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reBURB: Redefining the Suburban Family Unit Under a New Construction Ecology

Matthew A. Lobeck

University of South Florida

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reBURB: Redefining the Suburban Family Unit Under a New Construction Ecology

by

Matthew A. Lobeck

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Architecture
School of Architecture and Community Design College of Visual and Performing Arts University of South Florida

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Keywords: environmental, housing, modular, construction, vernacular, systems

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Table of Contents

List of Figures iii
List of Tables vii
Abstract viii

Chapter One: Crisis of the Home 1
Chapter Two: Considerations of Program and Site 6
  Occupant Description 6
  Definition of Program 7
  One Bedroom Facilities List/Adjacency Diagram 8
  Two Bedroom Facilities List/Adjacency Diagram 10
  Three Bedroom Facilities List/Adjacency Diagram 12

Prototypical Site 14
Selected Site 14
  Site Analysis-Macro 15
  Site Analysis-Micro 17

Chapter Three: Case Studies 21
  Florida Vernacular Dwellings 21
    Case Abstract 21
    Hypothesis 22
    Methods Used 23
    Analysis 24
    Conclusion 31
  FlatPak Home 32
    Case Abstract 32
  Zero Energy Home 35
    Case Abstract 35
  Florida Solar Cracker 40
    Case Abstract 40
Chapter Four: Skin Study 42
   Skin Study Abstract 42
   Volume 1 Construction and Thermal Performance 43
   Volume 2 Construction and Thermal Performance 45
   Volume 3 Construction and Thermal Performance 47
   Volume 4 Construction and Thermal Performance 49
   Volume 5 Construction and Thermal Performance 51
   Conclusion 53

Chapter Five: Building Assembly Development 54
   Site Assembly Versus Site Fabrication 54
   Building System Details 58
   Moving Beyond The Building System Details 61

Chapter Six: Support Systems Development 62
   Mechanical System 62
   Hot Water System 63
   Solar Electrical System 64

Chapter Seven: Environmental Performance 65
   Thermal and Energy 65
   Construction 67
   Conclusion 71

List of References 72
Bibliography 73
Appendices 75
Appendix A: Construction Timeline 76
List of Figures

Figure 1. One Bedroom Adjacency Diagram  9
Figure 2. Two Bedroom Adjacency Diagram  11
Figure 3. Three Bedroom Adjacency Diagram  13
Figure 4. Regional Aerial  15
Figure 5. Macro Aerial  15
Figure 6. Area Zoning  16
Figure 7. Macro-Circulation  16
Figure 8. Tree Coverage  17
Figure 9. Micro Aerial  17
Figure 10. Micro-Circulation  18
Figure 11. Site A Analysis  19
Figure 12. Site B Analysis  20
Figure 13. Florida Bungalow-Largo, FL  21
Figure 14. Elevation-Florida Bungalow  21
Figure 15. Elevation-Florida Dogtrot  21
Figure 16. Florida Dogtrot-Largo, FL  21
Figure 17. Dogtrot 1st Floor Plan  24
Figure 18. Dogtrot 2nd Floor Plan  24
Figure 19. Dogtrot Elevation  24
Figure 20. Bungalow Floor Plan  25
Figure 21. Bungalow Elevation  25
Figure 22. Dogtrot 1st Floor Plan  26
Figure 23. Dogtrot 2nd Floor Plan  26
Figure 24. Dogtrot Elevation  26
Figure 25. Bungalow Floor Plan  27
Figure 26. Bungalow Elevation  27
Figure 27. Dogtrot 1st Floor Plan  28
Figure 28. Dogtrot 2nd Floor Plan  28
Figure 29. Dogtrot Elevation  28
Figure 30. Bungalow Floor Plan  29
Figure 31. Bungalow Elevation 29
Figure 32. Dogtrot Section 30
Figure 33. Bungalow Section 31
Figure 34. Flatpak house 32
Figure 35. Packages 32
Figure 36. Site Assembly 32
Figure 37. Delivery and Installation of Flat Wall Panel 33
Figure 38. Assembly of Wall and Roof 33
Figure 39. Planning System 34
Figure 40. Material Palette 34
Figure 41. Simplification of Plan 34
Figure 42. ZEH and Control House Aerial 35
Figure 43. Roof Temperature Graph 35
Figure 44. ZEH Roof Thermal Image 36
Figure 45. Control Roof Thermal Image 36
Figure 46. Roof Overhang 37
Figure 47. Roof Overhang 37
Figure 48. Indoor Temperature Graph 37
Figure 49. Exterior Insulation 37
Figure 50. Heat Transmittance in Windows 37
Figure 51. HVAC Power Usage Graph 38
Figure 52. HVAC Closet Thermal Comparison 38
Figure 53. PV System 39
Figure 54. Annual Energy Use Graph 39
Figure 55. Daily Electrical Demand 39
Figure 56. Axonometric View 40
Figure 57. Material Usage 40
Figure 58. Building Section 41
Figure 59. Building Plan 41
Figure 60. Solar Array 41
Figure 61. Stack Ventilation 41
Figure 62. Interior/Exterior Thermometer 42
Figure 63. Radiant Barrier 42
Figure 64. Skin Test 6:00 a.m. 42
Figure 65. Volume 1 Section 43
Figure 101. Construction Timeline-Exterior Skin 80
Figure 102. Construction Timeline-Solar Hot Water System 81
Figure 103. Construction Timeline-Solar PV System 81
List of Tables

Table 1.1 One Bedroom Facility List 8
Table 1.2 Two Bedroom Facility List 10
Table 1.3 Three Bedroom Facility List 12
Table 2.1 Zoning Constraints 14
Table 3.1 Dogtrot Wind/Temp Study 24
Table 3.2 Bungalow Wind/Temp Study 25
Table 4.1 Dogtrot Light Study 26
Table 4.3 Recommended Daylight Factors 27
Table 4.2 Bungalow Light Study 27
Table 5.1 Volume 1 Interior Temperature Study 44
Table 5.2 Volume 1 Exterior Temperature Study 44
Table 6.1 Volume 2 Interior Temperature Study 46
Table 6.2 Volume 2 Exterior Temperature Study 46
Table 7.1 Volume 3 Interior Temperature Study 48
Table 7.2 Volume 3 Exterior Temperature Study 48
Table 8.1 Volume 4 Interior Temperature Study 50
Table 8.2 Volume 4 Exterior Temperature Study 50
Table 9.1 Volume 5 Interior Temperature Study 52
Table 9.2 Volume 5 Exterior Temperature Study 52
Table 10.0 Overall Temperature Study 3 Day Average 53
Table 11.0 40 Year Carbon Output 64
Table 12.0 Construction Time 67
Table 13.0 Construction Cost Breakdown 68
Table 14.0 Construction Cost Per Square Foot 69
reBURB: Redefining the Suburban Family Unit Under a New Construction Ecology
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ABSTRACT

“Our structures might be machines for living in, but there was no longer much about them that was alive.”

-William McDonough, Cradle to Cradle

Home ownership is a significant driver within American culture. In Florida single-family homes represent one of the largest components of our built surroundings, significantly impacting the environment through material use and energy consumption. Currently, homes typically are built with little regard to the environmental context. By designing for the immediate goal of separation from the elements, they do not provide for convenient spatial expansion or adaptability, using material assemblies that do not lend themselves to be recycled, reused, or returned to the earth safely. Homes are obsolete before they have been constructed.

The Florida single-family home, once closely linked to its environment both physically and experientially, has devolved into a statically defined entanglement of systems with a primary goal of separating humans from natural systems by providing a climatically fixed space with little regard to the environment. This separation has served to detach people and the buildings that they inhabit from their environmental context and responsibilities rendering the underlying physical, biological, and chemical processes of their environmental context irrelevant.

By viewing the dwelling unit and its components as not within their end function but part of a greater cycle, this elevates the dwelling unit to more than inanimate machine that separates but to a symbiotic entity within a greater construction ecology. Through the analysis of historical Florida dwellings it is the intent to distill a design approach that reconnects with the environmental context through use of passive systems and experiential environmental connection. Further study is to focus on modular systems and connections within building skins and structures to develop methods that allow for the assembly, disassembly and adaption thus strengthening the construction ecology by facilitating the reuse of materials. By redefining the construction cycle and the connection to the local environment of the Florida single-family home it is the intent to establish a contemporary construction methodology that acts to not only be environmentally efficient but environmentally effective for its user and its context.
Chapter One: Crisis of the Home

“Our structures might be machines for living in, but there was no longer much about them that was alive.”

-William McDonough, Cradle to Cradle

Within the United States, the construction industry, representing only 8% of the country’s gross domestic product, usurps 40% of the total material extracted and consumes over 30% of the nations primary energy. In looking at those numbers alone, it is easy to conclude that the built environment poses one of the greatest threats to our planet. While awareness of the construction industry’s impact is growing, the implementation of technology and new methods of production to curb this onslaught are only starting to be realized mainly in larger and more lucrative building projects. Because of this trend, the housing sector has been slow to adapt. While typically smaller in overall building size than structures for other uses, family housing construction for both new and remodeled accounted for over $262 billion dollars within the construction industry in 2002. This accounted for over half the value of total construction within the United States.

Home ownership is a significant driver within American culture. In 1993, approximately 44% of the nation’s wealth was accounted for in home ownership. In Florida single-family homes represent one of the largest components of our built surroundings. That volume significantly impacts the environment through material use and energy consumption. The basic construction of the typical present day home is either block or balloon framed. Both of these methods were developed at the middle to end of the 19th century and have change little since. The 20th century has served not to advance the methods of home construction but to interweave those once elegant structures with an array of technological advancements such as plumbing, electricity, HVAC, and communication systems.

“Each part of these service and structural systems no doubt represents, in itself, the best product for the least cost, available from the world-wide building products industry, each installed by a different trade and each serving a perceived need. This interweaving process seems to have worked up to now for four main reasons: the remarkable structural redundancy and forgiveness of wood or steel framing, the expectation that the next stage of work in this conventional chain of events will cover any depredations of the previous player, the relatively low cost of materials, and the availability of skilled workers.”
This interweaving of systems throughout a protracted timeline has dissolved the inherent passive systems of the original building prototype and fostered the entanglement of materials and systems. Due to these factors, homes typically are built with little regard for the environmental context unlike vernacular structures of the past. Prior to the installation of plumbing, electrical, and HVAC systems, greater care was taken in linking dwelling to the site to take advantage of passive systems for use in lighting, water resource management, and climate management.

This entanglement of materials can also be seen within the systems themselves. Materials are bonded in ways that do not promote their disassembly. The systems typically designed and implemented for their immediate use with little or no regard to their future use. This method of design serves to sever the materials from their “ecological feedback loops”. It is estimated that as much as 90% of the extracted stock of materials in the USA is contained in the built environment, making it a potential great resource or a future source of economic waste. ¹ Redefining the construction ecology for the single-family home, is not a just good approach, it is a necessity. Designing for the immediate use of the materials and systems and not the entire life cycle disregards our environmental responsibilities and renders the ecology of construction inert.

Similarly, this approach of designing for the immediate use or single focus goal has translated through the dwelling’s function, style, and spatial characteristics.

“American houses built in the eighteenth and nineteenth centuries are a good background against which to trace the evolution of our present entanglement, because then, neither electricity, plumbing, nor central heating were present. In these early houses, which people could afford to build, often following principles of compositional clarity and formal simplicity brought from European traditions², the few spaces were organized in such a way that they could be and were used for many household activities. Often, sleeping, living, bathing, and cooking occurred in one space in a time-sharing approach. It was normal to have change of use in harmony with the seasons and, of course, change of activity patterns when a new family moved into a house. This was accomplished by the repositioning of furniture and storage elements such as wardrobes, armoires, and the like. Rooms were labeled “hall,” “north parlor,” “south parlor,” “chamber,” etc. Few could afford to build use-specific rooms. Indoor toilets and bathrooms were nonexistent, and kitchens were found in any room where a fireplace provided a place to cook or located in a shed attached to the back of the house.” ³

This traditional attitude of having multi-functional spaces that can be readily adapted to desired purposes with little or no permanent impact allowed for the dwelling to change with the needs of
the inhabitant. As the families changed size or moved on to allow for new inhabitant, the space could be adapted. Today, dwellings are spatially “fixed” in many ways by not providing for future adaptation without demolition by statically controlled boundaries. Without considering future change, homes are obsolete before they have been constructed. This impact is condition is compounded due to the fact that the demographics in Florida are in constant state of flux due to the rate of growth, shifting job markets, and advent of rapid transportation. Gone are the days of living and dying in the place from which one is born.

“Most of us have read about or directly experienced the rapidly shifting demographics in our neighborhoods and regions and the changes of household types and sizes accompanying the larger statistical perturbations. In part because of these social dynamics, housing developers today build for specific market niches and unit mixes in their projects. The way buildings are organized today, building income may suffer, and operating costs increase if piecemeal or even substantial upgrading or “repositioning” of a building is needed to maintain its attractiveness in the market.

If these statistically targeted buildings are not entirely obsolete, facing abandonment or mistreatment, they at least may not make a good fit with the next statistical cohort of households. While in a very large aggregate sense all of these mismatches may even out, in any one building or locale the discontinuity can have telling but difficult to measure negative effects on household well-being, contributing to a sense of powerlessness over the place of dwelling at a very personal level where dwellings mean the most to us as inhabitants, an effect often felt in the community at large.”

The single-family home of Florida, which was once closely linked to its environment both physically and experientially, has devolved into a statically defined entanglement with a primary goal of separating humans from natural systems by providing a space that is climatically controlled with little regard to the environment. This separation has served to detach people and the buildings that they inhabit from their environmental context and responsibilities. This detachment has rendered the underlying physical, biological, and chemical processes of their environmental context irrelevant for the buildings and their inhabitants.

Redefining the dwelling unit and its construction ecology in the context of natural systems elicits the question: How does it contribute to its environmental context? How does it “feedback” to the “loop”? By viewing the dwelling unit and its components as not within their end function but merely as a point and part of a greater cycle, this elevates the dwelling unit as more than
inanimate machine that separates but as a symbiotic entity where the measure of value is not only on its environmental efficiency but its environmental effectiveness. It is the intent of this research to redefine the single-family home of Florida prototype under a new construction ecology by reconsidering life span of the dwelling and the methods in which it is to be constructed.

Reconsidering the life span of the dwelling and its elements will provide a basis from which to evaluate the overall impact on the environment. Through this evaluation it is the intent to center on developing a methods, which promotes the adaption of the dwelling over time to extend it usefulness. By redefining and disentangling of the elements including the site, building structure, building skin, spatial organization, and service systems this will promote primarily reuse and secondarily recycling elements that compose each system within the dwelling unit with the focus not only on their current use but future use. Inherent to this will be the disentanglement of the different systems and the development of methods that allow for disassembly and adaption. The evolvement of this project is to follow a combined strategy approach in development. The primary strategies that are to be implemented are the research of case studies historical dwelling types of Florida and the analysis of modular systems development, experimental research focusing on the material usage and connections within the structural and building skin system, and simulation research focusing on computer modeling.

The case studies of historical dwelling types of Florida will focus on houses of two basic time periods those that were constructed prior to World War II or “pre-war” and those that were constructed prior to 1900. The pre-war homes are selected because they were constructed prior to the housing boom that occurred after the war and did not include HVAC in the original design. It is my belief that these two factors have contributed to the detachment of the building from its site. The second housing time period is selected to encapsulate the traditional or “cracker” housing type of Florida. The cracker housing style being the vernacular of the region was constructed with out the infusion of modern building systems and relied mainly on passive systems to mitigate its environmental climate. Through the analysis of typological pre-war Florida homes and the traditional “cracker” style homes it is the intent to distill common lines of approach to passive climate mitigation, resource use, experiential environmental connection, and site integration that reconnects with the environmental context of Florida.

The second group of case studies to be preformed is to focus on the use of modular systems in housing design. Modular systems inherently use materials efficiently and can reduce construction time and impact. Through the study of previous works incorporating modular systems it the intent to discern potential system that could be implemented or at least serve as catalyst for the development of new systems that facilitate the assembly and disassembly of the main structure thus promoting the reuse of the components and the adaption of the space over time as the needs
of the inhabitants change. It is also the hope to discern the potential positive and negative affects that implementing such systems impose.

The second strategy being implemented is an experimental research will focus on the material usage and connections within the structural and building skin system. This is to be a developmental study with an emphasis on assembly, materials, connections, layering, climatic sensitivity, and environmental effectiveness for the building skin and structural systems. A focus will also be given to the redefinition of hierarchies and disentanglement of the building systems. It is the intent is to develop a prototypical modular system in the building’s structure and skin and clearly define the building’s system hierarchy in order to promote the assembly and disassembly of the major space defining and structural elements as to foster reuse and adaption. By designing for disassembly and adaption this will serve to alleviate the current “fixed” spatial condition of the current dwelling and in turn reduce waste and energy consumption.

The final design strategy of simulation will be used to serve as a baseline of environmental and economical efficiency of the methods and systems developed under the other strategies. This strategy will focus on the creation of building information models or BIM models of the new and existing dwelling prototypes. Once developed these models can all be subjected to the same climate simulation and material use comparisons. This will serve to illustrate advantages or disadvantage for using one method over another. The testing will focus on projected energy use, projected construction time, material use/separation, and adaptability.

It is the hope of this research to yield a viable contemporary construction methodology for the Florida single family home that redefines and disentangles the systems and elements that make up the dwelling, restores passive climate mitigation, and reconnects to the environment both physically and experientially. The redevelopment of the dwelling’s structural and skin systems into an adaptive modularized system and disentangling the systems will help to minimize the overall resource impact and promote component reuse thus strengthening construction’s “feedback loops”. The restoration of passive climate mitigation will reduce the operating needs of the building and begin to physically connect it to its environment. By redefining the construction cycle and the home’s connection to the local environment, this new contemporary construction methodology of the Florida single family home will serve to not only be environmentally efficient but environmentally effective for its user and its context challenging us not only to construct better but to live better as well.
Chapter Two: Considerations of Program and Site

Occupant Description

As material and labor prices rise, so do the current home prices. This causes home ownership within the lower- and middle-income families difficult to attain. Whether it is a single person household, retired couple, or even newlyweds starting a family, this project aims to provide an environmentally responsible alternative to current methods of home construction. By providing a modular based system for construction that focuses on adaptability and reuse, it allows for greater flexibility and economy for the inhabitants. As the user make-up changes over time whether it is an addition to the family or a child leaves the nest, this system will facilitate the spatial expansion and contraction to suit the users needs.

Secondly, by focusing on minimizing energy and resource use through the use of passive climate mitigation, alternative energy systems, reusable components will provide a dual role by reducing the life-cycle cost and environmental impact. This will in turn serve to strengthen the users financial base by providing a reduced monthly cost within the energy and water bills. When it does come time to alter the structure due to a change in the family dynamics or just a need for more or less space the modular based system will not only reduce labor costs but it will also be a source of recovered income because the components not used in the alteration will be able to be sold to someone else for there use or donated so that they may benefit the underprivileged and if fully realized even returned to the place of purchase for store credit.
Definition of Program

In defining the program for an occupant whose family dynamic is or maybe in flux one must consider the expansion and contraction of the spatial requirements of the occupant. In consideration of this I have proposed not just the static program of how the dwelling is to be built today but variations of how the program could be adapted to meet the user’s requirements at a future date. In doing this certain parameters or relationships must be defined between the interior and exterior living space, private bedroom space and interior living space, and interior space to circulation space. The tables below begin to illustrate those relationships. They are to serve as a benchmark for the project development not as a mandatory square footage requirement because throughout this project is an exploration of environmental efficiency and environmental connectedness.
<table>
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<th>Description</th>
<th>Clg. Ht.</th>
<th>NSF/Unit</th>
<th>NSF Total</th>
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<td>Dining</td>
<td>10'</td>
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<td>60 sqft</td>
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<tr>
<td>1</td>
<td>Bedroom</td>
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<td>150 sqft</td>
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<tr>
<td>1</td>
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Figure 1. One Bedroom Adjacency Diagram
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<td>Common Room</td>
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<td>Kitchen</td>
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<td>Outdoor Living Area</td>
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<td>10 sqft</td>
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<td></td>
<td></td>
<td>778 sqft</td>
</tr>
<tr>
<td>Total Area</td>
<td></td>
<td></td>
<td></td>
<td>1904 sqft</td>
</tr>
</tbody>
</table>
Figure 2. Two Bedroom Adjacency Diagram
### Three Bedroom Facility List

<table>
<thead>
<tr>
<th>No. of units</th>
<th>Description</th>
<th>Clg. Ht.</th>
<th>NSF/Unit</th>
<th>NSF Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary Space</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Common Room</td>
<td>10’</td>
<td>200</td>
<td>200 sqft</td>
</tr>
<tr>
<td>1</td>
<td>Kitchen</td>
<td>10’</td>
<td>120</td>
<td>120 sqft</td>
</tr>
<tr>
<td>1</td>
<td>Dining</td>
<td>10’</td>
<td>120</td>
<td>120 sqft</td>
</tr>
<tr>
<td>2</td>
<td>Bedroom</td>
<td>10’</td>
<td>150</td>
<td>300 sqft</td>
</tr>
<tr>
<td>1</td>
<td>Bathroom</td>
<td>10’</td>
<td>50</td>
<td>50 sqft</td>
</tr>
<tr>
<td>1</td>
<td>Master Bedroom</td>
<td>10’</td>
<td>200</td>
<td>200 sqft</td>
</tr>
<tr>
<td>1</td>
<td>Master Bathroom</td>
<td>10’</td>
<td>75</td>
<td>75 sqft</td>
</tr>
<tr>
<td>n/a</td>
<td>Outdoor Living Area</td>
<td></td>
<td></td>
<td>50% of prime 532.5 sqft</td>
</tr>
<tr>
<td><strong>Support Space</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Mech-HVAC</td>
<td>11</td>
<td>11</td>
<td>11 sqft</td>
</tr>
<tr>
<td>1</td>
<td>Mech-Elec</td>
<td>11</td>
<td>11</td>
<td>11 sqft</td>
</tr>
<tr>
<td>1</td>
<td>Utility</td>
<td>50</td>
<td>50</td>
<td>50 sqft</td>
</tr>
<tr>
<td>1</td>
<td>Closet-Hall/Service</td>
<td>5</td>
<td>5</td>
<td>5 sqft</td>
</tr>
<tr>
<td>1</td>
<td>Closet-Entry</td>
<td>5</td>
<td>5</td>
<td>5 sqft</td>
</tr>
<tr>
<td>1</td>
<td>Closet-Bedroom</td>
<td>15</td>
<td>15</td>
<td>15 sqft</td>
</tr>
<tr>
<td>1</td>
<td>Closet-Master</td>
<td>25</td>
<td>25</td>
<td>25 sqft</td>
</tr>
<tr>
<td>1</td>
<td>Service Area</td>
<td>10’</td>
<td>10</td>
<td>10 sqft</td>
</tr>
<tr>
<td>n/a</td>
<td>Circulation</td>
<td></td>
<td>8% of cond</td>
<td>96 sqft</td>
</tr>
<tr>
<td>2</td>
<td>Garage</td>
<td>320</td>
<td>640</td>
<td>640 sqft</td>
</tr>
</tbody>
</table>

**Total Conditioned Area**: 1292 sqft  
**Total Unconditioned Area**: 1173 sqft  
**Total Area**: 2465 sqft
Figure 3. Three Bedroom Adjacency Diagram
Prototypical Site

Prior to the selection of an applicable site for the project, a review of regional zoning requirements was conducted to provide the parameters for a Prototypical Lot. The review focused on zoning constraints for lots that would be typical of medium density residential zoning. This was done to tighten the constraints on project so that the resulting solution could be implemented with the greatest versatility easily into the regional context.

Table 2.1 Zoning Constraints

<table>
<thead>
<tr>
<th>Municipalities</th>
<th>Designation</th>
<th>Min. lot width (ft.)</th>
<th>Min. Area (sq. ft.)</th>
<th>Setbacks (ft.)</th>
<th>Max. height (ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clearwater</td>
<td>LMDR/MDR</td>
<td>50</td>
<td>5,000</td>
<td>25 5 10</td>
<td>30</td>
</tr>
<tr>
<td>Dunedin</td>
<td>R-60</td>
<td>60</td>
<td>6,000</td>
<td>25 7.5 20</td>
<td>2 strys liv</td>
</tr>
<tr>
<td>Oldsmar</td>
<td>R-2</td>
<td>50</td>
<td>6,000</td>
<td>25 6 10</td>
<td>35</td>
</tr>
<tr>
<td>Pinellas*</td>
<td>R-3</td>
<td>60</td>
<td>6,000</td>
<td>20 6 10</td>
<td>45</td>
</tr>
<tr>
<td>Pinellas Park</td>
<td>R-1</td>
<td>75</td>
<td>7,500</td>
<td>25 10</td>
<td>45</td>
</tr>
<tr>
<td>Safety Harbor</td>
<td>R-2/RS-50</td>
<td>50</td>
<td>6,000/5,000</td>
<td>25/20 8/7.5</td>
<td>20/15</td>
</tr>
<tr>
<td>St. Petersburg</td>
<td>RS-75</td>
<td>75</td>
<td>7,500</td>
<td>25 7.5 20</td>
<td>35</td>
</tr>
<tr>
<td>Tampa*</td>
<td>RS-50/RS-60</td>
<td>50/60</td>
<td>5,000/6,000</td>
<td>20/25 7</td>
<td>20/35</td>
</tr>
<tr>
<td>Tarpon Springs</td>
<td>R-70A</td>
<td>60</td>
<td>6,500</td>
<td>25 7.5 20</td>
<td>35</td>
</tr>
</tbody>
</table>

Selected Site

The two sites selected are located in a transitional neighborhood just north of the downtown core of Dunedin, FL. The opposing orientation provides for prototypes to be developed for an East-West solar orientation and a North-South solar orientation. The site sizes are also representative of the typical scale of lot sizes for medium density residential zoning for the area with the dimensions of 96'-6" x 89'-5" on the Western lot and 61'-5" x 133'-4" on the Eastern lot respectively. Although a transitional neighborhood with lower income housing, there are many surrounding features that provide for a strong desirability for this area such as its well established grandfather oaks and close proximity to the Dunedin downtown core, various parks, Pinellas Trail, Dunedin Marina, and the Intercoastal Waterway.
Site Analysis-Macro

Figure 4. Regional Aerial

Figure 5. Macro Aerial
Figure 6. Area Zoning

Figure 7. Macro-Circulation
Site Analysis-Micro

**Figure 8. Tree Coverage**

**Figure 9. Micro Aerial**
Figure 10. Micro-Circulation
Figure 11. Site A Analysis
Figure 12. Site B Analysis
Chapter Three: Case Studies

Florida Vernacular Dwellings

Case Abstract

This case study is analysis of two pre-war Florida homes. These homes represent the dwelling forms known as the “cracker” style of Florida representing the vernacular typologies employed in the region. More specifically the forms to be studied are the dogtrot and the Florida bungalow style. These forms developed in response to the local climate, available materials, and the required environmental connection. This study is an attempt to survey and understand the methods used within these responses in hopes of distill common lines of approach to passive climate mitigation, resource use, and experiential environmental connection. In each style of home, there was a focus on overall spatial organization, shading, passive ventilation, passive lighting, materials used, and interstitial spaces between interior and exterior. The results of the studies showed that the methods employed within these structures proved to be successful in creating passive cooling through ventilation in and around the structure and strengthening the experiential environmental connection through use of passive lighting and interstitial space.
Hypothesis

Through the analysis of the cracker home typologies of the dogtrot and the Florida bungalow style it is my belief that the passive systems employed for climate mitigation and experiential environmental connection are essential for their success within the Florida climate and will provide a baseline for the modern home in resource use and environmental connectedness. This study will examine the characteristics of wind flow using an anemometer in and around each structure, measure the corresponding temperature at the interior, exterior, and interstitial spaces of each structure, catalogue the construction style, eave width, and foundation configurations, catalogue the ratio of wall openings to floor area of each space within each structure, measure the available exterior light within each space within each structure, catalogue the ratio of interstitial floor area to interior floor area of each structure, and examine the spatial characteristics and programming of each structure. Based on the information gathered, I expect to distill common lines within the structures that will serve passive climate mitigation and experiential environmental connection that should be employed within today’s Florida home.
Methods Used

1. Wind/Temperature:
   A combination anemometer/thermometer will be used to perform these tests. An anemometer is a device that measures wind speed. For each structure the air speed, temperature, and wind chill will be measured at the exterior, interior, interstitial space, underneath the structure (if applicable), and above the roof.

2. Wall Openings/Passive Lighting:
   This study will examine the ratio of wall openings made up by window and doors to floor area of each space within each structure. This will be used to study potential ventilation characteristics similarities between the structures. Secondly a measure of the available exterior light within each space within each structure will be conducted. Although intrinsically linked to wall openings, this study will use a light meter to establish available light parameters within each structure.

3. Interstitial Space:
   This study will examine the ratio of interstitial floor area to interior floor area of each structure. This study is being conducted to elucidate the importance of the “in between” space in connecting the interior and exterior.

4. Construction Style:
   This will be a physical analysis of each structure. This analysis is to determine foundation, floor, wall, and roof composition, spatial volume and organization. Focusing on composition and organization, items outside of materials to be catalogued will be the eave widths, floor height (if raised), and locations of heat sources.
Analysis

1. Wind/Temperature:
   A. Dogtrot

   Location: Largo, FL
   Date of Study: 5-31-08
   Time of Study: 10:30 a.m.

   Figure 17. Dogtrot 1st Floor Plan

   Figure 18. Dogtrot 2nd Floor Plan

   Figure 19. Dogtrot Elevation

   Table 3.1 Dogtrot Wind/Temp Study

<table>
<thead>
<tr>
<th>Plan Mark</th>
<th>Wind (ft per sec)</th>
<th>Temp. (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2.2</td>
<td>86.9</td>
</tr>
<tr>
<td>B</td>
<td>2.05</td>
<td>87.1</td>
</tr>
<tr>
<td>C</td>
<td>2.05</td>
<td>87.3</td>
</tr>
<tr>
<td>D</td>
<td>2.35</td>
<td>86.1</td>
</tr>
<tr>
<td>E</td>
<td>.73</td>
<td>87.5</td>
</tr>
<tr>
<td>F</td>
<td>2.2</td>
<td>88.0</td>
</tr>
<tr>
<td>G</td>
<td>2.35</td>
<td>86.8</td>
</tr>
<tr>
<td>H</td>
<td>2.2</td>
<td>87.0</td>
</tr>
<tr>
<td>I</td>
<td>1.91</td>
<td>86.6</td>
</tr>
<tr>
<td>J</td>
<td>.9</td>
<td>85.9</td>
</tr>
<tr>
<td>K</td>
<td>2.05</td>
<td>86.2</td>
</tr>
<tr>
<td>L</td>
<td>2.05</td>
<td>86.2</td>
</tr>
<tr>
<td>M</td>
<td>1.17</td>
<td>86.0</td>
</tr>
<tr>
<td>N</td>
<td>2.05</td>
<td>86.4</td>
</tr>
<tr>
<td>O</td>
<td>1.02</td>
<td>86.0</td>
</tr>
<tr>
<td>P</td>
<td>1.32</td>
<td>86.0</td>
</tr>
<tr>
<td>Q</td>
<td>.9</td>
<td>86.0</td>
</tr>
</tbody>
</table>
B. Bungalow

Location: Largo, FL
Date of Study: 5-31-08
Time of Study: 9:00 a.m.

Table 3.2 Bungalow Wind/Temp Study

<table>
<thead>
<tr>
<th>Plan Mark</th>
<th>Wind (ft per sec)</th>
<th>Temp. (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3.08</td>
<td>89.6</td>
</tr>
<tr>
<td>B</td>
<td>2.49</td>
<td>87.2</td>
</tr>
<tr>
<td>C</td>
<td>4.55</td>
<td>89.8</td>
</tr>
<tr>
<td>D</td>
<td>5.13</td>
<td>87.8</td>
</tr>
<tr>
<td>E</td>
<td>3.82</td>
<td>90.4</td>
</tr>
<tr>
<td>F</td>
<td>2.93</td>
<td>88.0</td>
</tr>
<tr>
<td>G</td>
<td>1.17</td>
<td>89.5</td>
</tr>
<tr>
<td>H</td>
<td>2.2</td>
<td>87.8</td>
</tr>
<tr>
<td>I</td>
<td>-</td>
<td>88.0</td>
</tr>
<tr>
<td>J</td>
<td>2.35</td>
<td>88.1</td>
</tr>
<tr>
<td>K</td>
<td>2.64</td>
<td>87.8</td>
</tr>
</tbody>
</table>

Figure 20. Bungalow Floor Plan

Figure 21. Bungalow Elevation
2. Passive Lighting:

A. Dogtrot

Location: Largo, FL
Date of Study: 5-31-08
Time of Study: 10:30 a.m.

Table 4.1 Dogtrot Light Study

<table>
<thead>
<tr>
<th>Plan Mark</th>
<th>Illuminance (Lux)</th>
<th>Daylight Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2,000</td>
<td>-</td>
</tr>
<tr>
<td>B</td>
<td>1,000</td>
<td>-</td>
</tr>
<tr>
<td>C</td>
<td>2,000</td>
<td>-</td>
</tr>
<tr>
<td>D</td>
<td>2,000</td>
<td>-</td>
</tr>
<tr>
<td>E</td>
<td>2,000</td>
<td>-</td>
</tr>
<tr>
<td>F</td>
<td>4,000</td>
<td>-</td>
</tr>
<tr>
<td>G</td>
<td>8,000</td>
<td>-</td>
</tr>
<tr>
<td>H</td>
<td>16,000</td>
<td>-</td>
</tr>
<tr>
<td>I</td>
<td>500</td>
<td>-</td>
</tr>
<tr>
<td>J</td>
<td>500</td>
<td>-</td>
</tr>
<tr>
<td>K</td>
<td>500</td>
<td>-</td>
</tr>
<tr>
<td>L</td>
<td>1000</td>
<td>-</td>
</tr>
<tr>
<td>M</td>
<td>125</td>
<td>-</td>
</tr>
<tr>
<td>N</td>
<td>125</td>
<td>-</td>
</tr>
<tr>
<td>O</td>
<td>125</td>
<td>.7%*</td>
</tr>
<tr>
<td>P</td>
<td>125</td>
<td>12.5%</td>
</tr>
<tr>
<td>Q</td>
<td>63</td>
<td>-</td>
</tr>
<tr>
<td>R</td>
<td>125</td>
<td>-</td>
</tr>
<tr>
<td>S</td>
<td>16</td>
<td>1.5%</td>
</tr>
<tr>
<td>T</td>
<td>32</td>
<td>.2%*</td>
</tr>
<tr>
<td>U</td>
<td>1000</td>
<td>-</td>
</tr>
</tbody>
</table>

*Window obstructions present

Figure 22. Dogtrot 1st Floor Plan

Figure 23. Dogtrot 2nd Floor Plan

Figure 24. Dogtrot Elevation
B. Bungalow

Location: Largo, FL
Date of Study: 5-31-08
Time of Study: 9:00 a.m.

Table 4.2 Bungalow Light Study

<table>
<thead>
<tr>
<th>Plan Mark</th>
<th>Illuminance (Lux)</th>
<th>Daylight Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>32,150</td>
<td>-</td>
</tr>
<tr>
<td>B</td>
<td>2,000</td>
<td>-</td>
</tr>
<tr>
<td>C</td>
<td>2,000</td>
<td>-</td>
</tr>
<tr>
<td>D</td>
<td>4,000</td>
<td>-</td>
</tr>
<tr>
<td>E</td>
<td>32,150</td>
<td>-</td>
</tr>
<tr>
<td>F</td>
<td>16,000</td>
<td>-</td>
</tr>
<tr>
<td>G</td>
<td>2,000</td>
<td>-</td>
</tr>
<tr>
<td>H</td>
<td>250</td>
<td>12.5%</td>
</tr>
<tr>
<td>I</td>
<td>125</td>
<td>6%</td>
</tr>
<tr>
<td>J</td>
<td>125</td>
<td>4%</td>
</tr>
<tr>
<td>K</td>
<td>250</td>
<td>1.4%*</td>
</tr>
<tr>
<td>L</td>
<td>500</td>
<td>5.5%</td>
</tr>
<tr>
<td>M</td>
<td>31,150</td>
<td>-</td>
</tr>
</tbody>
</table>

*Window obstructions present

Table 4.3 Recommended Daylight Factors

<table>
<thead>
<tr>
<th>Task</th>
<th>DF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ordinary seeing tasks</td>
<td></td>
</tr>
<tr>
<td>i.e. reading, filing, easy office work</td>
<td>1.5-2.5%</td>
</tr>
<tr>
<td>Moderately difficult tasks</td>
<td></td>
</tr>
<tr>
<td>i.e. prolonged reading, stenographic work, normal machine tool work</td>
<td>2.5-4.0%</td>
</tr>
<tr>
<td>Difficult, prolonged tasks</td>
<td></td>
</tr>
<tr>
<td>i.e. drafting, proofreading poor copy, fine machine work, fine inspection</td>
<td>4.0-8.0%</td>
</tr>
</tbody>
</table>
3. Interstitial Space:

A. Dogtrot

Location: Largo, FL
Date of Study: 5-31-08
Time of Study: 10:30 a.m.

Total interior space=960 sqft
Total exterior space=900 sqft
Interior/exterior ratio= 1 : 0.93
B. Bungalow

Location: Largo, FL
Date of Study: 5-31-08
Time of Study: 9:00 a.m.

Total interior space=724 sqft
Total exterior space=141 sqft

Interior/exterior ratio= 1 : 0.19

Figure 30. Bungalow Floor Plan

Figure 31. Bungalow Elevation
4. Construction Style:

A. Dogtrot:

The structure of the dogtrot is entirely made of wood, most loosely fit to promote ventilation. The entire structure is on a pier foundation system raised 18" above the ground to promote ventilation for cooling and to reduce rot and decay. While the ceiling height is just above 8' high at the first floor it is crafted in a way to allow ventilation between the two floors essentially acting as one volume. The dwelling has substantial shading due to the large porches and eaves. There is a fireplace at the western wall but this is segregated from the sleeping volume due to the configuration of the plan.
B. Bungalow

The structure of the bungalow is entirely made of wood with a metal roof. The entire structure is on a pier foundation system raised 18" above the ground to promote ventilation for cooling and to reduce rot and decay. The ceiling height is 9'-9" high in the main rooms promoting air stratification. The dwelling has substantial shading at the southern exposure due to the large porch. All cooking was done outside of the dwelling to reduce heat gain. The windows are oriented directly across from one another, which promotes cross ventilation.

Conclusion

Both of the vernacular dwellings provide valuable lessons of resource management, passive climate mitigation and experiential connection with the environment. All of the concepts employed could easily be incorporated into today’s home with little more than proper planning to provide opportunities for natural light, cross ventilation, and shading to strengthen exterior awareness.
FlatPak Home

Case Abstract

The review of this case was selected because of its focus on modular design and aims at production efficiency. The major issues raised during the development of the project were the reduction of cost, which included the reduction of construction time, waste and transportation of material concerns, planning flexibility, and waste reduction.

Cost:

Reduction of cost focused on the simplification of detailing, simplifying the material palette used, grouping of the buildings components into “packages”, and the reduction of on-site construction and focusing on on-site assembly.
Transportation:

The development of the components off site required attention to be placed on the delivery of the components to the site, which in turn fostered the need for the components to be designed for “Flat” packaging to reduce the cost and increase the efficiency of transportation.

Assembly:

Optimizing site assembly versus site construction reduced fieldwork and allowed for Building shell to be weathered in within ten days allowing for the various trades to work simultaneously completing the project much faster than conventional methods.
Planning Flexibility:

In developing a system that was simple enough for the client to develop their own configuration to meet their own personalized need while conforming to the requirements of FlatPak style dwelling also enhanced the cost reduction by providing the client the parameter within which to work in turn reducing the design costs. Within the planning system was embedded a set material palette for which the detailing was already in place for its use. This provides the client with choices to personalize their home while reducing cost by using standardized detailing.

Figure 41. Simplification of Plan

Figure 39. Planning System

Figure 40. Material Palette
Zero Energy Home

Case Abstract

The review of this case was selected because of its focus on energy efficiency. The ZEH (Zero Energy Home) home was a real world test of different methods of energy consumption reduction within the Florida climate. The study was developed and executed by the Florida Solar Energy Center. The project followed a more scientific approach by constructing a control house and a test house. Both houses were similar in geographic location, orientation, plan, and context. The control house was built using typical construction practices of the region and met the Florida Energy Code in place at the time of its construction. The ZEH variations included differences in roofing, overhangs, insulation, HVAC duct installation, energy efficient appliances, and solar power system.

Roofing:

The ZEH home employed a white tile roof while the control house use a typical asphalt shingle roof. The study showed that this significantly reduced the roof temperatures throughout the day keeping the ZEH roof close to the ambient air temperature and subsequently reduced the cooling demand on the structure.
Figure 44. ZEH Roof Thermal Image

Figure 45. Control Roof Thermal Image
Overhangs:

The variation of roof overhangs also reduced the cooling load of the ZEH home. The ZEH home employed 3'-0" roof overhangs around the entire perimeter while the control house used the more typical 1'-0" roof overhang.

Insulation:

The ZEH and control home both used a standard R-30 insulation in the attic. The variation between the two homes came in the wall insulation used. While the control used the standard rigid insulation at the interior of the masonry wall, the ZEH employed a rigid insulation at the exterior of the masonry. This allowed the building to use the thermal capacitance of the masonry to buffer the temperature variations throughout the day and provide a more stable interior air temperature. Another variation within the insulating of the homes was the usage of insulated windows in the ZEH home. This also served to reduce the heat transmittance into the interior significantly.
HVAC:

The ZEH home utilized a duct system that consisted of ducts which were oversized to reduce the air flow resistance and which were placed within the cooled space of the home. This served to reduce the heat gain to the cool air within duct, which are typically installed within attic spaces as in the control house. This allowed for the ZEH HVAC systems cooling capacity to be reduced by over 1 ton.

Figure 51. HVAC Power Usage Graph

Figure 52. HVAC Closet Thermal Comparison
Solar Power:

While the control house did not use any solar power generation, the ZEH utilized a photo voltaic array and a solar water heater with a natural gas powered back-up. The PV power system was composed of a 4kw system using fixed panels. Two-thirds of the panels were oriented facing South and the remaining third of the panels were oriented facing West. The system was tied into the local power grid to supply the grid with the excess power generated and to power the home at night.
Florida Solar Cracker

Case Abstract

This case was selected because of its use of passive system for climate mitigation, resource use and management, and its independence for the utility grid. The project utilized various ventilation strategies in conjunction with shading techniques to serve to passively cool the dwelling structure. Within the designer’s concerns was also having a minimal impact on the surrounding environment.

Environmental Impact:

By using local materials and those materials, which could readily be recycled a reduction of the environmental impact was achieved. Through the use of self-sourced lumber from the site and locally managed forests as the main structural component the designer was able to reduce embedded transportation energy. The site also employed a rainwater collection and storage system to provide the required water for the site. The water use was also decreased by dividing the wastewater for proper disposal and use.
Passive Cooling and Shading:

Incorporated into the design of the home are strategies of heat source segregation, cross ventilation, large overhangs, raised floor system, and covered exterior space at the eastern and western side of the structure to provide substantial shading to these elevations. These strategies serve to passively cool the structure and reduce the mechanical cooling requirements.

Power Management and System:

With the disconnection from the utilities grid power management becomes a critical factor. The power for the home is supplied with a PV system that was designed for a 1.2kw power demand. The PV arrays are mounted on a tracking system that orients them to the optimum angle throughout the day. The supply a battery bank system that provide energy at night and when power demand is higher than that produced by the PVs. Electrical demand is reduced through the use of alternative energy appliances such as a wood stove and solar water heater and the use of passive cooling strategies.
Chapter Four: Skin Study

Skin Study Abstract

This study was conducted to measure the temperature variances between five various wall assemblies. The study was conducted over a three day period measuring the interior and exterior temperature of the five volumes constructed of the various wall assemblies every hour. From this study it was the intent to see how variations in insulation, material layers, and airspace affected the interior and exterior temperature. Included within the various wall assemblies variations was two volumes in which a modified rain-screen was applied. This rain-screen incorporated a radiant barrier behind the exterior sheathing and an oversized airspace that was continuous from the base of the wall up through the roof. All of the volumes were painted white to reduce the heat gain due to color variances.

Figure 62. Interior/Exterior Thermometer

Figure 63. Radiant Barrier

Figure 64. Skin Test 6:00 a.m.
Figure 65. Volume 1 Section
Table 5.1 Volume 1 Interior Temperature Study

Table 5.2 Volume 1 Exterior Temperature Study
Figure 66. Volume 2 Section
Table 6.1 Volume 2 Interior Temperature Study

Table 6.2 Volume 2 Exterior Temperature Study
Figure 67. Volume 3 Section
Table 7.1 Volume 3 Interior Temperature Study

Table 7.2 Volume 3 Exterior Temperature Study
Figure 68. Volume 4 Section
Table 8.1 Volume 4 Interior Temperature Study

Table 8.2 Volume 4 Exterior Temperature Study
Figure 69. Volume 5 Section
Conclusion

Table 10.0  Overall Temperature Study 3 Day Average

From the tests the data showed that the modified rain-screen helped regulate the interior temperature throughout the three days of testing on volume 3 and volume 5. The rain-screen system provides a much needed opportunity for providing passive cooling of structures through the use of ventilation induced through convection. Incorporating this type of system, while on a single day would not impact the energy demand for cooling of a building greatly, over a year or even the life of the building would make a dramatic effect on the buildings cooling requirements. The addition of a rain-screen also provides another layer of protection from moisture which is always welcome in the region. Along with the practical benefits of using this system is that the application allows for various skins to be applied to the exterior which allows for personalization, integration into existing context, or mating with existing finishes.
Chapter Five: Building Assembly Development

Site Assembly Versus Site Fabrication

In the rethinking of the construction cycle for the development of a new construction methodology for the Florida single-family home one must consider how the building will not only be constructed but how it will be disassembled for change. While one likes to think of a home in a state of permanence, it is anything but in today society. Currently homes are built in a linear progression from raw material to the eventual landfill. This can be seen in even at the connective detail level where materials and systems are joined with one-way connections binding them almost permanently. Whether it is nailed, glued, or formed in concrete, materials joined in this manner inhibit recycling and predominately deny reuse. By designing for the inevitable disassembly one takes more concern with the materials and systems pushing the design cycle throughout the process not just the point at which they reach the site. Preparing the materials and systems to receive one another in a standardized manner promotes the simplification of connection in engagement and disengagement thus encouraging reuse, adaption, and recycling back into the overall construction cycle and moving the cycle from a linear progression to a circular progression where the home is just a point at which the materials are assembled for a time until they are returned to the cycle.
The idea of a construction methodology that promotes site assembly versus site fabrication has many benefits. By preparing the materials and systems off site in a controlled environment under an industrial setting, there is a reduction of material waste and tighter construction tolerances. Also only the material that is required to complete the project is shipped to the site reducing transportation costs. With the materials and systems have their connections inherently integrated within them from the factory, the skill and labor force to erect them are minimized thus reducing cost and construction time.

Figure 71. Building Section
Within the development project, the focus moved from developing a single house on a particular site to providing a starting point or set of rules from which to move forward. During the process, the factors which helped to define the parameters of the materials and systems used and developed were their thermal performance, cost, ability for personalization, skills required for assembly, weight, and the ability for reuse or recycling. The basic structure can be broken into three main sections the foundation piers and base frame, the panel systems, and the skin systems.

The skin system provides the initial barrier against heat gain while allowing for the personalization of the exterior surface through various skins which can be applied to integrate into existing context, or mate with an existing finish. Being able to mate with an existing finish allows this method of construction to be used not only on new construction but to be used in alterations of existing structures. In defining the skin as a system in itself allows for variations to develop. Variations such as a vegetative skin which could provide extra evaporative cooling to edges of the building that are not able to be shaded by more conventional means or just used solely as character defining feature to link the structure to the site.

The panel system incorporates three panel types, one for the floor system, one for the exterior walls and roof, and one for the interior walls. The floor system panels vary from the other panels because they require an integrated support spline in between the panels to provide...
the extra support needed to carry the floor load. The exterior wall and roof panels have an interlocking snap system that connects panel to panel in a series and a track system that connects them to other systems. Integrated into their outer layer of the exterior panels is a furring strip which allows the attachment of the skin system. The interior panel system is comprised of corrugated paper panel that allow for easy field modification and act as a sink for recycled paper products. Using the panel systems has many advantages. The external panels reduce thermal breaks thus increasing the buildings efficiency. They also reduce construction time by facilitating site assembly and in turn promote reuse and recycling.

The foundation system composed of helical piers allows the structure to be elevated to promote passive cooling and is adaptable to most soil conditions while being minimally invasive to the environment. Resting on the piers, the base frame is composed steel framing members provide the support for the floor panels and also house the ducts for the HVAC system in a double member branch beam and trunk beam. The branch and trunk beam were developed to allow the ducts for HVAC system to be placed in a cooler location as to reduce the cooling demands on the HVAC system.
Building System Details

Roofing system advantages:
- Metal roof panels recyclable
- White roof finish reflects heat
- 8" SIP provides R-36 value alone
- SIP panels reduce thermal bridging
- Panelized system reduces construction time
- System promotes site assembly vs site fabrication
- Increased airspace of rain-screen increases ventilation
- SIP panels can be reused when disassembled

Exterior wall system advantages:
- Skin system allows flexibility of exterior finishes
- 6" SIP provides R-26 value alone
- SIP panels reduce thermal bridging
- Panelized system reduces construction time
- System promotes site assembly vs site fabrication
- Increased airspace of rain-screen increases ventilation
- SIP panels can be reused when disassembled
Interior wall system advantages:
- Paper wall panels serve as a sink for recycled paper
- Panelized system reduces construction time
- System promotes site assembly vs site fabrication
- Panels can be reused when disassembled

Wall opening advantages:
- Panelized system reduces framing requirements
- System promotes site assembly vs site fabrication
- Windows can be reused when disassembled

Floor system advantages:
- SIPs system reduces framing members
- Duct located within cooler space reduces cooling load significantly
- Raised floor system increases passive ventilation
- System promotes site assembly vs site fabrication
- Locating all services in plenum and below floor reduces Material Entanglement
Foundation assembly advantages:

- Screw pile system easily adjustable to various soil conditions
- Reduces site impact
- Screw piles reusable
- Screw pile system reduces construction time
- System promotes site assembly vs site fabrication
- Allows for a raised building which promotes passive cooling

Figure 80. Interior Partition Detail

Figure 81. Wall Base Detail

Figure 82. Trunk Beam Detail
Moving Beyond The Building System Details

Where the development of this project moved its focus towards a more finite view of the actual building systems details, they alone can only do so much for a building's impact and efficiency toward the environment and its user. Many of the decisions made in the planning of the spaces themselves and their like to the site, such as orienting the wall opening to capture the prevailing breezes, have an equally important role in the overall impact and efficiency of the building. From planning for the inherent expansion in both the detailing and the spatial arrangement to linking the building to the site both physically and experientially.

From the Florida vernacular dwelling study it is evident to see how these links can mediate these impacts and increase a building's efficiency. By emulating the shading, interior to exterior space, natural light use, and siteing principles found in those structures, one can reduce the thermal load on a structure by sheer passive means. Couple that with the isolation of heat sources within the structure and the impact can be great. The use of these principles also serves to link the inhabitant of the structure to the environmental context outside the walls of the structure.
Chapter Six: Support Systems Development

Mechanical System

**Geothermal Exchange System**

Similarly to conventional systems, the HVAC system has a condenser and air handler but instead of the condenser operating on an air heat exchange it uses a ground loop as the heat exchanger. Although more expensive than traditional systems, federal tax credits and energy savings often make them a better long-term solution. This system utilized 100’ of tubing per ton placed 6’-10’ below the ground for a closed system. Upon completion of the thermal analysis of the BIM for the test house, the required size of the cooling system would have to be 2.0 tons. The ZEH case study illustrated that the placement of the supply air duct located in a cool space as opposed to the traditional attic location allowed a reduction of approximately 1.0 ton in the system design. With that information, conservatively the system was sized at 1.5 tons. Geothermal exchange systems typically return 30%-60% energy savings.
Water heaters are typically the second largest power consumers within the home. By using a solar water heater, energy use can be almost completely eliminated depending on demand. In Florida, a solar water heater can provide year-round energy savings. The system contains a solar collector which the water is pumped through and then circulated through the storage tank. More expensive than traditional systems, federal tax credits, local power company rebates, and energy savings often make them comparable to traditional systems.
The photovoltaic power system used in this project for comparison is a standard grid tied system of 4kw that is connected to the electrical grid. This allows for the system to generate more power than is required during the day and use power from the grid at night resulting a net zero power usage. It also reduces the required maintenance in a battery backed system. The federal and state rebates allow for the system to have a break even point at approximately 7 years. Current technology in this area is increasing greatly each year. In testing currently is a photovoltaic ink that could be applied to building surfaces eliminating the need for a panel system.
Chapter Seven: Environmental Performance

Setting a baseline for comparison two BIM models were created a control house and a test house. The control house implemented standard block construction practices representational of regional housing while the test house implemented the proposed construction practices developed within this project. Both BIM models were similar in interior square footage, interior layout, location, and orientation. Outside of the construction differences, the control had a standard roof eave of 1'-6" while the test house had an enlarged eave length of 3'-0". Along with the construction variations there was a planning variation which incorporated exterior living space along the western edge of the test house that was not incorporated into control house.

Thermal and Energy

For comparisons of thermal and energy performance a program was used that simulated the environmental conditions for one year and developed a report that estimated the energy use and carbon dioxide output. The results in the reports were generated by the IES ApacheSim module which is a rigorous building thermal simulation approach that conforms to ANSI/ASHRAE Standard 140. While the program allowed for many variables to be tuned to each model, it did not provide for the inclusion of the various mechanical and solar power systems explored or the modified rain-screen. Even though it did not allow for their inclusion, it did serve as a base point from which to establish the required energy needs of the two houses. The test house of course would incorporate those systems explored equalling a net zero carbon house after construction

Table 11.0 40 Year Carbon Output
Energy and Carbon Results

Energy: 52.9 MMBtu
Carbon: 10.3 tons CO₂

Energy Breakdown
- Heating: 14.7 %
- Cooling: 30.0 %
- Lighting: 14.0 %
- Equipment: 41.3 %

Architecture 2030 Challenge

Meets 2030 Challenge
Target for:

Design Building Energy Use Intensity: 61 kBTU/ft²
(Average Building Energy Use Intensity: 44 kBTU/ft²)

Figure 90. Control Thermal/Energy Analysis

Energy and Carbon Results

Energy: 35.8 MMBtu
Carbon: 7.0 tons CO₂

Energy Breakdown
- Heating: 1.6 %
- Cooling: 24.8 %
- Lighting: 20.6 %
- Equipment: 52.9 %

Architecture 2030 Challenge

Meets 2030 Challenge
Target for:

Design Building Energy Use Intensity: 42 kBTU/ft²
(Average Building Energy Use Intensity: 44 kBTU/ft²)

Figure 91. Test Thermal/Energy Analysis
Construction

Inherent in the within the proposed system is the focus on site assembly versus site construction. While this approach increases the starting cost due to its unconventional method, it decreases the construction time and increases the chances that the materials and components used within the building will be reused or recycled once the structure has passed its usefulness. And even without this assumption, the proposed method breaks even with the conventional construction methods in under ten years if the energy consumption is included into the equation.
Table 12.0 Construction Time

Days

Test

Control
Table 13.0 Construction Cost Breakdown
Table 14.0: Construction Cost Per Square Foot

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Conclusion

Through this research I have focused on assembling a viable contemporary construction methodology for the Florida single family home that redefines and disentangles the systems and elements that make up the dwelling in an effort to move towards a society which can reduce its environmental impact. It is my hope that this project will serve as a platform to move forward from. It is not the end design but the methodology to begin a new conversation within architecture and construction in the realm of residential architecture. By shifting the production of residential structures from a linear progression to a more circular progression where materials and components are not lost to landfills we stand a chance at making a difference. By opening up a new level in which we measure a structures value by it lack of energy use we begin to put the environment before the structure. For at the end of the day we all go home and it is there where we can make the biggest impact.
List of References


Bibliography


Appendices
Appendix A: Construction Timeline

**Delivery**

Figure 92. Construction Timeline-Delivery

**Foundation Piers**

Figure 93. Construction Timeline-Foundation
Appendix A (Continued)

Figure 94. Construction Timeline-Base Frame

Figure 95. Construction Timeline-HVAC Duct Work
Appendix A (Continued)

**Floor Panels**

Figure 96. Construction Timeline-Floor Panels

**Exterior Walls**

Figure 97. Construction Timeline-Exterior Wall Panels
Appendix A (Continued)

**INTERIOR WALLS**

![Interior Wall Panels Timeline](image)

Figure 98. Construction Timeline-Interior Wall Panels

**ROOF PANELS**

![Roof Panels Timeline](image)

Figure 99. Construction Timeline-Roof Panels
Appendix A (Continued)

**Openings**

Figure 100. Construction Timeline-Exterior Openings

**Skins**

Figure 101. Construction Timeline-Exterior Skin
Appendix A (Continued)

**Solar Hot Water**

![Solar Hot Water Diagram](image)

Figure 102. Construction Timeline-Solar Hot Water System

**Solar PV System**

![Solar PV System Diagram](image)

Figure 103. Construction Timeline-Solar PV System