

⁶⁵ The International Living Future Institute. Web. Nov. 2011. <<https://ilbi.org/>>.

systems recycle the waste water that is produced from bathing and the washing of laundry and dishes, filters it, and then provides this water back into the system for irrigation or toilet flushing. These water systems are currently being tested and experimented with in residential settings to resolve the current problems and challenges that are prohibiting City By-law regulations and the National Building Code from allowing them to be more commonly used. A few of the municipalities in Ontario are encouraging the research and development of recycling water systems so that they can be used more effectively in the future. The City of Guelph has a Residential Grey Water Reuse Pilot Program that gives money to home owners to help install a grey water system.⁶⁶

Bioswales and porous paving methods are storm water practices that can help to filter water naturally, reduce pollution, reduce surface run-off to storm sewers, and bring the site back to the natural hydrologic system. The problems with excessive water being removed from the site through storm sewers is that less rainwater infiltrates and evapotranspires, which causes increased flood risks, land erosion, and poor water quality.⁶⁷ This simple act of using a small engineered pond system with native species surrounding it can have a large impact on the environment, compared to the current model of planting unnatural grass and removing the valuable water from the site. A 2008 Performance Evaluation of Permeable Pavement and a Bioretention Swale conducted by The Toronto and Region

Figure 53: Porous paving methods

Figure 54: Sectional drawings of bioswales

⁶⁶ "Residential Greywater Reuse Pilot Program." *Guelph.ca*. 2012. Web. < <http://guelph.ca/living.cfm?itemid=77268>>.

⁶⁷ Toronto and Region Conservation Final Report. *Performance Evaluation of Permeable Pavement and a Bioretention Swale*. Rep. 2008. Print. Pg. iv.

Conservation concluded that these design elements perform well through the demanding and changing seasons of Ontario's climate. "The bioswale also performed well during the winter. Soil temperatures remained above freezing and infiltration occurred throughout cold weather. There was no evidence of melt waters backing up onto the parking lot as a result of ice and snow build-up around the perimeter of the swale."⁶⁸

Design Elements:

The design proposal explores different ways to reduce water pollution, reduce surface run-off to storm sewers, use grey water systems to repurpose water, and use natural water filtration systems in residential designs. The reduction of the non-porous paving area, which resulted from the research in the *House and the Car* chapter, allowed for a re-design of the typical drive-way focused front yard and a rehabilitation of the polluting water run-off system. The street edge of a suburban lot is typically owned by the City. This thesis proposes that the City of Ottawa use this land to provide the simple system and native plantings for a bioswale on each lot, as well as the standard individual tree. The front yard has been designed to absorb any runoff on the street side of the house. Porous paving is used from the street to the garage to absorb water into the ground rather than funnel it into a

⁶⁸ Toronto and Region Conservation Final Report. *Performance Evaluation of Permeable Pavement and a Bioretention Swale*. Rep. 2008. Print. Pg. vii.

Rough section showing the water collection from roof to water cistern

Site Plan showing front yard layout

drain. The green roof absorbs and delays water runoff from the garage roof and street facing roof area of the house. The bioswale filters and cleans excess water and allows it to slowly soak into the ground. The steep slope and the large surface area of the roof create an essential structure to collect rainwater at the base of the roof and store it for irrigation. By absorbing more water into the yards with native species plantings, porous paving, bioswales, green roofs and green walls the relationship between the suburban home and water is regenerated.

Site Plan showing water cistern location between houses

Street View (showing the bioswales and green roofs)

Figures 55: House and Water Designs

DRAWINGS

NO. 114

CONCLUSION

The demand for single family suburban tract housing continues strong, and represents an enormous cultural inertia. It is not clear whether the developers are creating the market or the market is demanding the uninspiring and environmentally destructive standard house that is currently available. From the developer's point of view, there is no financial incentive to stray from the tried-and-true tract model, and from the buyer's point of view, there is fear and uncertainty attached to investing in a property that is "different" and therefore might not sell in the future. But the fact is that current developments are fuelling a lifestyle that is simply not sustainable. A paradigm shift is absolutely necessary, and architects should take a leadership role in making this shift happen.

Alternative house designs need to be developed and marketed to the public in a way that is understandable and places an emphasis on life cycle costs rather than initial cost. Projects, such as the C-RISE house represent the first step to getting the public and the building industry to become more comfortable with design features such as bold sloping roofs that respond to the orientation of the sun, building integrated solar panels, flat green roofs, and alternative building materials such as rammed earth walls. The orientation of a house to its site can no longer be ignored. Architects need to work with developers to find a way to construct and market houses that profit from their solar orientation. This thesis demonstrates how house designs can respond to their site while maintaining a consistent floor plan with a north or south facing orientation. The garage needs to be removed as the

focal point of tract housing and neighbourhoods. The acts of sinking the garage, reducing the size of the driveway, re-framing the front yards, and inhabiting the space above the garage encourage and re-define the social space of the street. The incorporation of additional private exterior spaces in the form of rooftop green space, courtyards, patios and balconies allow the front and backyards to be used as public shared spaces, offering the possibility of community gardening. Tract houses need to be more responsible and less wasteful, incorporating the harnessing of renewable energy and water.

The suburban environment has a long way to go to become sustainable and build the dynamic layers needed to develop diverse and engaging communities. Interventions need to be made from multiple disciplines, levels, and perspectives. This thesis does not attempt to answer all of the daunting problems of the suburban context, nor does it directly challenge its social structure, however it does open up a space for the culture of suburbia to evolve. This act of challenging and prototyping alternative models needs to continue at the local, community and urban scales, in order to reinvent the suburbs as a sustainable option.

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Figure 1: Top: "A New Blueprint for Levittown - Time Magazine." *A New Blueprint for Levittown - Time Magazine*. Web. 2011.

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Bottom: "1951: Levittown." *1951: Levittown*. Web. 2011. <<http://www.capitalcentury.com/1951.html>>.

Figure 2: "~ St. Catharines' Wartime Neighbourhoods." *The Designs*. Web. 2011. <<http://wartimehouses.com/the-homes/the-designs/>>.

Figure 3: "The Grass Isn't Greener... Permaculture Research Institute." *The Grass Isn't Greener... Permaculture Research Institute*. Web. 2011.

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Figure 7: "1945 - 1980s: Raised Ranch House Style." *About.com Architecture*. Web. 2011. <<http://architecture.about.com/od/periodsstyles/ig/House-Styles/Raised-Ranch-Style.htm>>.

Figure 8: "1945 - 1980s: Split-Level Ranch Style." *About.com Architecture*. Web. 2011. <<http://architecture.about.com/od/periodsstyles/ig/House-Styles/Split-Level-Ranch.htm>>.

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Figure 11: "Mid-Century Modern Ottawa." : *May 2011*. Web. 2011. <http://modernrealtor.blogspot.ca/2011_05_01_archive.html>.

Figure 12: "VERONA DAILY PHOTO." : *October 2009*. Web. 2012. <http://veronadailyphoto.blogspot.ca/2009_10_01_archive.html>.

Figure 13: Photo by A. Yeatman

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*"Go to nature, thou builder of houses, consider her ways and do not be petty and foolish. Let your home appear to grow easily from its site and shape it to sympathize with its surroundings if nature has manifest there, and if not, try to be as quiet, substantial, and organic as she would have been if she had the chance."*⁶⁹ (Frank Lloyd Wright)

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