2011

Zoning and designing for affordability using modular housing

Joseph Terry Cartwright

Iowa State University

Follow this and additional works at: https://lib.dr.iastate.edu/etd

Part of the Architecture Commons

Recommended Citation

Cartwright, Joseph Terry, "Zoning and designing for affordability using modular housing" (2011). Graduate Theses and Dissertations. 10238.

https://lib.dr.iastate.edu/etd/10238

This Thesis is brought to you for free and open access by the Iowa State University Capstones, Theses and Dissertations at Iowa State University Digital Repository. It has been accepted for inclusion in Graduate Theses and Dissertations by an authorized administrator of Iowa State University Digital Repository. For more information, please contact digirep@iastate.edu.
Zoning and designing for affordability using modular housing

by

Joseph Terry Cartwright

A thesis submitted to the graduate faculty

in partial fulfillment of the requirements for the degrees of

MASTER OF ARCHITECTURE

MASTER OF COMMUNITY AND REGIONAL PLANNING

Co-majors: Architecture; Community and Regional Planning

Program of Study Committee:  
Susan Bradbury, Co-major Professor  
Thomas Leslie, Co-major Professor  
Riad Mahayni

Iowa State University

Ames, Iowa

2011

Copyright © Joseph Terry Cartwright, 2011. All rights reserved.
TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER 1. OVERVIEW
   Introduction
   Definitions
      Manufactured Housing
      Modular Housing
   Purpose Statement
   Research Questions
   Boundaries of the Study
   Importance of the Study for Audience

CHAPTER 2. LITERATURE REVIEW
   Introduction
   A Brief History of Factory Built Housing
   Perception of Modular Housing
   Advances in Technology
   Financing
   Architects and Modular Housing
      Aesthetics
      Exterior
      Cladding
      Roofing
   Interior
   Design
   Planners and Modular Housing
      Michelle Kaufmann Case Study
   Quality of Modular Housing
CHAPTER 3. METHODOLOGY

Introduction
Case Study Methodology
What is a Case Study
Strengths and Weaknesses
Reliability
Validity
Data Collection
Documents Reviewed
Interviews
Conclusion

CHAPTER 4. RESULTS

Introduction
Data Analysis
Cologne
Chaska
Minnetonka
Minneapolis
Cross Case Comparison
Conclusion

CHAPTER 5. CONCLUSIONS & RECOMMENDATIONS

Summary of What Learned
Significance of Results
Relevance to Architects
Relevance to Planners 90
Relevance to Manufacturers 91
Future of Modular Housing 93

APPENDIX A. 95
Clover Ridge Neighborhood Design Guidelines

APPENDIX B. 106
List of Interview Questions

REFERENCE LIST 109

ACKNOWLEDGEMENTS 114
<table>
<thead>
<tr>
<th>Figure Number</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Image of BSB Design’s Abôd</td>
<td>6</td>
</tr>
<tr>
<td>2.1</td>
<td>Image of Aladdin’s Style F Summer Cottage</td>
<td>9</td>
</tr>
<tr>
<td>2.2</td>
<td>Image of Sears, Roebuck and Co. Kit Home</td>
<td>9</td>
</tr>
<tr>
<td>2.3</td>
<td>Image of Cusato Katrina Cottages</td>
<td>10</td>
</tr>
<tr>
<td>2.4</td>
<td>Exterior Image of Manufactured House</td>
<td>12</td>
</tr>
<tr>
<td>2.5</td>
<td>Exterior Image of Modular House</td>
<td>12</td>
</tr>
<tr>
<td>2.6</td>
<td>Exterior Image of Modular Houses</td>
<td>13</td>
</tr>
<tr>
<td>2.7</td>
<td>Image of Dymaxion Bathroom</td>
<td>15</td>
</tr>
<tr>
<td>2.8</td>
<td>Image of Kurokawa’s Capsule Unit</td>
<td>16</td>
</tr>
<tr>
<td>2.9</td>
<td>Image of Gas Package Kitchen</td>
<td>17</td>
</tr>
<tr>
<td>2.10</td>
<td>Image of Hinged Eave Overhang Detail Drawing</td>
<td>18</td>
</tr>
<tr>
<td>2.11</td>
<td>Image of Hinged Eave Overhang</td>
<td>18</td>
</tr>
<tr>
<td>2.12</td>
<td>Image of Hinged Roof System</td>
<td>18</td>
</tr>
<tr>
<td>2.13</td>
<td>Image of Hinged Roof System</td>
<td>18</td>
</tr>
<tr>
<td>2.14</td>
<td>Exterior Image of Manufactured House</td>
<td>22</td>
</tr>
<tr>
<td>2.15</td>
<td>Exterior Image of Modular House</td>
<td>22</td>
</tr>
<tr>
<td>2.16</td>
<td>Interior Image of Manufactured House</td>
<td>23</td>
</tr>
<tr>
<td>2.17</td>
<td>Interior Image of Modular House</td>
<td>24</td>
</tr>
<tr>
<td>2.18</td>
<td>Interior Image of Manufactured House</td>
<td>24</td>
</tr>
<tr>
<td>2.19</td>
<td>Interior Image of Modular House</td>
<td>24</td>
</tr>
<tr>
<td>2.20</td>
<td>Image of TVA Sectional House</td>
<td>25</td>
</tr>
<tr>
<td>2.21</td>
<td>Exterior image of Alchemy Architects’ Weehouse</td>
<td>25</td>
</tr>
<tr>
<td>2.22</td>
<td>Image of Tim Pyne’s M-House</td>
<td>25</td>
</tr>
<tr>
<td>2.23</td>
<td>Image of Green Ready-Built Home</td>
<td>26</td>
</tr>
<tr>
<td>2.24</td>
<td>Image of Rocio Romero’s LV Home</td>
<td>27</td>
</tr>
<tr>
<td>2.25</td>
<td>Image of Doublewide Mobile Homes</td>
<td>27</td>
</tr>
<tr>
<td>2.26</td>
<td>Image of Multi-family Modular Houses</td>
<td>27</td>
</tr>
<tr>
<td>2.27</td>
<td>Image of Palace Corporation’s Emergency Shelter</td>
<td>28</td>
</tr>
</tbody>
</table>
Figure 2.28. Image of a Suburban Modular House 28
Figure 2.29. Image of Buckminster Fuller’s Grain Bin House 29
Figure 2.30. Image of Dymaxion House 29
Figure 2.31. Image of Copper House 30
Figure 2.32. Image of Walter Gropius’ Growing House 30
Figure 2.33. Image of Josef Hoffman’s Steel House 31
Figure 2.34. Image of Rocio Romero’s Fishcamp House 31
Figure 2.35. Image of Tim Pyne’s M-House 32
Figure 2.36. Image of Collins and Turner’s Silverbox Home 32
Figure 2.37. Image of LOT EK’s Container Kit House 33
Figure 2.38. Exterior Image of Lustron Steel Home 33
Figure 2.39. Image of Alchemy Architects’ Weehouse 34
Figure 2.40. Image of Haus Der Gegenwart 35
Figure 2.41. Image of Spanish Design Modular House 35
Figure 2.42. Image of Johannes Niemeyer’s Fixed Price House 36
Figure 2.43. Image of Subdivision Modular House 36
Figure 2.44. Image of Avco Manufactured House 37
Figure 2.45. Image of Kaiser Community Homes House 37
Figure 2.46. Exterior Image of Manufactured House 38
Figure 2.47. Image of Vinyl Siding Detail on a Manufactured House 38
Figure 2.48. Image of Chimney Detail on a Manufactured House 38
Figure 2.49. Image of Traditional East Coast Clapboard Modular House 38
Figure 2.50. Image of Continental Homes Stylex Modular House 39
Figure 2.51. Image of Buckley Gray Yeoman’s The Retreat House 39
Figure 2.52. Image of NAHB Research House VII Concrete House 40
Figure 2.53. Image of Lazor Office’s FlatPak House 40
Figure 2.54. Image of SoHo Architektur’s Haus Sunoko House 41
Figure 2.55. Image of Behring Corporation Modular House 42
Figure 2.56. Image of Fiberglass Roofing Detail 42
Figure 2.57. Exterior Image of Lustron Steel Home 43
Figure 2.58. Exterior Image of MKD’s Glidehouse 43
Figure 2.59. Exterior Image of Hive Modular’s B-Line House 44
Figure 2.60. Interior Image of Kitchen and Dining Room from Factory Built House 45
Figure 2.61. Interior Image of Lustron Steel Home 45
Figure 2.62. Interior Image of Bathroom in Tim Pyne’s M-House 46
Figure 2.63. Interior Image of Kitchen in Tim Pyne’s M-House 46
Figure 2.64. Interior Image of Kitchen in Alchemy Architects’ Weehouse 47
Figure 2.65. Interior Image of Crestwood House 47
Figure 2.66. Interior Image of Kitchen in KFN Products’ Su-Si K House 48
Figure 2.67. Interior Image of Dymaxion House 48
Figure 2.68. Interior Image of Living Room in KFN Products’ Su-Si House 49
Figure 2.69. Interior Image of Living Room in Rocio Romero’s LV Home 49
Figure 2.70. Image of Lustron Steel Home and Garage 50
Figure 2.71. Image of Two Bedroom Lustron Steel Home and Garage 51
Figure 2.72. Exterior Image of Hive Modular’s X-Line House 51
Figure 2.73. Rendering of Rocio Romero’s LVG 52
Figure 2.74. Exterior Image of Rocio Romero’s LVT and LVG on an LV Home 52
Figure 2.75. Sketch of Rocio Romero’s LVC 52
Figure 2.76. Image of re4a’s Sub-Urban House “Bars” 53
Figure 2.77. Image of re4a’s Sub-Urban House and Carport 53
Figure 2.78. Image of Littlewoods Ltd. Gas Kitchen Package 54
Figure 2.79. Image of Littlewoods Ltd. Gas Kitchen Package 54
Figure 2.80. Image of Braithwaite Gas Kitchen Package 54
Figure 2.81. Interior Image of IKEA’s BokLok Component Kitchen 55
Figure 2.82. Image of Jicwood Bungalow Bedroom 55
Figure 2.83. Interior Image of a Bedroom in Tim Pyne’s M-House 56
Figure 2.84. Image of MKD’s Glidehouse Storage Bar and Gliding Doors 56
Figure 2.85. Image of Manufacturing Facility 58
Figure 4.1. Map of Four Communities and Surrounding Area 74
Figure 4.2. Image of Modular Housing Development Streetscape 80
Figure 4.3. Exterior Image of Modular House  82
CHAPTER 1: OVERVIEW

Introduction

Factory built housing has been around in the United States since the 1600’s. One possible way to making housing more affordable is by the use of modular housing. What does this mean to the average home buyer? It means that there are options for getting a quality single family home that doesn’t necessarily have to be completely built on site from the ground up such as in the case of a stick framed home. This study will examine the advantages and disadvantages associated with modular housing from the point of view of architects, developers, home builders, manufacturers, planners, and policy makers. The stereotypes and stigmas that are often associated with factory built housing can prevent its inclusion and acceptance as a viable construction alternative to traditional site building of homes. The stigma associated with this style of housing conjures up images of the stereotypical “double wide” which became quite popular in the United States during the 1970’s. Although many communities may not specifically differentiate between what constitutes a modular house versus a mobile home by definition in their codes or ordinances, there is a distinct difference between a stereotypical manufactured or mobile home (i.e. a trailer house) and a well designed, quality, modern modular house.

Definitions

Manufactured Housing

Along with the innovations in the design of factory built housing, the regulations governing the industry and the names associated with it have changed over the years as well. Prior to 1958, factory built housing was “equivalent to today’s HUD-code or mobile homes and were not modular homes. But when a home manufacturer first produced a two-section home conforming to an applicable building code in 1958, the modular housing industry was formally born” (National Association of Home Builders Modular Building Systems Council
In 1976, the distinctions between the two types of factory built housing were clarified when “the United States Department of Housing and Urban Development (HUD) put into effect the Federal Manufactured Home Construction and Safety Standards, now known everywhere as the HUD Code” (Davies 2005, 77). From that point on, the nomenclature of factory built housing can be distinctly broken into two separate categories: manufactured and modular. Manufactured homes are only required to comply with the less stringent HUD Code whereas, modular homes are required to comply with local building regulations in place for the jurisdiction in which the home will be located and erected. Also, the HUD code that manufactured homes must comply with is much less stringent than the IRC code that a modular or stick built home has to meet. This allows a manufactured home to be a more affordable option for potential home buyers in the end.

In layman’s terms, a manufactured home is a home that sits on a permanent chassis, typically made out of steel, and has axles and wheels attached to that chassis. The chassis becomes not only the structure for the home to be built on, much like the foundation of a stick built home, but it also serves another function as the trailer for getting the home to its site. This is where the term trailer house originated. The 2006 International Residential Code (IRC), Section AE201 defines a manufactured home as:

A structure transportable in one or more sections which, in the traveling mode, is 8 body feet (2438 body mm) or more in width or 40 body feet (12192 body mm) or more in length or, when erected on site, is 320 or more square feet (30m²), and which is built on a permanent chassis and designed to be used as a dwelling with or without a permanent foundation when connected to the required utilities, and includes the plumbing, heating, air-conditioning and electrical systems contained therein; except that such term shall include any structure which meets all the requirements of this paragraph except the size requirements and with respect to which the manufacturer voluntarily files a certification required by the secretary (HUD) and complies with the standards established under this title (International Code Council, Inc. 2006, 594).

Because of the nature of their assembly, manufactured homes are often viewed as less permanent dwellings. They become a dwelling that could conceivably be disconnected from utilities, hooked up to a truck and pulled to a neighboring state or even across the country and then reattached to utilities at a new location. This process could be repeated numerous times
since the chassis is designed as an integral part of this style of home. In fact, this phenomenon is described by Noriaki Kurokawa in his book *Metabolism in Architecture* where “population mobility in the United States” (Kurokawa 1977, 77) has created a situation in which “some workers own quite luxurious mobile homes and simply drive their homes to their new places of work because high mobility has become a pattern of life” (Kurokawa 1977, 77) for them.

Not all manufactured homes are built as the above described long and narrow trailer house though. Double wide homes are, just as it sounds, constructed of two halves which are hauled to the building site separately and then joined in the middle after being set on a foundation. The double wide name came from the simple fact that a home of this nature was basically twice, or double, the width of a standard trailer house. Many double wide homes get installed on permanent foundations, like a slab on grade or even a full basement. This makes the double wide more of a permanent housing option since it isn’t quite as easy to hook up to it and take off down the highway.

**Modular Housing**

Modular construction is defined as “completely fabricated or assembled and self-contained units for residential, office or other occupancy, set or installed individually or in clusters on tracts of land, or erected as related or self-contained elements of larger structures” (City of Chaska 2011e). Using this form of construction, modular housing has the potential to reform neighborhoods all across the United States. The benefits to this style of building are purported to be many. Claimed benefits include lower construction costs, higher quality control and a vastly quicker construction timeline, from breaking ground through occupancy (Modular Building Systems Association 2011).

As essential background information, there are several other terms pertaining to factory built housing that need to be defined as well. One of those terms is one whose popularity and use has increased a lot in recent times: *prefab*. Webster’s Third New International Dictionary of the English Language defines prefab as: “a prefabricated house or
structure” (Webster’s 2002, 1787). In light of the recent popularity of the term prefab, the concept of prefabrication was written about sixty-five years ago in the following passage:

Prefabrication is given a variety of meanings, according to enthusiasm, antagonism, or technical knowledge. For the purpose of this book it is taken to mean the preparation away from the site of the framework, walls, floors, roof and equipment of a house, so that such material may be delivered either from one or many sources, and assembled on prepared foundations (Gloag 1946, 2).

The underlying principle of the factory-made house is to prepare by mass production as many parts and units of the house as possible, thus reducing erection time and site work to a minimum. Such parts and units made under factory conditions of controlled power and mechanical operations achieve accuracy, efficiency and economy. The ideal of prefabrication is to increase the size of the factory-made units to a maximum, until the whole side of a house or a complete room is produced (Gloag 1946, 5).

Depending on whom one asks, some might say that all of the factory built housing options could be defined as prefab. However, many people associate the term prefab with housing that has more of a modern aesthetic. A lot of the press that factory built housing gets these days centers around these “modern” flat roofed, glass lined boxes with austere interiors that look great in pictures, but fail in practicality for many of today’s families. This can create confusion to the consumer who may not be familiar with the term prefab and how it is used in the industry.

Also relevant to the discussion of factory built housing, especially when talking about panelized home kits is the term SIP. SIP is short for structural insulated panel. SIPS are a prefabricated, composite building material consisting of foam insulation between an inner and outer layer of structural wood, such as oriented strand board (OSB). Widely known for their excellent insulation R-value, building a home with SIPS requires the home buyer to thoroughly think through and sign off on the design of their home prior to manufacture of the panels.
Purpose Statement

The purpose of this study is to explore why more high quality modular housing isn’t being built and how one can build affordable and well designed modular housing in more communities.

Research Questions

The questions to be examined in the study are as follows:

1) How does the quality of a modular house compare to that of a more traditional “stick built” house?
2) How do construction techniques for modular houses compare to those for traditional “stick built” houses?
3) Are modular houses more affordable than “stick built” houses?
4) Do zoning codes restrict or prohibit modular houses?
5) If so, why do zoning codes restrict or prohibit modular houses?

Boundaries of the Study

This study will also look at the economic and ecological factors of why we build the way we do. As discussed in the essays from Good Deeds, Good Design: Community Service Through Architecture, it is estimated “that only 2% of new-home buyers work directly with an architect to design the space in which they live” (Design Corps 2011). As an aspiring architect and planner, I view this as not only problematic, but opportunistic at the same time. The potential for growth in the area of residential design is staggering. Jack Bloodgood, a pioneer in the field of residential architecture, built his West Des Moines, Iowa-based architecture firm, BSB Design, on the philosophy that every person in America should have the opportunity to live in a home designed by an architect (J. Bloodgood 2006, pers. comm.). Over the last forty-two years, Bloodgood’s philosophy has allowed his firm to grow from its
humble beginnings as a singular office in Iowa to now include five other offices within the United States and a design portfolio that includes projects all over the world. In fact, BSB Design recently launched its own factory built housing project, Abōd, in Soshanguve, South Africa. Partnering with several financial institutions, as well as an engineering firm in South Africa, has afforded BSB Design the opportunity to give something back to society with their affordable and portable house design. Seen here in Figure 1.1, the Abōd is meant “to eradicate destitute living conditions and homelessness across the globe” (Abōd Shelters 2011) with its simplistic design that can be assembled by a family in less than a day with a few ordinary hand tools.

The study will discuss the use of modular building methods within residential construction and the potential that architects have for bringing not only design, but a higher level of design to the masses. Items such as technology (think innovation), affordability (think low cost), aesthetics (think curb appeal), and design (think customizable dependent upon the clients needs), amongst others, are to be part of the text. Modular houses are assembled from smaller pieces into a larger whole. Within those smaller pieces, there are again smaller pieces that make up the larger whole of the modules. This replication and assemblage of parts and pieces is where the efficiency and much of the cost savings of modular housing comes from. The climate controlled environment where modular homes are built has many benefits as well. The geographic boundaries of the study are four communities located in and around the Minneapolis, Minnesota metropolitan area. The outcome of this study will be recommendations on how quality design and zoning requirements can produce better and more affordable housing in the United States through the development of modular housing.

**Importance of the Study for Audience**

As above, the terms affordability and housing are often used in the same sentence. Unfortunately, that is where the relationship between those terms often stops. Because of this
gap, this study has far reaching implications. This research is directly aimed at fostering the
debate about why we build the way we do. Planners will be interested in this topic because it
will point out the restrictive implications of outdated codes and zoning ordinances. Also, this
study will spell out the differences in the two types of factory built housing, modular and
manufactured. These distinct differences will be described in easy to understand terms that
can be used to educate those opponents of factory built housing who have a negative and
stereotypical view of this style of housing. By providing more flexibility in zoning
ordinances, developers and planners will have more backing to propose alternative forms of
development and to challenge the status quo while maintaining the quality of the
developments within their respective communities.

Likewise, the affordable housing market offers an opportunity for architects,
developers and home builders to expand their businesses. Ultimately, potential home buyers
will benefit from having better designed and more affordable housing options available to
them. The more exposure that studies like this get, the more we will see debates over
challenging the status quo and doing things differently. Blindly sitting by and accepting
things as they are is simply irresponsible and ethically in violation of the charge for architects
and planners to maintain the public’s health, safety and welfare. The City of Chaska, MN
also states a similar mantra in the first section of their zoning ordinance which describes “the
basic purpose of this Ordinance is to ensure public health, safety, and general welfare” (City
of Chaska 2011d). The time is long past due for making a case that supports the necessity of
changing the way factory built housing is viewed and treated.
CHAPTER 2: LITERATURE REVIEW

Introduction

This chapter will explore a brief history; perception; advances in technology; aesthetics, both exterior and interior; design and customization of a multitude of factory built housing options, from “kit” houses to complete houses that can be delivered to a building site in nearly move-in completeness. Additionally, the literature review will help to address the first three questions previously identified in Chapter 1, pertaining to the quality, construction techniques and affordability of modular houses versus traditional stick built houses. The variation in the range of factory built housing, from manufactured to modular, kit houses to panel construction, will be described by using text and images. These distinct differences will be described in easy to understand terms that can be used to educate those who have little or no knowledge of factory built housing or who may have a negative and/or stereotypical view of this style of housing. The focus of this chapter is not a chronological history. However, it is still essential to provide some background information on factory built housing in hopes of educating those unfamiliar with changes that have shaped the industry over time. Therefore, multiple examples, old and new, have been chosen and will be used throughout this portion of the text to highlight the ever changing array of factory built housing available to home buyers now as well as in the past.

A Brief History of Factory Built Housing

In the United States, factory built housing has been used since the 1600’s when “an early version of a prefab home was sent from England” (Connors 2008). The access to and availability of plentiful resources, especially wood, necessary to support the requisite manufacturing facilities along with the growing demand for affordable housing started to cause an upturn in the fledgling factory built housing industry. However, the popularity of factory built housing in the United States didn’t really take off until the late 1800’s and early 1900’s when “the Aladdin Company started selling the earliest house kits from its catalog in
1906” (Connors 2008). Figure 2.1 shows one of Aladdin’s Summer Cottages from its 1908 catalog. The “Style F” cottage was a two bedroom, 576 square foot unit that sold for only $298. This was followed by what could be considered the heydays of house kits with the release of the Sears, Roebuck and Co. kit homes. The Sears kit homes were undoubtedly the most well known brand, selling “more than 100,000 homes from 1908 to 1940” (Connors 2008). An example of an early Sears kit home can be seen here in Figure 2.2.

The Great Depression led to harder times for the factory built housing industry when the stock-market crash of 1929 led to a sharp decline in the sale of kit houses. Despite the decrease in sales, the increased need for more affordable housing during the depression helped to spark a renewed interest in producing homes more cost effectively. “Idle factory space and the collapse of normal markets gave life to a new industry, and house prefabrication received energetic publicity” (Gloag 1946, 11) during this time. Despite the publicity, it wasn’t until after World War II that the factory built housing industry turned itself around with the advent of mobile homes.

During the post World War II years, the demand to house the returning troops and their burgeoning families pushed the housing market to crisis levels. In the midst of this crisis, a battle began to wage over who could build the cheapest homes in the least amount of time. This led to factory built housing manufacturers having to compete with site-built home builders who were attempting to perfect the use of “assembly-line techniques to housing construction” (Lacayo 1998, 148). The pioneer, and arguably most well known site-built home builder to go head to head with the factory built housing industry in the race to build
“houses fast and cheap” (Lacayo 1998, 148) during this era, was William Levitt. The aptly named Levittown, on Long Island in New York, was “the first place Levitt offered his houses” (Lacayo 1998, 148) for sale. Started in 1947, Levittown transformed 1,000 acres of New York farmland into a town of 17,000 cheap, “but still reasonably sturdy” (Lacayo 1998, 148) site-built homes. In terms of suburban America, Levittown “is as much an achievement of its cultural moment as Venice or Jerusalem” (Lacayo 1998, 148) were to their respective places in history. Even though Levitt’s houses were not built in a factory, he streamlined the “construction process into twenty-seven operations, then mustered specialized teams to repeat each operation at each building site” (Lacayo 1998, 149). The use of these assembly line techniques, much like factory built housing, allowed Levitt to build thirty to forty homes per day on site. This efficiency in construction translated to affordable homes which secured many sales and, ultimately, home buyer’s dollars for Levitt and his company. Levitt’s company experienced continued growth that led to other large scale developments such as the suburban Washington, D.C. city of Bowie, MD. After 20 plus years in the homebuilding industry, Levitt sold his company in 1968 for a hefty sum after it “had built more than 140,000 houses around the world” (Lacayo 1998, 152).

Today, there are myriad options to choose from in the realm of factory built housing. Everything from portable, disaster relief housing units, like the Cusato Katrina Cottages shown in Figure 2.3, to upscale, multi-story houses are available straight from factories today. The face of factory built housing has definitely changed since its infancy.
Perception of Modular Housing

Many challenges lie ahead for the factory built housing industry. One of those challenges will be to deal with the perceptions and misconceptions potential home buyers may have towards it.

It may well be that the perception of the factory-made house as a temporary solution only, a perception shared by the public and the manufacturers of these buildings, inevitably prejudiced the use of these methods in the settled environment of the established cities, and mitigated against their use within the traditional urban fabric (Herbert 1984, 18).

There are probably, as we have already hinted, more misconceptions about prefabricated houses than about any other type of dwelling. Some think of them as mass-produced cracker boxes, flimsy and cheap, and standardized down to the last switch plate. Others see them as the last word in efficient modernity and smartness, and far superior to anything the custom builder can supply for the money (Graff, Matern, and Williams 1947, 4).

Even though the latter quote above is from a book written over a half century ago, it still remains relevant to the discussion of factory built housing. Unfortunately, when many hear the phrase “factory built housing” a stereotypical image of a trailer house and the stigmas associated with it are the first things that come to mind, even though there are vast differences in the spectrum of what legitimately fits the moniker of factory built. This opposition to the public’s acceptance of factory built housing is further described in the following quote from Burnham Kelly’s book on The Prefabrication of Houses:

It stems chiefly from dislike of the minimum-standard prefabricated dwellings built during the war emergency under government contract. The bad reputation acquired in this way persists in spite of the fact that the vast majority of prefabricated houses built since the war compare favorably in every respect with conventional houses in the same price class (Kelly 1951, 90).

In hopes of changing this negative perception, home buyers need to be educated on the recent trends and advances in manufacturing technology, which allow many of today’s factory built houses to be anything but trailer houses. Despite the advantages of factory built
housing described above, breaking down the longstanding stereotypes associated with factory built housing is difficult at best. The idea, “because that’s the way we’ve always done it,” seems ingrained in the minds of not only homebuilders, but potential home buyers as well.

...efforts to streamline house construction have been hampered by the unsophisticated building methods typically available to the home-building industry—a situation that remains true today. ‘Stick-building,’ or conventional two-by-four framing, despite its enormous redundancy, is still the favored method for mass home construction because it requires the least skill to erect, and the materials required—standard lumber and finish materials—are the easiest to obtain (Adamson and Arbunich 2002, 26).

This stereotypical imagery of “streamlined house construction” (i.e. factory built housing) is discussed in *Eichler: Modernism Rebuilds the American Dream* where it states, “consumer resistance surely stemmed from the image of the many modern houses that were designed specifically for prefabrication” (Adamson and Arbunich 2002, 35). The home buyers within the grey area, between the fringes of the “flimsy and cheap cracker boxes” like this manufactured house here in Figure 2.4 and the “efficient modernity and smartness” of this modular house shown in Figure 2.5, comprise the largest potential segment of buyers for housing built in a factory.
Therein lies another challenge facing the industry. With the trend towards “manufacturers of factory built housing doing their best to make their products (emphasis added) look like traditional, stick built houses” (Crosbie 2008), we tend to end up with houses, like these modular houses by Norse Building Systems in Figure 2.6, that look right at home next to their suburban counterparts, but are a far cry from the architect-designed factory built houses that “look like, well, machine-made objects” (Crosbie 2008). This very phenomenon was described by Le Corbusier in his book *Towards a New Architecture* from the chapter on “Mass-Production Houses” where he wrote, “the mass-production state of mind is hateful to architects and to the ordinary man (by infection and persuasion)” (Le Corbusier 1927, 232). In an effort to alter long held beliefs, the use of quality materials and well thought out design decisions to achieve an architectural, or custom, aesthetic, both on the exterior and interior, are critical to changing the negative connotations and perceptions associated with factory built housing. Furthermore, “the designer of the mass-produced house must have not only the requisite skills of an architect but also the expertise of ‘the scientist, the economist and the industrial engineer’” (Wright 1983, 102).

**Advances in Technology**

With the push towards energy efficiency, sustainability and “green” design, factory made housing offers benefits in these areas as well as many others. Affordability, accelerated construction timelines and quality control are just a few of the other areas where factory built housing excels. However, despite the list of benefits associated with factory built housing, it is still the exception rather than the rule in residential construction in the United States. Many
advances in technology have had a profound impact on the affordability, efficiency and quality associated with the manufacturing of all types of factory built housing.

In the early 1800’s, one phenomenon that gave rise to the advances in factory built housing was the innovation that was happening in industrial production that allowed for economical and efficient manufacturing of building materials, such as “accurately sawn timber and mass-produced nails” (Davies 2005, 46). These technological advances are described by the following quote from John Gloag’s book *House Out of Factory*:

In the U.S.A. prefabricated timber houses have reached a development and output far ahead of any other country. The idea of prefabrication already familiar was extended, and its practical application increased a hundred years ago by the invention of the machine-cut nail and the power saw, which between them finally transformed the log hut into the wood frame house. The making of such houses was originally confined to the preparation of scheduled material, the erection still remaining a handicraft process (Gloag 1946, 11).

One of those revolutionary changes from that era, which facilitated the growth of factory built housing, was Jesse Reed’s nail-making machine which “could produce 60,000 good-quality nails in a day” (Davies 2005, 46). Early in the 1900’s, gypsum board, commonly referred to as drywall, once again changed the capabilities for producing factory built housing economically and efficiently. The burgeoning prefabricated housing industry benefited from other concurrent advancements in the building products industry. Specifically, “the development of large sheet material took place, such as Celotex, Homosote and Douglas Fir plywood, which, together with plastic glues, permitted large panel construction. In prefabrication, the larger the panel the less the site work, provided weight does not become too great for handling” (Gloag 1946, 12). An additional benefit of using larger panels in construction is the reduction in “the number of visible and vulnerable joints” (Gloag 1946, 12) which could develop into potential trouble spots over the life of the home. Progressing further into the 1900’s, “the proven success of American industry during World War II suggested that the industrial process could be harnessed to provide innovations to the home-building industry” (Adamson and Arbunich 2002, 85). Furthermore, Gilbert Herbert’s book entitled, *The Dream of the Factory-Made House*, goes on to say that “houses should be made by mass-production methods, using the assembly-line production processes of factories, and
monitored by precise flowcharts and other control methods” (Herbert 1984, 60). Assembly-line production effectively boosts quality and efficiency because of the specialization and repetition inherent within this style of manufacturing. Through the careful monitoring of the manufacturing process on an assembly line, changes can be made and, then evaluated, as to whether or not the change produced the desired outcome. Also, the level of control over the processes on an assembly line is unachievable in the field where unforeseen and uncontrollable circumstances, especially the weather, can have drastic effects on the building process.

The benefits of prefabrication extend beyond just the buildings themselves to components within the buildings. John Gloag wrote of this extension:

An assembly of plumbing units, produced in the factory by the thousand, can give far better value for money and reach far higher efficiency than anything installed in situ in traditional building. All such installations and equipment in a factory-made house may be easily and inexpensively renewed at future time, to meet wear and tear, or to allow advantage to be taken of new and improved appliances, without pulling out any of the structural parts – an extremely important consideration (Gloag 1946, 5-6).

Several well known examples of these types of prefabricated plumbing systems first appeared in the first half of the 1900’s. The first of which was Richard Buckminster Fuller’s Dymaxion Bathroom, circa 1936, seen here in Figure 2.7. Although not formally trained as an architect, Fuller gained his fame and notoriety working as “a self-taught engineer and inventor” (Davies 2005, 25), which led to him being awarded a patent for the geodesic dome. The Dymaxion Bathroom was incorporated into Fuller’s Dymaxion House (later known as the Wichita House) design where two of the plumbing units were centrally located within the plan of the house. Fuller’s design for his plumbing system was so technically advanced, he “demurred on the basis that his designs were always 25 years ahead of their time and, since the Dymaxion House had been designed in 1927, it would not be ready for production until 1952” (Davies 2005, 25-26).
This was a precursor to the ultimate fate Fuller’s “great dream of designing a successful mass-produced house,” as well as the Dymaxion House itself, would eventually meet. Despite all the hype over Fuller’s design, it never had a chance to reach its potential. “The delay lengthened, confidence ebbed away and eventually the company was liquidated” (Davies 2005, 29) after merely a single prototype house was constructed. Fuller’s pre-fab housing dreams died right there on the floor of the Beech Aircraft factory in Wichita, Kansas.

The second widely publicized example of prefabricated plumbing systems from this era was the bathroom unit within the individual capsules of the Nakagin Capsule Tower, circa 1972, designed by Noriaki Kurokawa. “Prefabrication is the basis of the capsule” (Kurokawa 1977, 83), and Kurokawa saw the possibilities for meshing the benefits of prefabrication with the “aim to produce space which will react sensitively to the changes in people’s life styles” (Kurokawa 1977, 83). Shown here in Figure 2.8, Kurokawa’s design afforded the end user with the ability to customize window and entrance locations, the position of equipment within the capsule, a choice of two different bathroom units as well as furniture and interior finishes. An inherent problem with any type of construction, but specifically referring to pre-fabrication in this instance, comes into play when one views a structure as a cohesive unit. “As long as the whole structure is constituted of many units of different lengths of durability, it may still be destroyed when the individual parts of the shortest durability give out” (Kurokawa 1977, 86). Because of the holistic approach to manufacturing the individual capsule units, maintenance of the plumbing units and the location of the bathrooms was a crucial part of the design “because the capsules contain built-in furniture and other furnishing that must be moved to allow workmen to open the floor for repair” (Kurokawa 1977, 108). The one hundred forty capsules in the Nakagin Capsule Tower were manufactured off site in a shipping container factory, transported to the site via truck and attached to a concrete shaft at the site.
The idea of self contained plumbing systems was deemed to be “ideal for factory prefabrication: precision, proper examination of workmanship and testing can thus be easily achieved” (Gloag 1946, 115). However, during the early 1950’s, the challenge and downfall of factory built housing was often the designers’ inability “to reconcile their experiments in building technologies with the traditional values of individuality and domestic comfort” (Adamson and Arbunich 2002, 87) that home buyers insist upon. In fact, some factory built houses of this era became victims of an overzealous desire for the “complexities of technical problem-solving” (Adamson and Arbunich 2002, 87).

Despite the dangers of these “experiments,” many approaches to the inclusion of plumbing services into factory built housing have been tested over the years, and, generally speaking, those innovations in plumbing and electrical wiring have helped the factory built housing industry grow over time. This idea of prefabricating systems also included other areas of the house such as kitchens. The gas package kitchen shown in Figure 2.9 was “designed by Jane Drew, F.R.I.B.A., and produced by Littlewoods Ltd., of Liverpool, England” (Gloag 1946, Plate 47). The self contained unit includes a stove, a sink, and cabinet space.

Another noteworthy innovation that helped push the growth of the factory built housing industry, especially non-kit houses, was the design of hinged roof systems. More specifically, hinged eaves are an example of one of those earliest innovations in roofing technology for factory built housing. One of the challenges faced prior to this design innovation was the severe limitations on how wide or tall a home could be due to the restrictions and problems encountered when transporting them from the factory to the building site. The ability to hinge portions of the roof into place once the home is delivered to the site allows for much larger overhangs and steeper roof pitches to be offered as options to the home buyer.
This sequence of Figures shows a hinged roof system commonly used for the overhang or eave portion of the house, starting with a detail for an actual design in Figure 2.10, through the transport and construction phase in Figure 2.11, and ultimately after being hinged into place and buttoned up on site in Figure 2.12. Later on, even further advances to hinged roofs were made. Some manufacturers have gone to a system where the whole roof is hinged with bolts along each edge on top of the bearing walls. The system, shown here in Figure 2.13, splits the whole roof down the middle at the peak allowing for one half of the roof to fold nearly flat over the top of the other half during transport to the site. Once on site, the halves are hoisted into place and the necessary structure for supporting the roof and the insulation, drywall and so forth is added to complete the construction as needed. These advances in roofing construction technologies have helped to “ease the problems of trailer size, of road loading and bulk, or of access to the site wherein some cases these will offer serious difficulties”
Over time, these are just a few of the processes and innovations that have increased the range of factory built housing available to consumers.

The array of prefabricated construction techniques within the factory built housing industry continues to evolve and now consists of four basic types:

1) Precut system: such as the Sears catalog kit houses.
2) Panel system: such as the “FlatPak” house by Lazor Office.
3) Modular system: such as the “B-Line” by Hive Modular.
4) Complete system: such as the “Weehouse” by Alchemy Architects.

These four basic types can be further divided into two similar categories. The first two, the precut system and panel system, are more of a “kit of parts” that get fabricated in a factory and then transported to and assembled on the building site. The last two, the modular system and the complete system, differ greatly from the precut and panel systems as they come to the site either in modules, which get assembled on site, or as a complete unit ready to be set on a foundation. With the latter two systems, and dependent upon which one of the two, modular or complete, one chooses, the house can be ready for occupation within days, or even hours, of arriving on the site.

A precursor to what we would call the precut system today and dating back as far as the twelfth century, the timber frames of English houses “were first shaped not far from the woods where they were felled; they were then seasoned and ultimately carted to the site” (Gloag 1946, 3). Houses built using the precut system are oftentimes referred to as “kit” or “mail order” houses. The rapid growth and construction of early “kit” houses are described in this 1872 writing of Horace Greely:

> With the application of machinery, the labor of house building has been greatly lessened, and the western prairies are dotted over with houses which have been shipped there all made, and the various pieces numbered, so that they could be put up complete by anyone (Davies 2005, 47).

The factory built portion of the precut system of construction involves cutting the lumber to proper size and then numbering the parts for ease of assembly. Then, the whole “kit” gets delivered to the building site to await assembly at a later date. The precut system and panel system have several advantages over a traditional, stick built home. One is the vast reduction in construction waste. “The factory allows for more precise cutting and use of
materials. If there are any extra materials from one home, the factory is able to store those materials for the next...home coming down the line” (Kaufmann 2007b, 5). Anyone who has driven through a neighborhood where houses are being built has undoubtedly seen the huge dumpsters overflowing with the massive amounts of “waste” material headed for the landfill. All of the factory built housing systems, including the precut and panel systems, significantly reduce the amount of waste that ends up in the landfill. Another advantage is quality. The panels and/or parts are built to close tolerances in the factory setting to help ensure the assembly goes smoothly once the materials are delivered to the site. Also, the construction process and timeline for the precut and panel systems can be reduced somewhat over a stick built home because of the ability for concurrent construction and fabrication to take place. For example, a foundation for a project could be put in while, at the same time, the wall panels are being built off site in the factory. One disadvantage of these systems is that the materials, once delivered to the site, are exposed to the elements for extended periods of time just like a stick built home. This is a problem because “once materials are left outside for more than two weeks, rain and sun compromise the materials integrity” (Kaufmann 2007b, 7). As with stick built construction, there is also the risk of theft of materials from the job site, which is an increasingly popular crime as of late. This can create myriad headaches and delays, even if the disappearance of materials is immediately detected.

The latter two systems, the modular system and the complete system, offer distinct advantages over not only stick built houses, but over the precut and panel systems of factory built houses as well. In both of these systems, and unlike the panel or precut systems, the home buyer can expect their home to have less potential problems related to moisture because the building materials are never exposed to the elements. Due in part to compromised building materials, problems associated with poor indoor air quality and mold growth are becoming more and more common in construction today. With homes being built more air tight, litigation involving claims for mold growth and abatement have been steadily increasing in recent times. Because they eliminate the exposure of building materials to harsh exterior elements, the modular and complete systems are an efficient and healthy way to construct one’s new home.
Financing

Financing is one aspect of the factory built housing experience that could provide some headaches for the potential home buyer. Because modular houses have to conform to the local building codes, financing is handled just like a stick built house and typically doesn’t create any issues. On the other hand, manufactured houses are sometimes handled differently. “Manufactured homes aren’t considered real estate until they are permanently installed, so it can be more difficult to get financing for them” (Connors 2008). This generally isn’t a problem, but there have been instances in the past, of banks being reluctant to approve loan applications for certain types of factory built housing (i.e. manufactured houses) because lenders fear that the value of manufactured homes will quickly depreciate. The industry has adjusted to conform to this situation, either because of pressure from consumers trying to get financing or from lending institution’s low tolerance of risk, and we now see “most of the houses offered at the present time are of traditional design, that being what most people want. This attitude is encouraged by banks and loan organizations who always have a weather eye open for resale value and therefore lean toward the largest market” (Graff, Matern, and Williams 1947, 8). Burnham Kelly also wrote of this very practice:

Though the banks have presented no general obstacle, they have in some areas been very conservative and very skeptical about prefabrication. Sometimes this conservatism has made itself felt in the difficulty of obtaining working capital loans; more often it has been exerted in the field of mortgage financing. With present-day mortgages amortized over long periods, usually considerably in excess of the average span of homeownership, it is natural that lending institutions are concerned about resale value. Their opposition to unconventional appearance affects site-built as well as prefabricated houses, but, reflecting local prejudice, they have sometimes objected to prefabrication as such, refusing to lend on it or taking a mortgage for only a small fraction of the value (Kelly 1951, 93).

Today, lending institutions treat modular homes the same as stick built homes, and home buyers can expect a nearly identical financing process for either type of home. Even if financing challenges are encountered, the affordability of factory built housing offers an
opportunity for many to still live out the American Dream in light of the present day mortgage crisis. In fact, “one of the original reasons for prefabrication was the belief that there was a tremendous potential market for very low-cost houses. It was obvious that such houses could not be supplied by ordinary methods of building, and mass production seemed the logical solution” (Graff, Matern, and Williams 1947, 21).

**Architects and Modular Housing**

**Aesthetics**

Aesthetics, how a house physically looks on the exterior and on the interior, depends greatly on decisions that are often made weeks or months before construction ever begins. First of all, it is of utmost importance to start with the reality that there are aesthetic differences within the range of factory built housing, especially between a manufactured home and a modular home. As defined earlier, a manufactured home need only comply with the less stringent HUD Code. This translates to greater affordability, but, oftentimes, less desirable or a complete lack of aesthetic design choices. Figures 2.14 and 2.15 show the difference in aesthetics between the two categories of factory built houses at the detail level, and not according to style alone, for a manufactured house and a modular house. The differences between these examples may not be obvious to the casual observer, but they include some of the following:

- Cladding (the use of cheap, vinyl siding
versus steel and fiber cement siding)

- Fenestration (a few openings of relative uniform size to satisfy code compliance versus multiple openings of varying sizes designed to achieve a desired effect)
- Details (fake shutters on the facade only versus architectural elements on all four sides, sometimes referred to as 360° architecture)

The importance of aesthetics is described in the following quotes:

The factory-made house, compact and tidy in design, finished in colours that brighten life instead of depressing it, could restore to the town and countryside something which has been missing since the Middle Ages in domestic architecture – gaiety (Gloag 1946, 135).

On the other hand, it must not be supposed that mass production of houses means that every house must be alike, or even that it must look like a factory job. The important point about appearance, however, is not that one house may look like another—as so many traditional custom and speculative houses do—but that they do not look as though they had been made elsewhere and dumped on the site (Graff, Matern, and Williams 1947, 8-9).

To date, the most effective arguments presented are those based on the simplicity of this method of construction, its practicability, low price, hygienic character, durability, and the rapidity with which these steel houses can be erected. The prejudice against the steel house is traditional in the Cologne area and is based principally upon aesthetic (emphasis added) grounds. The houses which are being erected are, admittedly, useful but cannot be called beautiful, which fact the producers seem to have taken into account in that they base their sales arguments rather on the practicability than the beauty of these structures (Herbert 1984, 69).

The tremendous differences become increasingly apparent when one continues to compare the aesthetics of the two different types of factory built housing, manufactured and modular. On the manufactured side, cost is unfortunately the driving factor for many of the questions involving form versus function. In Figures 2.16 and 2.17 we compare an example of this. In Figure 2.16,
one can see the corner detail of an end wall from a manufactured house. The trim on the manufactured house is sloppily butted together and nailed to the wall at random distances along its length. There is no attempt to conceal or cover up the nail heads used for attaching the trim to the wall. In fact, one of the nail heads is visible near the bottom of the left hand image. Figure 2.17 shows the same condition from a modular house. The wall from the modular house is finished just like a stick built house would be with a metal corner bead and drywall tape and mud. The corners get sanded to a smooth finish and are then primed and painted. Aside from the fact that the manufactured home has been designed with this aesthetically unpleasing corner detail, the wall panels and their coverings themselves are also flimsy and cheap feeling. This gives the manufactured home a drastically different look and feel from the gypsum board wall panels and paint used to finish the interior of the modular home. A further example of the difference between a manufactured house and a modular house is shown in the following figures. Again, in Figure 2.18 we have the detail from a manufactured house and in Figure 2.19 the same condition for a modular house. The manufactured house uses a section of quarter round trim to conceal the joint between the wall and ceiling panels. Figure 2.18 also shows the vertical trim pieces used to hide the joints between the wall panels themselves. In both cases, the trim has been
attached in a haphazard way with the nail heads visibly exposed. The image from the modular house shows the clean transition between the wall and ceiling capable with the traditional drywall finishing techniques described above. With the contrasts between the aesthetic qualities from the manufactured house and the modular house, it is no wonder that some have negative opinions of factory built housing.

There will always be a market for factory built housing in some fashion, be it temporary worker’s houses like this Tennessee Valley Authority (TVA) sectional house from the 1940’s seen here in Figure 2.20 or a modern weekend getaway retreat like this variation of ALCHEMY Architects Weehouse shown in Figure 2.21. The question of aesthetics seems torn between the two factions of factory built housing, manufactured and modular. The more affordable and, typically, lesser design-focused manufactured houses are generally not aesthetically pleasing, but they do provide low-cost housing for those who need it. The typically more expensive, but more design-focused modular houses allow for home buyers (who can afford to) to get an aesthetically pleasing, custom feeling house for a fraction of what it would cost to build a similar, architect designed, site-built house. However, there are exceptions to every rule, and the M-House, seen here in Figure 2.22, turns out to be an affordable
manufactured house that comes fully loaded with design features. As with stick built homes, there is the question of style when one begins to look at purchasing a factory built house. Over the years, there has certainly been no shortage of attempts to create a good quality, affordable and stylish house built in a factory. Some have been more successful than others in, not only initial sales, but also withstanding the elements along with enduring the changes to how we live today. In the next section, a pictorial history of different designs for factory built housing that have been produced over the years in various styles, from traditional to modern and even a few in between will be shown.

Exterior

Since the first view anyone sees of a home is that of the exterior, we’ll begin with a look at the aesthetics of the outside of a house before venturing to the interior. On the exterior, factory built housing allows the opportunity for “many architectural qualities to be maintained by the new building technique, namely, good composition and proportion, good colour, and good design in every detail” (Gloag 1946, 133). Cladding, windows, roof styles and materials, and accessory structures, such as garages, are all part of what your existing or future neighbors will see from the outside of your house. Therefore, these items are all necessary parts of the discussion on the exterior aesthetics of the factory built house. So much so that the aesthetics of the design shall not be relegated “to a role that was ‘somewhat in addition’ to other qualities of such self-evident utility as ‘a way to keep weather off’ and ‘more or less durable’” (Koch 1958, 87).

In Figure 2.23, we have an image of a “Green Ready-Built Home” (Kelly 1951, 231) that was “designed mostly by George Fred Keck of Chicago” (Kelly 1951, 231). The house was manufactured using “stressed skin panels that were 39” wide, of wall height, and composed of 3/8” exterior grade and 1/4” interior finish plywood glued (by high frequency induction hot
press) to a frame of 2” x 3” edge members supported by two 1” x 3” intermediate studs” (Kelly 1951, 231). The style is very similar to Rocio Romero’s highly acclaimed, modern design for the LV Home shown in Figure 2.24. The narrow, rectangular box shape and generous use of glass in both designs allow for daylight to flood the interior spaces, ultimately reducing the dependence on artificial illumination.

The collage of images in Figure 2.25 shows several stereotypical factory built houses. The early mobile home and double wides that are shown would be considered HUD Code or manufactured homes today. The details reinforce why the stigmas of factory built housing have been difficult to overcome. These houses are easily identifiable because of their shallow roof pitches, typically a low 3/12, necessary for clearance when being transported to the site, and a general lack of detail that contributes to their cheap look.

Figure 2.26 shows a multi-family unit of two story modular homes that appears to be based on the four square style of the early 1900’s. Nicely detailed with exterior window trim, corner trim, divided window sashes and low slung hip roofs, the symmetry of the stacked windows creates a uniform look without becoming too mundane.
Many systems for factory built housing have been experimented with over the years. The following example doesn’t really fit a particular style. However, it could be classified as peculiar. The foldable unit shown in Figure 2.27 was designed as an emergency shelter (by the Palace Corporation). There are many other examples of emergency type shelters that have been built in factories as well. The Cusato Katrina Cottages, discussed earlier in this document, are another take on providing quick, portable and cheap emergency shelter. This is an area where the factory built housing industry could really expand its market share.

Many of the modular homes being built today are hard to distinguish from their stick built counterparts. As developers begin to understand the benefits that modular housing can bring to their bottom line, we will most likely see more and more suburban neighborhoods being mass produced. The modular house shown in Figure 2.28 could be located just about anywhere in suburbia within the United States. Once constructed, it would be difficult to discern it from a site built home.

Cladding

Material choices abound in the factory built housing industry. Over time, there have been more new materials and methods tried within the factory built houses than on stick built houses. Unfortunately, change does not come easy, especially in an industry that is driven by
a mentality of what banks will or won’t finance and what will be easily saleable when one wants to move in the future. That aside, there are some interesting choices for options in cladding, roofing, and structure that manufacturers have tested and sold in their factory built houses. Among those choices, there is a vast array of exterior cladding materials available on factory built housing today. There are houses throughout the years that have used everything from wood to metal, vinyl to copper and even translucent Plexiglass panels as their first defense to keep out the weather. The following section will show examples of some of the different cladding materials available today for factory built houses as well as in the past.

**Metal**

Buckminster Fuller’s circular houses were never very well received by home buyers and, ultimately, resulted in the demise of Fuller Houses, Inc. Fuller’s grain bin house shown in Figure 2.29, was constructed of a corrugated metal exterior and a sloped metal roof. However, Fuller’s better known design was the Dymaxion house or Wichita House, seen here in Figure 2.30. The objective for the design was “to maximize the performance of the house per pound of material in its structure, along with enclosing the maximum volume with the minimum surface” (Kelly 1951, 27). Clad in shiny metal panels and supported by tension “wires from a central mast” (Kelly 1951, 26) the design “did not meet with public approval” (Herbers 2004, 18) and was never put into production.

Other early examples of factory built houses that used metal as cladding and for structural purposes abound. “During 1930, the Hirsch Company began to experiment with the
The use of copper in building” (Herbert 1984, 105) and “they acquired the rights to a system of prefabrication of dwellings, invented by Friedrich Förster and later further developed by Förster in conjunction with Robert Krafft” (Herbert 1984, 105). Figure 2.31 shows a two-story, five room house from the “German building exhibition in Berlin from 1931” (Herbert 1984, 110) that became known as the Copper House. The house was built using the Förster and Krafft principle, which included a wood framed structure that was clad on the exterior by thin copper sheets. The roof of the house was also clad with copper, and it was “claimed that the house could be erected in only 24 hours” (Herbert 1984, 108).

Walter Gropius experimented at length with metal clad houses as well. Taking the Förster and Krafft methods and the Hirsch system used in the Copper House, Gropius “refined them technically and aesthetically” (Herbert 1984, 146) and, in 1932, produced his prefabricated, copper clad dwelling, deemed the Growing House, for an exhibition in Berlin, Germany. Seen here in Figure 2.32, Gropius’ design incorporated “a horizontally ribbed corrugated copper sheet instead of the rather clumsy original” (Herbert 1984, 146) and smooth sheathing of the Copper House as well as a flat roof versus a hip roof. Gropius’ design changes created an aesthetic that was much more in line with the International Style than the original Copper House.
The use of corrugated metal as exterior cladding did not stop with Gropius’ foray into the world of factory built housing. In Figure 2.33 is Josef Hoffman’s 1929 design for a steel house. Manufactured by Vogel and Noot, Hoffman’s design, like Gropius’, used horizontally ribbed panels as exterior cladding. Unlike Gropius’ design, the panels were made of lightweight steel and not copper. The horizontal ribs were broken up by vertical joints where the panels were split. The white trimmed windows produced a bold aesthetic contrast with the darker colored cladding.

Today’s examples of factory built housing that use corrugated metal are plentiful as well. We have already seen Rocio Romero’s LV Home earlier in the text. One option Romero offers home buyers is a choice of cladding materials, including Galvalume (an aluminum-coated, corrugated tin) in thirty different color combinations. As Romero’s homes are designed as “kit” homes, home buyers have the option to choose something completely different for their cladding material and, therefore, deduct the cost of the standard Galvalume siding from the price of the house kit. A popular choice is the standard, silver metallic color shown in Figure 2.34, of Romero’s one room Fishcamp prefab.
house. The simple structure’s exterior is a combination of the horizontally ribbed Galvalume, a row of clerestory windows on the rear wall, and two translucent, barn doors on the front of the house. Romero’s mobile unit is a stylish and affordable way for home buyers to venture into the prefab home market.

Another modern design that was shown previously in the text and appears here again in Figure 2.35 is the M-House designed by Tim Pyne. The M-House uses a similar type of corrugated metal cladding to Romero’s Galvalume siding. Pyne’s design is actually considered a manufactured home, and it “comes in just two pieces, which are then ‘zipped together’ on the site” (Herbers 2004, 78). Estimated time for assembly of an M-House by two people is one day. The M-House also incorporates “a self-supporting steel structure, one of the key elements distinguishing it from traditional mobile homes” (Herbers 2004, 78). The house “is so mobile, in fact, it can be placed in the country, floated on water, sited on the roof of a city building, in a garden in back of a main house, or just about anywhere else” (Herbers 2004, 76). Home is just a utility connection away. In Figure 2.35, one sees the exterior of the M-House and the corrugated aluminum cladding which is accentuated by the awnings located over the openings for the windows and doors.

Yet another example of a modern, prefab house clad with corrugated metal siding and aluminum and supported by a steel structural skeleton, similar to Pyne’s design, is the Collins and Turner Silverbox Home shown here in Figure 2.36. However, the opposing pitched roofs create a distinctly different aesthetic than the flat roofed, rectilinear boxes of the LV Home and the M-
House. The steel structure allows for the design to incorporate huge expanses of glass which not only flood the interior with natural daylight, but help to warm the concrete floors that radiate heat back into the home on cooler nights. The house sits on pedestals which helped minimize the disturbance of the site during construction and now help to create an illusion that the house is floating.

The final example of a prefabricated house using corrugated metal cladding that we will see is the LOT-EK Container Kit shown in Figure 2.37. LOT-EK’s idea for their factory built house began life as a shipping container. The containers are then fashioned into livable dwellings which “can be made and ordered, like items from a houseware catalogue” (Herbers 2004, 139). The vertical ribs of the cladding create an interesting aesthetic when contrasted with the window’s horizontal bands of glass.

For an alternate aesthetic while staying in the realm of metal cladding, the next few examples use smooth metal versus the corrugated metal cladding like the examples previously shown. One of, if not the most, well known examples of a factory built house that used a smooth metal exterior cladding system was the Lustron Steel Home, an example of which is seen here in Figure 2.38. The Lustron houses fall into the category of a “kit” home. They were manufactured in the factory as a precut system and were then shipped to the site for assembly as a kit of parts. The unique
feature of the Lustron homes was the porcelain enamel coated panels used for cladding the exterior. Available in four colors, Surf Blue, Dove Gray, Desert Tan and Maize Yellow, the panels have proven to hold up very well to the elements over time. However, one of the downfalls of the Lustron system, much like the all-too-common vinyl siding we see today, is that it is difficult, if not impossible, to paint. If the owner of a Lustron home desires to change the aesthetics of their home by changing its color, their options are limited at best. Due to a number of factors, including how the homes were sold to Lustron dealers, the grossly underestimated time it took to assemble one, and even “the technical design of the house” (Davies 2005, 59), Lustron was forced into bankruptcy in early 1950 after only 2,500 homes had been constructed. Today, the popularity of the surviving Lustron homes is evidenced by the almost cult like following they have attained, especially on the internet. Their owners “cherish them with pride” (Davies 2005, 59) even though the company has been out of business for over 60 years. In fact, the Lustron home in Figure 2.38 is a well preserved 1940’s era example that is located just several blocks south of the Iowa State University campus on Hunt Street.

The next example we see is another modern, modular type factory built house that uses smooth metal cladding. The exterior of Alchemy Architects’ Weehouse, shown in Figure 2.39, is clad with smooth, oxidized metal panels that weather and age naturally from their exposure to the elements. Available in seven other color combinations, the metal cladding can be custom tailored to fit the home buyer’s aesthetic desires for their new house.

The final example using metal exterior cladding is from the German Haus Der Gegenwart. This house uses smooth, thin gauge galvanized metal panels for its cladding.
Seen here in Figure 2.40, the virtually maintenance free, and mostly rectilinear, panels create a clean and modern aesthetic for the house. The thin horizontal and vertical gaps between the panels help to break up the expanse of silver colored metal which contrasts with the transparent areas of the home’s exterior. The aesthetic of the house is characterized by the opposition between the soft edges of the natural hedges located around the yard and the more hard edged, man-made, rectilinear metal panels attached as cladding.

**Wood, Vinyl and Stucco**

As the above examples show, metal is a popular choice for exterior cladding on factory built houses. However, corrugated metal siding, such as the Galvalume used on Rocio Romero’s homes, would look out of place on a more traditional design. The following examples use cladding materials that most people would be more familiar with, like wood, vinyl and stucco.

The house shown in Figure 2.41 is a modular home that isfinished with stucco and a clay tile roof. This Spanish design provides clean lines and minimal ornamentation. Virtually indistinguishable from a site built home, this factory built house would be right at home in any number of southwestern states, like Arizona, New Mexico or California. Stucco has been used to clad factory built houses for many years. The stucco clad “Fixed Price” (Herbert 1984, 77)
house, shown in Figure 2.42, was designed by Johannes Niemeyer and dates back to 1932. The house sports an aesthetic based on the international style that was popular in that era. The structure of the house was “a steel skeleton frame of light channel sections at 1-m spacing, to which were bolted steel plates which formed the interior surface of the wall” (Herbert 1984, 74).

Next, Figure 2.43 shows a more traditional-looking modular home that uses common materials to blend into the existing suburban neighborhood where it is situated. The fake shutters, vinyl siding and brick masonry treatment used on the façade are typical of developments all over the United States. Devoid of trim or any other accents, the lack of aesthetic design consideration is evident on the gable end elevation. In an effort to match the surrounding homes, and not look out of place, the roof has been finished with asphalt shingles. Notice the huge three car attached garage that is pushed to the front. The garage dominates the façade and screams of suburbia’s dependence on the automobile. The choice of materials appears to be driven by the fear of having “a negative impact on the value of other homes on the same block and further reinforcing the public notion of ‘cheap’ mobile homes” (Hutchings 1996, 15) rather than any individual design intentions.
In keeping with this theme of treating only the façade while forgetting about the other elevations of the house, the example in Figure 2.44 by Avco Homes is again decorated with the requisite vinyl siding, fake shutters and asphalt shingles of the preceding example. However, this time the façade is treated with fake, synthetic stone instead of brick masonry. In an effort to dress up the appearance of the house, one might be better off to spend their money on a covered porch rather than cheap, imitation materials that are intended to look like something they are not.

In an attempt to enhance the exterior of this Kaiser Community Homes house, Figure 2.45 shows how cedar shake shingles were used on the façade of the home and attached garage. This does little to help the awkwardness of the roof line where the garage meets the house. The lack of any eave overhangs also adds to the cheap feeling of what could have been a nice little factory built house, had some well thought out design sense been more a part of the equation.
Another example that epitomizes the cheap, stereotypical manufactured home, is the *log cabin* shown in Figures 2.46, 2.47 and 2.48. The vinyl log siding does a poor job of looking anything like the real thing. The gaps present in the seams of the siding, seen in the Figure 2.47, are large enough to permit rain water to infiltrate. Ultimately, this could create numerous problems for the homeowner down the road. The fake chimney looks like it was tacked on as an afterthought. Its placement on the sloped side of the roof has created another potential trouble spot for water infiltration as well.

The placement of a fireplace, which seems relatively simple, needs to be designed into the whole of the house in order to avoid the creation of a potential bad situation like the one shown here in Figure 2.48.

This two story modular house, shown in Figure 2.49, employs the use of traditional clapboard siding for cladding and cedar shake shingles on the roof. The symmetry of the stacked windows along with the use of window trim and a square muntin (the bars that divide the window glass) pattern all help reinforce the
aesthetics of this regionally identifiable style in its East Coast locale.

The modular, ranch house shown in Figure 2.50 is from Continental Homes’ Stylex line. Albeit small and rather unassuming by today’s standards, the house is nicely done. The wide lap siding and generous eave overhangs, coupled with the vertical wood siding on the gable ends, help to give the house a distinctive character, one that doesn’t appear to be solely cheap. Even though the shutters are merely ornamentation, they help to complete the house because of their use on all four sides and not just the facade.

Before we had any of our modern day composite materials like vinyl or asphalt, houses were built from readily available local materials like wood. Due to its inherent desirable qualities such as being renewable, economical and beautiful, wood is a natural choice when it comes to building. Most people can identify with wood, as chances are they have spent a good portion of their lives in structures built with it. This modern wood clad, modular house, shown in Figure 2.51, is designed with “materials which are as natural as possible, which are also 100 per cent recyclable” (Kunz and Galindo 2005, 40). The home’s extensive use of natural materials, such as wood, creates a warm and welcoming aesthetic that draws one into the interior courtyard that splits the home down the middle. This feeling is quite fitting, as the
modular-designed structure is dubbed “the retreat” (Kunz and Galindo 2005, 40) by its British designers.

*Concrete*

One more material that has been used for manufacturing factory built houses is concrete. The “Research House VII” (Reidelbach 1970, 56) townhouse project of 1968, shown here in Figure 2.52, was built using “pre-stressed concrete panels and mechanical core units” (Reidelbach 1970, 57). The homes were built as part of an experiment by the National Association of Home Builders (NAHB) to test alternative materials and construction techniques for factory built housing. NAHB sought to take advantage “of the increased acceptance of industrialized housing by the conventional home building industry” (Reidelbach 1970, 1957) by using unique materials in the form of modular construction.

Shown in Figure 2.53, this panelized modular house seamlessly blends two materials, concrete and wood, into its clean lines and modern aesthetic. This modern home is the “FlatPak” by Lazor Office in conjunction
with Dwell Magazine. The choice for exterior cladding is Douglas fir wood panels and light pigmented concrete wall panels. The contrast between natural and man-made materials creates a pleasing aesthetic that appears warm and welcoming while, at the same time, seeming solid and grounded. The FlatPak system allows for an almost endless possibility of combinations to satisfy the desire for a custom feeling home straight from a factory setting.

_Plexiglass_

The final example showing exterior cladding is this unique, modular house, in Figure 2.54, by SoHo Architektur called the “Haus Sunoko” (Kunz and Galindo 2005, 150). The Haus Sunoko uses corrugated, translucent Plexiglass panels as cladding. The corrugated ribs run in a vertical direction and exterior ornamentation is nearly non-existent. The translucent panels allow for an aesthetic look that changes throughout the day depending upon the light conditions. The interaction between the material and the house’s inhabitants blurs the lines between interior and exterior, as well as public and private.

_Roofing_

“Neither tile, slate nor asbestos has been able to provide roofs of a quality that could achieve beauty by weathering; today roofs of such materials look as hard and new in many a housing scheme as when first put up” (Gloag 1946, 132). The variety of roofing materials used in factory built housing is nearly as diverse as the choices for exterior cladding, and sometimes they are even the same. The examples of roofing materials already discussed and shown in some of the previous text and figures include cedar shake shingles, asphalt shingles, clay tile, as well as several others. Various other materials such as metal, fiberglass and
rubber are also used as roofing materials in factory built housing and these will be shown as well.

**Cedar Shakes**

In Figure 2.55, we again see the use of cedar shake shingles on the roof, like the two story East Coast clapboard sided house shown as an earlier example. However, this modular house by Behring Corporation uses an alternative design, a mansard roof, combined with the same material to create a drastically different aesthetic effect than the standard gable roof of the earlier example.

![Figure 2.55 Courtesy of Reidelbach](image)

**Fiberglass**

The modular house shown in Figure 2.56 uses a “fiberglass roofing with a slate appearance” (Hutchings 1996, 26). In certain instances, the use of imitation materials that are expected to look like the real thing, but don’t, can and have created negative attitudes towards factory built houses. This idea of using fake or imitation materials is expounded upon by Wes Jones of Jones, Partners: Architecture in the following quote: “Too much energy has been expended making faux bricks and siding to mimic traditional housing” (Tolme 2003, 66-67). The aesthetics of a factory built house can be improved dramatically with wise choices and combinations of materials.

![Figure 2.56 Courtesy of Hutchings](image)
Metal

The Lustron Steel Home kit houses did not only use Lustron’s patented porcelain enamel coated panels for exterior cladding, they also used them as the roofing material. The similarity of the cladding and roofing materials used on the Lustron homes gives them a cohesive and finished aesthetic, one that does not try to be something it isn’t. This may very well be one of the reasons that the Lustron Homes are so dear to many of those who’ve had the opportunity to live in one. Shown here in Figure 2.57, the metal roof used on a Lustron home is much like a typical shingle style roof in that it is comprised of many small, overlapping pieces covering the sheathing underneath.

Another example of a factory built house using a metal roof is the Glidehouse, by Michelle Kaufmann Designs, seen here in Figure 2.58. The Glidehouse uses a pitched roof that is covered by standing seam metal roofing panels. The panels provide a sleek and clean aesthetic that lends itself to the modern look of the rest of the house. As has been done in this example, the roof can be tailor made for those wanting to “green” up their house by the addition of photovoltaic (i.e. solar) panels for harvesting the sun’s power.
Rubber

This modular home by Hive Modular uses a membrane type roof to achieve its clean lines and modern aesthetic. The B-Line model shown here in Figure 2.59, uses a “vented flat roof system featuring a factory-installed seamless EPDM (ethylene propylene dieneterpolymer) rubber roofing” (Hive Modular 2011) membrane. Flat roofs tend to be easier to fabricate than pitched roofs. This typically translates into a lower initial cost, but, long term, flat roofs can be very expensive to maintain. This is especially true in wet or icy climates where the potential for leakage is higher than with a pitched roof design, which drains much more efficiently than a low sloped, flat roof design.

Interior

As stated earlier in the text, the first view anyone sees of a home is that of the exterior, and that outside view is not only a matter of the homeowner’s aesthetic tastes, but their neighbor’s concerns as well. Aside from that, most people still wouldn’t care to live in an “ugly” house, be it ugly on the outside or inside. However, depending upon how friendly one is with their neighbors, the fact is that many may never even see the interior of their neighbor’s house. This should in no way diminish the importance of what good design choices can do for turning a house into a home. The interior space is the realm that one, as a homeowner, will become most intimately aware of over time. One might not care or even notice if their shingles are made from asphalt versus cedar, but one will certainly become aware of a poorly designed interior, either by their own experience or from being told. As an
example of the latter case, if the kitchen doesn’t have enough cabinet space, one will certainly hear about it and, suddenly and remarkably, begin to care. From finishes to fixtures, to the space itself, the interior of a factory built house is much less about one’s neighbors, and much more about the individual, the one who will actually be living in it each day.

The spaces within a house are a critical element of the aesthetics as well. The sterility of the kitchen and dining area, from this 1945 factory built house in Figure 2.60 by Herbert J. Manzoni, takes over and creates an unwelcoming nature for the space. Almost institution-like, the space appears functional in terms of providing the necessary room for preparing, cooking and eating a meal as well as cleaning up afterwards. However, the space looks somewhat unfinished. On the right side of the figure, notice the sink basin and associated pipes that are left exposed and the huge amount of unenclosed, wasted space that surrounds this area. The rest of the fixtures, from the clock on the wall to the ceiling mounted light; appear as if they came straight from an institution, such as a hospital, as well.

**Metal**

Just like the overwhelming choices of exterior cladding and roofing materials, interior finish choices for factory built houses run the gamut from mild to wild, boring to bold and just about everything in between. Some early designs for prefab houses even went as far as to carry the choice of exterior finishes right into the interior as well. Such is the case with the Lustron Steel Home shown here in Figure 2.61. The familiar
porcelain enamel coated panels from the exterior are also used on the interior ceilings and walls of the Lustron houses. The features of the second bedroom, seen in Figure 2.61, were described in a Lustron marketing brochure as “privacy, ample wall space, and large double closest with sliding doors” (Fetters 2002, 27). Aesthetically, “metal was used as metal in the Lustron and there was no attempt to disguise it as wood, brick or any other material” (Fetters 2002, 27). In fact, “the embossing of the interior wall panels was totally functional and gave them added strength” (Fetters 2002, 27). Although not necessarily unique to factory built housing, one of the challenges facing it may very well be the battle between form and function.

*Tile and Wood*

Fortunately, not all factory built housing is conceived with the primary goal to build a house as cheaply as possible. Typically, that seems more the case with the manufactured houses on the market rather than the modular ones that are available. However, there are exceptions. On the interior of Tim Pyne’s M-House, a manufactured house, finish options include mosaic tile in the bathroom, seen here in Figure 2.62, as well as the tongue and groove wood ceiling and black linoleum flooring available in the kitchen and dining room, shown here in Figure 2.63. The tongue and groove wood ceiling affords a drastically different aesthetic from the cheap, textured ceiling panels of the aforementioned manufactured home. As a side benefit of using wood, and with the push towards “green” design,
many home manufacturers are now using wood from forests that is sustainably grown and harvested.

The beauty of natural wood is hard to beat, whether it is on the exterior or interior of a house. The luxurious look of the carbonized bamboo wood used to clad the interior on Alchemy Architects Weehouse, shown here in Figure 2.64, flows seamlessly together from floor to wall to ceiling to create a striking aesthetic effect. The carbonized bamboo is just one of the options one can choose to make their Weehouse feel personally customized, rather than factory bland. Not only do most people who live in mass-produced, spec or tract houses from production builders never get to experience this level of detail, but most wouldn’t believe something as extravagant as this would even be available in a factory built house.

Moving away from the modern style, but sticking with the use of wood, we have this example in Figure 2.65 of a steel framed, kit house from Kodiak Steel Homes. The Crestwood model is finished with a combination of tongue and groove pine wall covering, slate tile flooring and a drywall ceiling. To those who are unaware, one would be hard pressed to
believe that this nicely finished, rustic look came from a factory and not a high-end custom builder.

On the other end of the spectrum, and to show the nearly endless possibilities for customization available with factory built housing, in Figure 2.66 we have an extreme example of the interior of a modern, modular house. The Su-Si K, also by KFN Products, is designed with KFN’s “OA.SYS, or ‘Open Architecture System,’ which consists of panels and planes that can be mixed and matched into different designs” (Herbers 2004, 92). The minimalist modern aesthetic, devoid of any clutter or decoration, is fully realized in this factory built house, and for a fraction of the cost to replicate it in a custom, stick built format.

Buckminster Fuller’s Dymaxion house that was looked at previously in the text is also a fine example of the extremes possible with a house built in a factory. To contrast with the Dymaxion’s shiny metal exterior, Fuller designed the interior of the house, seen here in Figure 2.67, with some natural materials, including generous doses of rich, dark stained wood on the floors as well as the walls. In fact, the flooring was designed with a beautiful radial pattern that accentuates the circular shape of the house itself.
Glass

The openness of the glass wall panels, in effect, blur the lines between inside and outside, public and private, in the Su-Si House by KFN Products shown in Figure 2.68. The ceiling and floor are covered with natural wood, a light colored birch. The addition of the shelves, in matching birch, along each glass wall is not only a practical solution for storage in the relatively small house, but it also helps to break the open and airy space up into more distinct zones. This helps in making the house seem larger than it is while, at the same time, reducing the effect of feeling like you are living in a tunnel. The aesthetic result is that the perceived square footage is much larger than the actual square footage of the house.

The “institutionalized” Manzoni house, shown earlier, appears even more unwelcoming when contrasted with the interior of Rocio Romero’s LV Home, shown here in Figure 2.69. The recessed lighting, minimal decoration, and extensive use of glass create a space which is not only functional, but beautiful as well. The glass wall panels frame the views of the home’s outside surroundings, while welcoming in scores of natural daylight and blurring the lines between interior and exterior.
This space was clearly designed with a specific intent in mind. One that appears Romero has fully achieved through the choice of materials.

**Design**

The design of factory built houses “becomes many times more complex when the solution is to be arrived at in terms of mass production” (Adamson and Arbunich 2002, 102). The difficulty with early prefabrication, and even still today for that matter, is the inability of designers never being “able to satisfactorily resolve the dilemma of how to make houses that could be both mass-producible and individualized” (Adamson and Arbunich 2002, 35). An inherent danger in this method of construction is the “greater tendency towards monotonous standardization in the completed house” (Gloag 1946, 5). Even a simple thing like hanging a picture on the wall or repainting a room or two can become problematic for a home owner if the initial design parameters fail to take the end user’s desire for customization into account, even at the smallest level.

**Options**

Aside from these dilemmas, the growth of factory built housing has been, in part, due to the availability of optional accessory structures that compliment the original aesthetics of the existing house. By offering options, such as garages or additions, that match the original design, manufacturers can sell a potential home buyer a complete package and, thus, reinforce the mass-customization possible with factory built houses while, at the same time, offer the affordability and cost savings achievable with mass-production techniques.

One of the earliest examples of adopting this “complete package” mentality by a kit home manufacturer was that of the Lustron Corporation. As seen in Figure 2.70 and 2.71, Lustron Home kits were available with

![Figure 2.70](image-url)
either a double or single garage as an option. Complete with the same porcelain enamel coated panels for exterior cladding and roofing, the garage kits complement the aesthetics of the houses simply by matching the existing materials of the house. Were one to attempt to add a garage at a later point in time to this Lustron steel home, say using lap siding and asphalt shingles, the end result would seem out of place and would certainly nullify any argument to the contrary.

A more recent example of the ability for option customization is, shown here in Figure 2.72, yet another modular house by Hive Modular, the X-Line. The X-Line can be designed and configured to accommodate a tuck under double or even triple (as shown) car garage. Simply based on aesthetics, the triple garage located adjacent to the front door is a poor design choice, but a sign of the times in the auto-dependent United States. However, the point here is not solely about the design, but, rather, the aesthetic value itself. The option for matching the materials, along with the ability to customize the home right from the factory, are the important points. In addition to the flat roofed example shown, Hive Modular also offers the option of a gable style roof. Aside from the aesthetic desires of the client, the importance of where the home will be located once constructed plays a tremendous role in material choice and style.
Rocio Romero has fully embraced the idea of offering options in her product line as well. To complement her LV Home kits, a home buyer can choose to add a 625 square foot LVG double garage to their order, complete with matching cladding and the same modern aesthetic as their new house. The rendering, shown here in Figure 2.73, depicts the clean lines of the LVG in the spirit of the LV Home. Figure 2.74 shows a built example of an LVG double garage attached to an LV Home, along with the addition of an LVT (tower) that completes the package. The LVT kit not only creates a stunning entry to the home, but it looks right at home doing so. Romero hasn’t stopped there. Another choice, shown in Figure 2.75 and dubbed the LVC (courtyard), has also been added to her growing list of customizable options available to LV Home purchasers. By offering an array of choices to her customers, Romero’s factory built houses will certainly allow home buyers the ability to make their individual house a home by personalization.

Another example of a modern, modular house that is highly customizable with options is the Sub-Urban House by Resolution: 4 Architecture, or re4a for short. The re4a team has designed their system of prefabrication around adapting to “the individual buyer’s needs, wants, and budget; the site; the region of the country; the climate; and the tastes of the moment” (Herbers 2004, 118). Their geometric...
modules, referred to as “bars” (Herbers 2004, 118) and shown here in Figure 2.76, can be designed in an almost infinite number of configurations to fulfill the client’s desires. One of those available options, shown in Figure 2.77, is a carport, which could easily be converted to an enclosed garage space if the homeowner so desires. Again, the flexibility of the re4a system gives the home buyer many options to choose from while ensuring that those options will match the aesthetic of the original design. This is a win-win situation for re4a’s clients and factory built housing in general.

Components, Fixtures and Built-Ins

The quest for the manufacture of factory built houses, “while socially responsible and sometimes exhilarating in their expressions of technology, were often overly standardized and too mechanical-looking to promote sympathy from any but the most needy home buyer or the most zealous fan of new technology” (Adamson and Arbunich 2002, 87). Many of the early houses that were built in a factory fell victim to an aesthetic of machine made standardization that drove many potential home buyers away. This was especially true in the design and development of the fixtures incorporated into many factory built houses when the industry was still in its infancy.

The following figures show several examples of this machine made standardization. The prefabricated gas kitchen package by Littlewoods Ltd., shown in Figures 2.78 and 2.79, contained a complete kitchen on one side of the common wall as well as a full bath on the
other side. Fully furnished with two sinks, a stove, a cook top, a bathtub, a water closet, cabinets and even a clock on the wall, the package included all the amenities one could want as part of their new house, except the ability to customize (i.e. personalize) it for themselves.

This non-customizable component system mentality drove the factory built housing industry for many years. Shown in Figure 2.80, here is another example of a kitchen package from an early prefab house. Included in this Braithwaite package were a “refrigerator, cooker, built-in cupboards and a washing machine” (Gloag 1946, Plate 39). This optimization (of cost and efficiency of construction) by standardization (component and package systems) experienced its heyday in the mid 1930’s to the mid 1940’s when the industry saw a tremendous amount of manufacturers come and go, with some barely even making it off the ground.

The extent to which the component and package systems were incorporated
into factory built housing may very well have peaked in those early years, but there are still examples of this today. The galley style kitchen shown in Figure 2.81 is out of the BokLok line of prefab houses by Swedish furniture manufacturer, Ikea. Specifically designed to fit the space it is allocated, the kitchen package only allows for minimal customization by the home buyer. Clients are free to choose the material and color of the cabinets and countertops, but are otherwise limited by the configuration of this design. However, this system does offer more flexibility for personalization than some of the very early examples, such as the aforementioned gas kitchen package by Littlewoods Ltd.

Due to the space constraints of the oftentimes smaller size of factory built houses, manufacturers have extended the use of component systems to other areas of the house as well. The bedroom from this Jicwood Bungalow house, shown in Figure 2.82, minimizes the use of square footage and maximizes storage and work space by incorporating a desk, closets, and a built-in chest of drawers into the design. This is a technique still used today by many factory built housing manufacturers, from manufactured to modular. Tim Pyne’s M-House is one of those manufactured house examples. Prior to his days as a prefab house designer, Pyne “worked on a ship, so he knew planning the king-size beds and wardrobes in the bedrooms as built-ins would save space” (Herbers 2004, 79). The bedroom’s design creates a cozy nook for sleeping while maximizing the amount of storage space available in the tight quarters.
Designed in a simple and clean fashion, the pale birch wood fixtures combine with the black linoleum floor to create a bold aesthetic look for this “mobile” home, as seen here in Figure 2.83. It is through options such as this that manufacturers can offer the appearance of an architect-designed custom built house for the price of one that rolled off the assembly line.

Michelle Kaufmann’s Glidehouse is one of those modular house examples. In an effort to maximize the amount of storage space while maintaining the uncluttered, minimalist aesthetic for her design, Kaufmann incorporated these ingenious storage bars with glide-able (hence the name, Glidehouse) doors into the Glidehouse. Seen here in Figure 2.84, the gliding wood doors move back and forth to either reveal or discreetly hide the storage, work surfaces, and so forth that line the areas adjacent to the living spaces.
Planners and Modular Housing

Michelle Kaufmann Case Study

The cost savings, construction timeframe, and quality control of a factory built house versus a traditional, stick built house were well documented in the 2001 case study by Michelle Kaufmann, owner and design principal of Michelle Kaufmann Designs, “a full service architectural design firm that specializes in innovative, high quality, sustainable design” (Kaufmann 2007b, 3). Michelle’s case study grew out of an opportunity presented while she and her husband, Kevin, were building a new site built home for themselves in the San Francisco bay area of Northern California. While undertaking the design and construction of their site built home, friends and colleagues began to ask if Michelle and Kevin could design and build an identical home for them. These original questions snowballed into the idea for a mass-produced, factory built house that would later become known and marketed as the previously mentioned “Glidehouse.” The challenge had been laid out and the results were quite astounding.

In speed of erection the factory-made house finds no competition from traditional methods. Closely connected with this question of speedy erection is the immense advantage of any system of dry building, the most important aim being to get the roof on as soon as possible (Gloag 1946, 6).

Quality of Modular Housing

In Chapter 1, the question was raised as to how the quality of a modular house compares to that of a more traditional stick built house. In Kaufmann’s case, the factory built house again wins over the site built house in terms of quality control. Their factory built Glidehouse was required to meet the local and IRC codes just as the site built house was. However, the factory built house actually exceeds the site built house in certain areas. An example of this is the factory built house’s use of triple rim joists and glued and nailed or screwed connections as opposed to the solely nailed or screwed connections of the site built
house. This additional step of gluing the connections in the factory built house helps “ensure stability and strength for transport” (Kaufmann 2007b, 7), but the side benefit to this is that the house becomes more structurally sound and solid feeling over the site built house. Also, “another advantage of the factory-made house over the traditionally built types is the greatly improved insulation against heat, damp, and cold that becomes easily and cheaply available” (Gloag 1946, 6). Additionally, the materials for the factory built house were stored indoors in a climate controlled environment. With the unprotected, outside storage of the materials for the site built house, the potential for the introduction of additional moisture into the building materials can create problems with mold and indoor air quality that may not become evident until much further down the road. This is especially a problem in humid areas of the country, such as the Pacific Northwest, which tend to receive large amounts of rainfall.

Also, one other inherent benefit to the assembly line nature of the factory built house, and shown here in Figure 2.85, is the continual surveillance of the staff members in a controlled environment which leads to “repetition = worker specialization. Each home is built by the same construction teams that utilize the maximum time and material efficiencies of the factory” (Kaufmann 2007b, 5). This manufacturing technique is reiterated here by Jonathan Hutchings: “The assembly-line concept of modular construction allows trained craftspeople to concentrate exclusively on their particular specialty, using precise tooling to meet exacting standards” (Hutchings 1996, 4). This is an area that can be problematic for the site built home, even when you use reputable subcontractors. In a perfect world, subcontractors would never cut corners in the field and, therefore, there would be no need for architects to do construction administration on their projects. Due to these reasons, modular construction wins out over a traditional stick built home in terms of quality. This is good
news for home buyers contemplating the construction of a new house using modular construction.

**Construction of Modular Housing**

“It should be specifically pointed out that, for all intents and purposes, the basic objective of factory produced modular housing is not necessarily to lower the cost of the housing unit, but is instead to provide quality housing in volume, which might not otherwise be available” (Reidelbach 1970, 75). In terms of construction, the modular house wins again over a more traditional stick built house. The total project time for Michelle and Kevin’s site built house was twenty-one months including design, engineering, permitting and construction. Construction time alone was fourteen months for the site built house. The factory built house took ten months total to complete, including four months for construction. This equates to the site built house taking eleven months longer to build than the identical (except for the exterior cladding) modular, factory built house (Kaufmann 2007b, 6). Another example that lends further support to the findings of the Kaufmann case study was also well documented in Jonathan Hutchings book *Builder’s Guide to Modular Construction*. Hutchings found that in a line-by-line comparison of thirteen different tasks, including framing the walls, roughing in the plumbing and electrical, and putting on the roof, that a modular house saved 272 days of construction time over an otherwise identical site-built house (Hutchings 1996, 95). Similar findings were reiterated in an interview conducted as part of this study where it was stated that a modular home can be move-in ready in as little as six weeks where a similar stick built home could take from three to six months to be ready for occupation by the owner. The old adage that “time is money” becomes quite evident in these examples. Weather delays associated with site built construction are also a thing of the past with modular construction. “In most cases, the modular home can be delivered and set within a six- to eight-week period from the date of order and received deposit. The builder should have the home completed in one to three weeks thereafter and ready for owner occupancy in 60 to 65 days” (Hutchings 1996, 9).
Affordability of Modular Housing

The cost savings of the factory built house was $73,450 which is an approximately one-quarter reduction in the total construction cost over the Kaufmann’s site built house. The factory built house totaled $290,500 ($182/sf) including the factory cost, shipping and setting, and the on site button-up work (electrical connections, plumbing connections, and so on). The total for the site built house, including similar items (i.e. utility connections) to the factory built house, was $363,950 ($233/sf). Based on a four month versus fourteen month construction timeframe, other potential cost savings that were not included in this case study are the general contractor, project management and general conditions fees, mortgage payments on the land and construction loan, and construction insurance (Kaufmann 2007b, 7). “The strength of the prefabricated house lies in its popularity, its cheapness (emphasis added) and the industrial base from which it operates” (Davies 2005, 8). Costs are driven down because “factories, unlike most individual tradesmen, can buy supplies in bulk. In general, buyers can expect to pay 10 to 25 percent less for prefabricated houses over stick-built construction” (Connors 2008). This is an excellent time for factory built housing manufacturers to expand their businesses by offering a higher level of design in lower cost housing. Ultimately, potential home buyers will benefit from having better designed and more affordable housing options available to them straight from the factory.

Conclusion

To answer the questions posed in Chapter 1 that pertain to the quality, construction techniques and affordability of modular houses versus traditional stick built houses, this chapter researched the history, perception, technological advances, and financing for a range of factory built housing. Additionally, items of importance to both architects and planners, such as aesthetics, quality and affordability, were also looked at. A multitude of factory built housing was shown and the differences between a manufactured home and a modular home were discussed. The discussion about manufactured versus modular homes is of particular importance to helping the industry overcome the negative perceptions and stereotypes that
have plagued it for so long. From assembly lines to new, high tech materials, one cannot overlook the role and contribution that technology has played in helping to grow the factory built housing industry. A case study, along with several other sources listed in the chapter, help support the claim that modular housing is high quality, quick and efficient to construct, and affordable when compared to a traditional stick built home. Chapter 3 will discuss the methodology used to carry out the next portion of the research.
CHAPTER 3: METHODOLOGY

Introduction

The onset of any research project and much like planning for a road trip, one must first choose the supplies needed that will result in a successful outcome. Those supplies include the method for collecting and analyzing data that will be employed during the course of the study. There are myriad options for research methods. Quantitative, qualitative, and mixed-methods are the research methods most commonly used in the social sciences. Each of these three research methods can then be broken down further into the more specific means of investigation that fall beneath each of them. Before formal data collection can begin, decisions need to be made about what type of questions will be asked, “close-ended versus open-ended questions” (Creswell 2003, 17), whether there will be a focus on numbers versus informal responses, and so forth because these decisions will steer the researcher towards the most appropriate research style or design to use. Informally, Yin refers to “a research design as a logical plan for getting from here to there, where here may be defined as the initial set of questions to be answered, and there is some set of conclusions (answers) about these questions. Between ‘here’ and ‘there’ may be found a number of major steps, including the collection and analysis of relevant data” (Yin 2003, 20). In simpler terms, a research design can be defined as a “blueprint” (Yin 2003, 21) that will guide one’s research in everything from “what questions to study, what data are relevant, what data to collect, and how to analyze the results” (Philliber, Schwab, and Samsloss 1980, 21).

Case Study Methodology

“The case study strategy is most appropriate for ‘how’ and ‘why’ questions” (Yin 2003, 22) especially when those questions involve “a contemporary set of events, over which the investigator has little or no control” (Yin 2003, 9). This research focuses on asking mostly “how” and “why” questions. More specifically, this research will seek to answer how zoning codes restrict or prohibit modular houses from their communities and, if so, why do
zoning codes restrict or prohibit modular houses? These questions are of particular importance to architects and planners because their respective professions are charged with protecting the health, safety and welfare of the public. Architects want the opportunity to design affordable, high quality, well built housing that is expected to last. Planners see the necessity for affordable and well designed housing that will meet the needs of a range of residents within their individual communities. Therefore, a mixed method research design using a series of exploratory case studies has been chosen as the method of investigation for conducting this research. This research design allows for a better understanding of the research problem by converging both quantitative (broad numeric terms) and qualitative (detailed views) data. It is an appropriate research method for this study because of the pragmatic or practical consideration that the subject matter (i.e. modular housing) has multiple influences affecting when it is used or not used. The findings from the quantitative and qualitative data collection will be combined during the data analysis portion of this research and conclusions and recommendations will be drawn at that point.

**What is a Case Study**

Case studies have historically been a misunderstood research strategy. In fact, “most social science textbooks have failed to consider the case study a formal research method at all” (Yin 2003, 12) until more recent times. Case studies were often considered simply an “exploratory stage of some other type of research strategy” (Yin 2003, 12) barely garnering much more than a brief mention within the surrounding text. “A case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident” (Yin 2003, 13). A more in depth definition of case studies simply breaks the underlying logic of this approach into one of two categories: scope and “a whole set of technical characteristics, including…data collection and data analysis strategies” (Yin 2003, 13).

The case study inquiry copes with the technically distinctive situation in which there will be many more variables of interest than data points, and as one result relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and as another result benefits from the prior
development of theoretical propositions to guide data collection and analysis (Yin 2003, 13-14).

“Case studies rely on historical and document analysis, interviewing, and typically, some forms of observation as data collection” (Marshall and Rossman 1999, 159) and are dependent upon either observation or experience alone without the use of scientific method or theory. Furthermore, “case studies take the reader into the setting with a vividness and detail not typically present in more analytic reporting formats” (Marshall and Rossman 1999, 159).

Strengths and Weaknesses

As with other types of research design, case studies have many strengths and weaknesses. This research method has developed because of the ability that case studies have to help one “understand complex social phenomena” (Yin 2003, 2) by answering “how” and “why” questions. Strength of case studies is their “unique ability to deal with a full variety of evidence—documents, artifacts, interviews, and observations—beyond what might be available in a conventional historical study” (Yin 2003, 8). This method of using multiple sources of evidence is key in “the development of converging lines of inquiry,” (Yin 2003, 98) or what is commonly referred to as triangulation. Another strength of case studies is their “all-encompassing method—covering the logic of design, data collection techniques, and specific approaches to data analysis” (Yin 2003, 14) which rewards researchers with increased flexibility oftentimes absent from more regimented methods of research design. When one “deliberately wants to cover contextual conditions—believing that they might be highly pertinent to your phenomenon of study” (Yin 2003, 13), a case study offers the ability to merge that with “data collection and data analysis strategies” (Yin 2003, 13) resulting in “a comprehensive research strategy” (Yin 2003, 14).

One pitfall of using a case study is that this type of “research is remarkably hard, even though case studies have traditionally been considered to be ‘soft’ research, possibly because investigators have not followed systematic procedures” (Yin 2003, 17). While not technically a weakness, a misconception that plagues case study methodology is “the hierarchical view that case studies are only a preliminary research strategy and cannot be used to describe or
test propositions” (Yin 2003, 3). Another potential downfall of case studies is their complexity. As “the most complex research strategy, a case study may entail multiple methods—interviews, observations, document analysis, even surveys” (Marshall and Rossman 1999, 61), within the larger, overall research plan. This can ultimately be quite time consuming and may not be a viable option for some researchers depending upon their individual situation. Also, case studies lack the same level of intimacy that is present in other forms of research such as personal observation. These challenges can be overcome, but they are challenges nonetheless. The case study researcher has to be particularly careful not to allow “biased views to influence the direction of their findings and conclusions” (Yin 2003, 10) and to allow enough time to gather enough data to base one’s recommendations and conclusions on.

Reliability

Reliability is a principle component of case study research and it simply means a way “to maintain a chain of evidence” (Yin 2003, 105). The idea “is to allow an external observer—in this situation, the reader of the case study—to follow the derivation of any evidence, ranging from initial research questions to ultimate case study conclusions. Moreover this external observer should be able to trace the steps in either direction (from conclusions back to initial research questions or from questions to conclusions)” (Yin 2003, 105). In this way, reliability is a result of treating “research as if someone were always looking over your shoulder” (Yin 2003, 38). Reliability is brought about by thoroughly documenting the steps taken as part of one’s research. The intent of this documentation is for the researcher or someone else to be able to do “the same case study over again” (Yin 2003, 37) in the future, if they so choose, and to end up with the same results. “The goal of reliability is to minimize the errors and biases in a study” (Yin 2003, 37). Case study protocol “is a major way of increasing the reliability of case study research and is intended to guide the investigator in carrying out the data collection from a single-case study” (Yin 2003, 67). Furthermore, the protocol can be broken down into four distinct sections: an overview of the
Within a case study, “the overview should cover the background information about the project, the substantive issues being investigated, and the relevant readings about the issues” (Yin 2003, 69). The overview for this case study includes the following:

- Researching the use of modular construction in an attempt to create better designed and higher quality housing that is affordable and able to be built.
- Overcoming the weaknesses and highlighting the strengths of case study research.
- Highlighting the literature review portion of this text.

Next, the field procedures include the research team made up of the principal investigator along with co-major professors who will oversee the research being carried out. Also, much of the information will come from the literature that was reviewed and discussed in Chapter 2 as well as a series of one-on-one interviews conducted by the principal investigator. The Office for Responsible Research at Iowa State University governs the processes and procedures for research involving human subjects, such as in the one-on-one interviews, through the Institutional Review Board (IRB). The IRB has strict guidelines that must be followed in order to preserve the honesty and integrity of one’s research. Additionally, the principal investigator has personally visited and documented various aspects of the communities included as part of this research. The case study questions from the “Overview” section of this paper have acted as a guide throughout the data collection. Planners, developers and modular home builders, as well as zoning ordinances and countless books and journals, were invaluable sources looked to when searching for answers to the aforementioned research questions. The so-called “guide for the case study report” is what makes up the bulk of this document. It includes the “Table of Contents”, which can be considered a pared down outline, the one-on-one interviews that are one form of data, images interspersed throughout the text and, finally, the “Reference List” of sources used during the course of this research. By following a protocol, the research stays “targeted on the subject of the case study” (Yin 2003, 69) and allows for the anticipation of problems (Yin 2003, 69) ahead of time, thus helping the researcher “to avoid disastrous outcomes in the long run” (Yin 2003, 69). In the end, reliability will “remove evaluation from some inherent
characteristic of the researcher (objectivity) and place it squarely on the data themselves” (Marshall and Rossman 1999, 194).

Validity

Validity “is seen as strength of qualitative research [because] it is used to determine whether the findings are accurate from the standpoint of the researcher, the participant, or the readers of an account” (Creswell and Miller 2000, 195-196). The data can be collected and then analyzed by a number of different strategies in order to test accuracy of the research conclusions. Some of the strategies used to do this are triangulation, rich, thick description, bias clarification and discrepant information (Creswell 2003, 196). In order to establish validity for this research, the concept of purposeful selection was used. This allowed for the selection of “participants or sites (or documents or visual material), that would best help the researcher understand the problem and the research questions” (Creswell 2003, 185) in relation to the central phenomenon. In this case, that central phenomenon deals with aspects associated with modular housing in a range of different communities. Within the broad realm of validity, there are four different sub-categories that may or may not apply to a given case study. The first three, construct validity, internal validity, and external validity, will be described in more detail in the text to follow. The fourth one, reliability, has previously been discussed. Of the three remaining, only two apply to this research, construct and external validity. Internal validity does not apply because this research is not “a causal (or explanatory) case study” (Yin 2003, 36), but rather an exploratory study.

To establish construct validity, an “especially problematic aspect of case study research,” (Yin 2003, 35) the researcher “must be sure to cover two steps:

1) Select the specific types of changes that are to be studied (and relate them to the original objectives of the study) and

2) Demonstrate that the selected measures of these changes do indeed reflect the specific types of change that have been selected” (Yin 2003, 35).

By using *multiple sources of evidence*, in a manner encouraging convergent lines of inquiry along with a *chain of evidence* (Yin 2003, 97-98), one can greatly increase the construct
validity of a case study. For example, the individual city’s codes and ordinances can be another crucial piece of the documentation used to increase validity during this study. External validity “deals with the problem of knowing whether a study’s findings are generalizable beyond the immediate case study” (Yin 2003, 37). It is critical to point out that “case studies (as with experiments) rely on analytical generalization. In analytical generalization, the investigator is striving to generalize a particular set of results to some broader theory” (Yin 2003, 37). For this research, the generalization is that well designed, affordable modular housing may be a viable option for cities looking to expand the range of housing stock available to their residents.

Data Collection

A well thought out plan along with a set of requisite skills will make research go much more trouble free for a case study. The complexity of case studies requires a thorough understanding of data collection. For this study, a literature review, direct observation, one-on-one interviews, and specific pieces of documentation (e.g. city codes, zoning ordinances and photographs) will all be used as multiple sources of evidence. From these sources, triangulation of the collected data will be a key step following data collection. By using these aforementioned sources together, the results are “more convincing and accurate” (Yin 2003, 98) and help to validate what a singular source of data could not justify on its own.

Documents Reviewed

As described in an earlier section of this text, strength of case studies is the flexibility the researcher has to use multiple avenues for collecting data. By drawing on a wider array of sources, the researcher can “address a broader range of historical, attitudinal, and behavioral issues” (Yin 2003, 98) with the ultimate result being to conclude one’s research with factual and unbiased findings that are able to be backed up. The strength of documents as a form of data collection is their “stable, unobtrusive, exact and broad coverage” (Yin 2003, 86). Several weaknesses are also inherent to data collection from documents. They include
“retrievability, biased selectivity, reporting bias, and access” (Yin 2003, 86). Another caution when using documents is being careful regarding the source from which one collects the data.

The codes and ordinances for the respective cities chosen to be part of this research will provide the opportunity to clarify what is allowed to be built and how codes may restrict where one can build, along with other regulations pertaining to factory built housing not only within the individual communities, but when comparing the cities to one another. The city’s codes themselves are not the only form of regulation a potential homeowner will have to contend with. Design guidelines and standards are also a part of many cities’ regulations and permitting processes. Where appropriate, these additional regulations will be consulted and discussed. The International Residential Code was also consulted as a reference tool for certain definitions while the research was being carried out. Planning and zoning and/or city council meeting notes are another potential source of information, too. Additional resources will be included as necessary if they are pertinent to the subject matter.

**Interviews**

Interviews are a crucial form of data collection within case study research. The strength of interviews is their targeted, insightful nature that comes across as a “guided conversation rather than a structured query” (Yin 2003, 89). Case study interviews are typically “of an open-ended nature, in which one can ask key respondents about the facts of a matter as well as their opinions about events” (Yin 2003, 90) or specific phenomenon. As with documents, interviews also have their drawbacks. These include “bias due to poorly constructed questions, response bias, inaccuracies due to poor recall and reflexivity” (Yin 2003, 86). Keeping anonymity in mind, the respondents’ identities have been kept confidential in order to comply with the Iowa State University Institutional Review Board’s requirements. All of the interviews were conducted in an unstructured manner via telephone conversations. Some of the preliminary selected interview candidates had to be substituted with alternates because of the difficulty in contacting or even locating several of the originally proposed choices. For the one-on-one interviews, eight different individuals were
interviewed based on their first hand knowledge or expertise on the subject of designing and zoning for factory built housing. Those eight included one developer, three city planners, one city administrator, two modular home manufacturers and one wall panel manufacturer. The interviews were conducted in February and March of 2011.

In some instances, the interview questions were specific to a particular project or city while other questions were more general. By using a variety of open-ended questions, the interviews allowed the opportunity for a dialogue to develop between the investigator and the respondent. The nature of the questions was aimed at gaining a deeper understanding of the differences between manufactured and modular housing. Specific questions were included about how various jurisdictions treat the two different styles of factory built housing in regard to the approval process, zoning, any possible restrictions, and so forth. One of the communities researched has several unique developments within its boundaries, and a series of questions were asked in order to better understand what factors have driven that. Multiple questions were asked that will help educate one on the overall process of building a modular home, from financing to construction and all the other necessary steps in the process. Also, the degree of customization possible, or not, with modular housing was an important theme explored in some of the questions. A complete list of the interview questions is listed in Appendix B.

**Conclusion**

Architects and planners are engaged in protecting the health, safety and welfare of the public through their respective professions so this research is of particular importance to them. Without the proper supplies, one cannot expect a successful outcome to an endeavor. Choosing the proper research method will, at the very least, help guide one in the proper direction prior to beginning a study. Case studies work well for asking mostly “how” and “why” questions and two of the key research questions identified earlier in Chapter 1 seek to answer how and why questions; do zoning codes restrict or prohibit modular houses from their communities and, if so, why do zoning codes restrict or prohibit modular houses? Therefore, a mixed method research design using a series of exploratory case studies was
used as the method of investigation to carry out this portion of the research. A description of what a case study is along with its strengths, weaknesses, and techniques to overcome those were given. Data collection for this study included a literature review, direct observation, and one-on-one interviews to be used as multiple sources of evidence for triangulating the data. The methodology discussed in Chapter 3 leads one directly into Chapter 4 where the results of the data collection are presented.
CHAPTER 4: RESULTS

Introduction

Four cases or communities located in the Twin Cities metropolitan area of Minnesota were examined as the unit of analysis for this study. Ranked from smallest to largest, the communities include:

<table>
<thead>
<tr>
<th>City</th>
<th>State</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cologne</td>
<td>MN</td>
<td>1,012</td>
</tr>
<tr>
<td>Chaska</td>
<td>MN</td>
<td>17,449</td>
</tr>
<tr>
<td>Minnetonka</td>
<td>MN</td>
<td>51,301</td>
</tr>
<tr>
<td>Minneapolis</td>
<td>MN</td>
<td>382,618</td>
</tr>
</tbody>
</table>

Source: U.S. Census Bureau 2011b

The rationale for selecting multiple cases was in an effort to look for patterns and/or inconsistencies in how the individual communities treat the same issue, in this case modular housing, when compared to one another. To start with, Chaska was purposely selected because it is home to the Clover Ridge neighborhood, a development where approximately 25-30% of the homes were built using modular construction techniques. This unique development offered the opportunity to research the other three communities, all located within close geographic proximity to Chaska, and to look for similarities and differences in how they define, zone for, allow or disallow modular housing in their respective communities as compared to Chaska. Additionally, the communities represent a broad spectrum, spanning the range from a dense, urban environment to a rural area located on the fringes of where explosive growth has recently been taking place. Ranging in size from very small to extremely large resulted in a good representation of a typical American metropolitan area that is experiencing growth from its outer fringe, through its suburban areas, all the way to the inner core of the city. This allowed the chance to explore whether or not a community’s size has any bearing on how modular housing is treated.
With a population of just over 1,000 residents, Cologne is the smallest of the four cities used for this study, yet it sits on the fringe of where explosive growth has been taking place. Founded in 1881 and characterized as “a great place to live, work and play” (City of Cologne 2011a), Cologne offers residents a fitness center with 24 hour/7 day a week access, a new K-8 charter school, many parks and trails all in a laid back, small town atmosphere. Offering easy access from the St. Paul/Minneapolis metropolitan area via US Highway 212, the city finds itself poised for growth once the current economic downturn has passed.

Chaska is the second of the four cities on the list. Chaska’s claim to being “a quality small town” (City of Chaska 2011b), is reiterated in one of the City’s five core strategies, “maintain a sense of community and small town values” (City of Chaska 2011c). Located on the banks of the Minnesota River, Chaska was founded in 1852 and was well known for brick making in its early days as a city. Like Cologne, Chaska also sits along US Highway 212, and the city has already experienced considerable growth over the last several decades. Named to Money Magazine’s annual list of Best Places to Live in 2007 (Money Magazine 2011), Chaska was ranked number eight out of the one hundred cities that made the list.

Minnetonka is a large suburb located to the west of Minneapolis. The third of four cities chosen for this study, Minnetonka became an official village in 1956. It wasn’t until 1968 that Minnetonka became a city. The City grew as a manufacturing hub in its early years, due in part to its location on Minnehaha Creek, which provided a source for water-generated power. Today, Minnetonka has grown to just over 50,000 residents within its twenty eight square miles. As a densely populated urban area, housing has undoubtedly been one aspect of Minnetonka that has changed drastically from the humble beginnings the City experienced, first as a township, then as a village, and ultimately garnering the title of City. Also, the geographic proximity of Minnetonka to the lake of the same name, Lake Minnetonka, and the easy access to downtown Minneapolis via Interstate 394, make the City a desirable location for homeowners who want to be close to work and play.

Minneapolis is the final, and largest, of the four communities chosen for this study. Minneapolis grew largely in part to its location on the banks of the Mississippi River. With direct access to the mighty Mississippi for shipping, and the hydro-electric power resulting from its ever present current, commerce and industry flourished in the City’s early days. This
was particularly the case in the flour milling industry which sprang up along the river’s banks. Deemed the “City of Lakes,” Minneapolis is well known for its expansive parks and trail system. Boasting of over 180 parks and nearly 50 miles of paved trails, residents have an amazing collection of outdoor recreational opportunities available considering the urban environment of its locale. As in most cities of this size, Minneapolis has to deal with a vast array of housing issues, from blight to urban renewal as well as new development.

Figure 4.1 is a map showing the location of each of the communities and their relationship not only to one another, but to the whole Twin Cities metropolitan region.
Data Analysis

In this research, triangulation or, more specifically data triangulation, is used because it “encourages one to collect information from multiple sources with the aim of corroborating the same fact or phenomenon” (Yin 2003, 99). The pitfalls of construct validity can be taken care of “because the multiple sources of evidence used for data triangulation essentially provide multiple measures of the same phenomenon” (Yin 2003, 99) and, therefore, a better result to one’s research. The data triangulation was first done within the individual communities, and secondly to all four of the communities by way of a cross case comparison using the documents reviewed, responses to the interviews, and portions of the literature review. By using multiple cases, in this case the four communities, a similarity and consistency in how each jurisdiction treats modular housing began to emerge.

Cologne

The interview process, a review of the City’s Code of Ordinances, as well as a visit to a single family housing development that was under construction in early 2007, provided valuable insight into the type of development that is allowed and has been happening in recent times within the community. Today, the average cost for a single family home in Cologne is approximately $160K (Interview March 3, 2011). Through direct observation from the site visit, it was confirmed that the single family homes under construction at that time were being built using traditional stick framing on site.

As outlined previously, factory built housing can be broken into two broad, but separate, categories: manufactured and modular. Cologne’s Code of Ordinances contains a definition for one, but not the other. The definition for manufactured home from “Title XV: Land Usage. Chapter 153: Zoning Code. General Provisions. 153.003 Definitions” of the ordinance:

Manufactured Home: A structure, transportable in one or more sections, which in the traveling mode, is eight body feet or

---

1 All interviews were conducted with strict confidentiality, and the names of interviewees are withheld per Iowa State University’s Office for Responsible Research regulations involving human subjects.
more in width or 40 body feet or more in length, or when erected on site, is 320 or more square feet, and which is built on a permanent chassis and designed to be used as a dwelling with or without a permanent foundation when connected to the required utilities, and includes the plumbing, heating, air conditioning, and electrical systems contained therein; except that the term includes any structure which meets all the requirements and with respect to which the manufacturer voluntarily files a certification required by the secretary and complies with the standards established under this chapter (City of Cologne 2011b).

Historically, modular construction hasn’t been a popular method of home building in Cologne and, consequently, there are no housing developments within the City that have been built using that method of construction (Interview March 3, 2011). Therefore, a modular housing boom isn’t an issue that Cologne has had to deal with yet. A review of Cologne’s Code of Ordinances revealed that there is no definition for modular housing or modular construction. According to the City’s Code and reiterated during the interview process, modular homes are not specifically restricted as to where they can be built in Cologne based solely on the type of construction (City of Cologne 2011c and Interview March 3, 2011). This does not mean that modular construction is unregulated in Cologne, it is simply handled differently. A modular home would still have to meet all of the same codes that a stick built home would. The approval and permitting process for a modular home would be much the same as that for a stick built home, with some possible exceptions. Most notably, the City’s building inspector may need to go to the manufacturing facility where the modules are being assembled in order to do an on-site code inspection. However, this would only be necessary if the factory wasn’t using independent, third party inspectors already and wasn’t certified as such to do so (Interview March 3, 2011).

If the need shall arise, the City handles modular construction by referring to a section of their code that deals with single family dwellings, under which a home using modular construction techniques would fall. The specific definition from “Title XV: Land Usage. Chapter 153: Zoning Code. General Provisions. 153.009 Single-Family Dwelling Requirements” of the ordinance is as follows:
Single Family Dwelling Requirements: All single-family detached dwellings shall be constructed according to the following minimum standards:

(A) All dwellings shall have a minimum width of 24 feet.
(B) All dwellings shall have a permanent frost-free foundation as defined in the State Building Code. Split level, split entry and earth sheltered homes shall be considered to comply with this requirement.
(C) Main roofs shall have a minimum pitch of 3:12 per definition of the applicable building code.
(D) Roofs shall be shingled with asphalt, wood, tiles, sod or other comparable materials as approved by the applicable building code.
(E) Metal siding, with exposed panels exceeding 16 inches in width, shall not be permitted (Cologne 2011c).

Interesting to point out, sustainable design and construction techniques have apparently made their way into the codes of even small towns such as Cologne. As a sign that this is important to the community, “sod” is listed as an acceptable roofing material under section “D” of the requirements. With no modular homes having been built in Cologne, one can only speculate as to whether or not this form of construction will become popular in the future and if it would be readily accepted within the City. As Cologne continues to grow, this may change depending upon not only home builder’s, but also homeowner’s, desires at that point in time.

Chaska

Several interviews, a review of the City’s Ordinances as well as other documentation, and a visit to the Clover Ridge development in May of 2007 afforded the opportunity to see how all of these elements can come together and create a unique development using alternative zoning and construction techniques. As mentioned earlier, Chaska was voted number eight out of one hundred on Money Magazine’s annual list of Best Places to Live for 2007. One key factor for this distinction was cited as the City’s average cost of housing which was $272,932 (Money Magazine 2011).

Chaska has a City Ordinance that includes a Zoning Ordinance within it. There is some overlap of definitions between the two, although the specific wording is slightly different for the definition of a manufactured home. In reviewing the City of Chaska’s
Zoning Ordinance, one observes that the City addresses factory built housing within a portion of the Ordinance. The following definitions come from “Section 15: Definitions” of the Ordinance:

Manufactured Home: “Manufactured home” means a structure, transportable in one or more sections, which in the traveling mode, is eight (8) body feet or more in width, or 40 body feet or more in length, or, when erected on site, is 320 or more square feet, and which is built on a permanent chassis and designed to be used as a dwelling with or without a permanent foundation when connected to the required utilities, and includes the plumbing, heating, air conditioning, and electrical systems contained therein; except that the term includes any structure which meets all the requirements and with respect to which the manufacturer voluntarily files a certification required by the State of Minnesota (City of Chaska 2011e).

Modular Construction: Completely fabricated or assembled and self-contained units for residential, office or other occupancy, set or installed individually or in clusters on tracts of land, or erected as related or self-contained elements of larger structures (City of Chaska 2011e).

Additionally, the following definitions come from “Chapter 13: Manufactured Homes and Manufactured Home Parks, Article II. Manufactured Home Parks. Division 1. Generally, Section 15. Definitions” of the City Ordinance:

Manufactured home: “Manufactured home” means a structure, transportable in one or more sections, which in traveling mode is eight (8) body feet or more in width or forty (40) body feet or more in length, or, when erected on site, is three hundred twenty (320) or more square feet, and which is built on a permanent chassis and designed to be used as a dwelling with or without a permanent foundation when connected to the required utilities, and includes the plumbing, heating, air conditioning, and electrical systems contained therein; except that the term includes any structure which meets all the requirements and with respect to which the manufacturer voluntarily files a certification required by the secretary and complies with the standards established under Minnesota Statutes, Chapter 327 (City of Chaska 2011a).

Mobile Home: “Mobile home” is synonymous with manufactured home whenever it appears in parts 1350.0100 to 1350.6900 and in other documents or on construction or
installation seals. It is a structure having three hundred twenty (320) square feet or more of floor space which is so constructed as to provide facilities for person or persons to eat and sleep, has provisions for connecting to central utility system when ready for occupancy, the principal structure having a width of eight (8) feet or having no foundation other than wheels or removable jacks. Except that the principal structure may be greater than fourteen (14) feet (City of Chaska 2011a).

Chaska is home to several unique developments, including the Jonathon Neighborhood and Clover Ridge, within its city limits. The City has tried to make these developments a combination of the existing community character while, at the same time, incorporating affordable housing into them as well (Interview March 11, 2011). After reviewing the codes and conducting interviews, it was discovered that Chaska also treats modular housing like stick built housing (City of Chaska 2011e and Interview March 11, 2011), resulting in no different restrictions on where stick built homes and modular homes can be built in Chaska. Modular homes have to comply with the same codes, such as the International Residential Code (IRC) 2006, that any other new single family dwelling would have to meet (Interview March 11, 2011).

The underlying goals of creating a pedestrian friendly neighborhood, with a strong sense of place, while offering more affordable housing options for residents were the catalyst to a proposed new development to be located on 255 acres of farmland near Chaska’s western edge (Interview February 21, 2011 and Interview March 11, 2011). Started in 2002, that development was Clover Ridge, and it is the first traditional neighborhood development (TND) in the United States that was built with modular housing (Steuteville 2004, 7). Roughly one hundred and twenty-five homes, approximately 25-30% of the total homes, in the Clover Ridge development were built with modular construction techniques (Interview February 21, 2011).

In a unique development such as Clover Ridge, one would expect there to be some potential hurdles to overcome in getting approval for the project, be it from the City itself or from residents in neighborhoods adjacent to the project’s location. Surprisingly, at the planning level, the approval process for Clover Ridge wasn’t really controversial because there wasn’t an opportunity for residents to say they liked or disliked the development plan
The process was handled much like other developments in Chaska. Clover Ridge was done as a Planned Unit Development (PUD), but this is now the typical planning model that the City uses for new large scale developments. Using the PUD model in lieu of a singular development standard allows for greater flexibility and uniqueness within Chaska’s individual developments (Interview March 11, 2011). An example of this put into practice is directly observed when one visits the development and sees how small the front yard setbacks are in some areas of Clover Ridge, especially when compared to a typical suburban neighborhood with much deeper front yard setback requirements. Figure 4.2 shows a streetscape from one of the single family neighborhoods in Clover Ridge and how the homes have a much more intimate connection to the street due to the decreased setback. The alley-loaded homes have reduced side yard setbacks as well, and the neighborhood has a refreshing look and feel reminiscent of a bygone era.

The reduced setbacks might lead one to the assumption that the development has significantly higher density levels than the surrounding neighborhoods. Oftentimes, proposing higher densities comes with the price of major difficulty when obtaining approval for a new project. Many people equate higher density with increased traffic. Because it was done as a PUD, Clover Ridge allowed for a wide range of housing styles and lot sizes to be accommodated within the whole of the development. The overall density of the development is equal to approximately 3 dwelling units (d/u) per acre. There are areas within the development that are much higher than 3 d/u per acre because of the TND model, but it isn’t just about the density number for those blocks. It depends how you measure the density. For
example, many of the homes in Clover Ridge have small backyards and alley loaded garages. This allows for much more common space (parks, paths, etc.) to be dispersed throughout the development as well as for the preservation of the landscape for all residents to enjoy. That’s why, when you calculate the overall density for the whole development, it is equal to the density of the surrounding neighborhoods and wasn’t a concern to those residents (Interview March 11, 2011).

Minnetonka

By conducting an interview and reviewing Minnetonka’s Code of Ordinances, a snapshot of how the community addresses factory built housing was obtained. Minnetonka’s Code of Ordinances contains a definition for a manufactured home. Here is the definition from “Chapter 3: Zoning Regulations. Section 300.02. Number 91. Definitions” of the ordinance:

Manufactured or mobile home: A structure, transportable in one or more sections, that is built on a permanent chassis and is designed for use with or without a permanent foundation when attached to the required utilities. The term does not include a recreational vehicle (City of Minnetonka 2011a).

Modular housing is also not common in Minnetonka. In fact, there haven’t been any modular homes constructed in more than five years within the City (Interview February 25, 2011). Again, modular construction or modular home is not defined as part of Minnetonka’s Code of Ordinances. The City makes no differentiation between a modular home and a stick built home, so there isn’t specifically anything that would preclude either type of construction over the other (City of Minnetonka 2011b and Interview February 25, 2011). This fact was substantiated by a code review and an interview. However, the City’s code does have language that may or may not affect constructing a modular home. Under “Chapter 3: Zoning Regulations. Section 300.10. R-1 Low Density Residential District, Number 6, Additional Requirements,” there is language that would apply to constructing a modular home within the City. Here is the specific language from that portion of the Code:

a) All dwellings, including manufactured homes, shall have a depth of at least 20 feet for at least 50 percent of their width.
All dwellings, including manufactured homes, shall have a width of at least 20 feet for at least 50 percent of their depth.

b) All dwellings shall have a permanent foundation in conformance with the Minnesota state building code (City of Minnetonka 2011b).

As one can see, these requirements don’t necessarily restrict modular construction any more than stick built construction, but they certainly could have implications on either one depending upon a home’s particular design.

The approval process for a modular home would be no different, as far as planning and zoning is concerned, as long as the home meets applicable codes (Interview February 25, 2011). As a requirement for pulling a building permit, the City’s building inspector would need a full set of house plans to review. This requirement is not unique to modular construction. It is required for a stick built home as well (Interview February 25, 2011).

**Minneapolis**

A review of the City’s Code of Ordinances, an interview and the use of direct observation from a visit to a newly set modular home, seen here in Figure 4.3, in the spring of 2006, provided an idea of how Minneapolis regulates factory built housing within their community. The current average cost for a single family home in Minneapolis is unknown (Interview March 2, 2011). From the site visit, it was learned that a modular home can be set on a small urban lot without disrupting the flow of the neighborhood to an unacceptable level.

The City doesn’t specifically define either a manufactured or modular home as a part of its Code of Ordinances. However, the City’s code does define a manufactured home park, and from that definition, leads one to a Minnesota Statute
which defines a manufactured home. Here is the definition from “Title 20 – Zoning Code.
Chapter 520. – Introductory Provisions. 520.160. – Definitions.” of the City’s ordinance:

Manufactured Home Park: A development of two (2) or more manufactured homes as defined in Minnesota Statutes Chapter 327 (City of Minneapolis Code of Ordinances 2011).

Turning to the Minnesota Statute referred to in the City’s ordinance (Chapter 327), one finds a definition for manufactured home. The definition, from “The 2010 Minnesota Statutes. Chapter 327.31. Definitions. Subd. 6,” is as follows:

Manufactured Home: ‘Manufactured home’ means a structure, transportable in one or more sections, which in the traveling mode, is eight body feet or more in width or 40 body feet or more in length, or, when erected on site, is 320 or more square feet, and which is built on a permanent chassis and designed to be used as a dwelling with or without a permanent foundation when connected to the required utilities, and includes the plumbing, heating, air conditioning, and electrical systems contained therein; except that the term includes any structure which meets all the requirements and with respect to which the manufacturer voluntarily files a certification required by the secretary and complies with the standards established under this chapter (Minnesota Office of the Revisor of Statutes 2011).

Aside from the example shown in Figure 4.3 and mentioned in the preceding text, the use of modular construction has a very limited presence in the City of Minneapolis. In fact, this was confirmed in talking with the City representative who had no knowledge of any modular homes or projects within Minneapolis (Interview March 2, 2011). Even though this form of construction isn’t formally defined, Minneapolis doesn’t require anything special for the construction of a modular home. They must meet the same codes that a traditional stick built home must meet (City of Minneapolis 2010, 1 and Interview March 2, 2011).

Again, the process for building a modular home would be the same as that for a stick built home. The first step in the approval process for either type of home would be to fill out and submit an “Administrative Site Plan Review For Single- And Two-Family Dwellings And Multiple-Family Dwellings Having Three (3) or (4) Dwelling Units” application along with the necessary fee to the Planning Division of the City (Interview March 2, 2011).

Site plan review standards are established to promote development that is compatible with nearby properties, neighborhood character, natural features and plans adopted by
the city council, to minimize pedestrian and vehicular conflict, to reinforce public spaces, to promote public safety, and to visually enhance development while recognizing the unique character of land and development throughout the city and the need for flexibility in site plan review (City of Minneapolis 2010, 1).

Those standards include a requirement to obtain a minimum of fifteen (15) points from a list of items that vary in range from one (1) to five (5) points in value. Examples of some of the standards and their associated point values include one (1) point if “the structure includes an open, covered front porch of at least seventy (70) square feet that is not enclosed with windows, screens, or walls, provided there is at least one existing open front porch within one hundred (100) feet of the site” and five (5) points if “the structure includes a basement as defined by the building code” (City of Minneapolis 2010, 1 and Interview March 2, 2011).

Cross Case Comparison

Each one of the cities defines what a manufactured home is in some fashion within their codes or ordinances, be it directly or indirectly like in Minneapolis. The language of the codes from Cologne, Chaska, and Minneapolis, via Minnesota Statutes Chapter 327, are nearly identical. As a part of that, the City Ordinance and Zoning Ordinance from Chaska, which both define the term manufactured home, contain roughly the same basic language as well. Minnetonka’s ordinance differs slightly from the other three communities in that it contains a much shorter definition for a manufactured home. Regardless of the specific language within the respective codes, the basic premise behind the regulations remains true and consistent in all four of the communities. They all define a manufactured home as a structure attached to a permanent chassis. This is a distinguishing characteristic of a manufactured home and has much to do with the reason the term trailer house conjures up such negative connotations in communities across the United States.

On the surface, the fact that several of the communities, Cologne, Minnetonka and Minneapolis, do not have a formal definition for modular construction in their respective codes is a bit surprising. This could be due to a number of factors. Without a strong interest in this style of construction, there really is no good reason for a city to devote resources to
defining and regulating modular homes anymore than is already covered by an ordinance or code that deals with single family dwellings. As such, these three communities deal with the relatively rare application that comes in for a modular home building permit just as though it is a stick framed, site built home.

Unlike the other three communities, Chaska is unique in that it does formally define modular construction in its zoning ordinance. Understandably, Chaska is the one community out of the four that has a fairly substantial supply of homes that were built with modular construction techniques. Even so, the specific language contained within the definition is relatively generic in terms of what it states. It really just describes the physical characteristics, “completely fabricated or assembled and self-contained units...” (City of Chaska 2011e), of the assembly and does not spell out restrictions or other regulatory language that would prohibit one from building a modular home in the same place where a stick framed home could be built (City of Chaska 2011e and Interview March 11, 2011).

The common thread among all four communities is that modular homes are treated just like traditional, stick framed homes when it comes to regulating their construction. As stated previously, some of the communities have different requirements for what is necessary when obtaining a building permit, (e.g. Cologne’s building inspector possibly having to visit the manufacturing facility), but, beyond that, they don’t restrict where one can build a modular home in their community any differently than that of a stick framed home. Also, the approval process is no different for a modular home than a stick framed home in all of the communities. Code/ordinance wise and procedurally, a modular home is treated the same as a traditional, stick framed home that is built on the site.

Conclusion

Four communities located in the Twin Cities metropolitan area of Minnesota were used as case studies (i.e. unit of analysis) for this research. The communities range in size from very small, Cologne, to extremely large, Minneapolis, and one of the communities, Chaska, has a unique development where roughly 25-30% of the homes were built using modular construction techniques. A brief history on each of the four communities along with
a map showing their location and geographic relationship to one another was presented as well. Most notable from this, Chaska owns the distinguished honor of being named to Money Magazine’s 2007 annual list of “Best Places to Live” where it ranked number eight out of the one hundred cities on the list. Data was triangulated within the communities individually and then collectively through a cross case comparison using the various documents, responses to the interviews, and portions of the literature review. Each one of the four cities ultimately defines a manufactured home as a structure attached to a permanent chassis, in short. Chaska is the only community that has a formal definition pertaining to modular construction. Moreover, modular homes are treated the same as their stick built counterparts within all of the communities. The conclusions and recommendations for the study are presented in the next section of text, Chapter 5.
CHAPTER 5: CONCLUSIONS & RECOMMENDATIONS

Summary of What Learned

Factory built housing has gone through some dramatic changes over time. From the earliest kit homes, to technological experiments that never made it to production, like Buckminster Fuller’s Dymaxion House, into the vast array of options currently available to home buyers, the industry still holds a fairly minute share of the total number of houses built. Modular homes, which offer a substantial palette of materials and styles to choose from, are still the exception rather than the rule. As seen in the four communities that were an integral part of this research, factory built housing, and more specifically, modular housing, accounts for a relatively small number of new homes that are actually being constructed. In 2010, factory built housing, including manufactured, modular, panel and pre-cut systems, had a combined total of 74,000 homes completed and/or shipped as compared to 473,000 site built homes (U.S. Census Bureau 2011a, 1 and U.S. Department of Commerce 2011, 113). Other than the Clover Ridge development in Chaska, modular home construction was nearly non-existent in Cologne, Minnetonka and Minneapolis.

Zoning codes do not restrict or prohibit modular houses based upon the way they are constructed. Modular homes are treated the same as stick built homes in regard to the permitting and approval processes, and they are nearly indistinguishable from a site built home upon completion. Yet still, as recent as 2007, the percentage of factory built homes being constructed in the United States was less than ten percent (Kaufmann 2007a, 3). However, a large problem that has plagued the industry for years still exists today. Despite the technological advances and cost benefits, the stigmas associated with factory built housing from years past undoubtedly keep some home buyers from giving any consideration to its viability for housing their family. This can be somewhat attributed to the lack of education the public receives as to its benefits (and also that manufactured homes and modular homes are significantly different from one another in terms of quality and construction). Factors such as the homes being better built, being built inside in a climate controlled environment, the quickness of construction, the repetition of assembly line
construction by skilled workers, and being built to the International Residential Code (IRC) are all plusses associated with modular construction that potential home buyers need to be made aware of. Another side benefit of modular home building that often gets overlooked is the reduction in construction waste ultimately ending up in a landfill during the construction process. The lack of waste is especially pertinent in helping to drive down the cost of factory built housing.

As with most everything in the world today, technology changes at an astounding rate, one that can be nearly incomprehensible at times. Technological advances have allowed factory built housing to expand into areas and sites where these types of homes previously could not be constructed. Hinged roof systems, self contained kitchen and plumbing units, and many other innovations have all changed the way factory built housing has developed over time. There are new products and materials coming out almost daily that are already having an impact on the factory built housing industry.

Modular homes are financed by banks and other financial institutions just like a stick built home. There are no problems associated with obtaining financing for a modular home. Costs depend tremendously on the area where the home is being built, proximity to the manufacturing facility and how customized the home buyers want to make their new home. Once constructed, the cost of owning and living in a modular home is often less than that of a stick built home because of the high degree of energy efficiency designed into the homes.

**Significance of Results**

Ironically, one constant in factory built housing is that things will inevitably change. There is a huge potential for the industry to gain market share and wider acceptance from the public, but it will take time and perseverance to do so. The perception of factory built housing and the stereotypes that have been around since the first trailer houses hit the market all those years ago are still problems for the industry. The long held perception that factory built housing equates to sub-standard housing has to be overcome. The differences between manufactured and modular housing are simply not apparent to the masses. Even architects and planners oftentimes lack a depth of knowledge regarding these types of homes.
Modular homes aren’t unduly restricted as to where they can be built, so this can’t be cited as a cause for why more of this type of housing isn’t being built. Financing is more difficult to obtain today, but this isn’t due to the homes’ construction methods. It is more a reflection of the current United States economy and how that has had devastating effects on, not just the factory built housing industry, but the housing industry as a whole. As energy costs rise, home buyers will look to more energy efficient options to house their families. Factory built housing has the ability to fill that market with a high quality, well built home. In the case of modular construction, one must be certain to compare equal criteria when judging the ‘cost’ of a new home. Even though the actual bottom line dollar amount one pays for a modular house might be roughly the same as that of a comparable stick built home, the quality of the home and the shortened construction timeline increase the overall value the home buyer receives.

Relevance to Architects

Many architects today are not well educated in understanding how modular homes are built. There is a learning curve with using modular construction, and there are some things that one city realized, after the fact, which would need to be addressed by the architect up front on any future projects that propose to use modular construction techniques. Potential single family home buyers want and expect a higher level of customization than twin-home buyers or people looking to rent an apartment. As soon as you separate the walls (i.e. a single family home versus a twin home), people’s expectation for how much freedom they have to customize the home goes up dramatically (Interview March 11, 2011). Even small tasks like hanging a family photo on the wall can become difficult if the materials used for the finishes don’t easily allow for it or don’t perform as expected, like the interior metal panels and magnets in the Lustron Steel Homes. On a larger scale, this also became a problem with the homes in Clover Ridge that were built using modular construction because home buyers were hesitant to accept the inflexibility of the modular design. Modular construction has many of its efficiencies grounded in the replication of processes on the assembly line. When a home buyer wants to customize a home by changing the structure (i.e. moving and/or deleting
walls, etc.), the efficiency afforded by the modular construction goes away and the price can go up considerably, making it roughly the same price or more than a site built home. In the case of Clover Ridge, getting the home buyer (i.e. the market) to accept the modular construction and its inherent drawbacks turned out to be a larger problem than was anticipated (Interview March 11, 2011).

Typically standard items such as stairs may or may not work the same in a modular home because of the way the modules are designed and assembled. This again gets at the potential inflexibility of the design and the need for architects to be educated about how to overcome these obstacles. This very phenomenon seems to still be the case today and, ironically, fits right in with these quotes from Chapter 2 which describe a similar scenario. The difficulty with early prefabrication that continues today is the inability of designers “to satisfactorily resolve the dilemma of how to make houses that could be both mass-producible and individualized” (Adamson and Arbunich 2002, 35). An inherent danger in this method of construction is the “greater tendency towards monotonous standardization in the completed house” (Gloag 1946, 5). Architects need to understand the importance of home buyers desperately wanting the ability to make their house a home by personalizing it on multiple levels and the challenges that presents to modular housing.

Aesthetics play a crucial role in how factory built housing is perceived. In order to increase its acceptance even more, architects need to make wise design decisions with their style and material choices. It is hard to say for sure what has caused the Lustron Steel Homes to become so endearing to their owners, but the almost cult-like following they have maintained has a lesson in it that architects could most certainly learn from.

Relevance to Planners

Planners can also learn from real world examples that can be observed to examine what worked and what didn’t. Modular construction can be a great option for small, urban infill lots where disturbance and disruption to the neighborhood is minimized because of the shorter overall construction timeline. Using modular construction can help minimize the theft of materials from a job site as well because a house can typically be closed in and secured on
the same day the modules are delivered to the site. Also, modular construction fits right in with the new urbanism trend of moving towards smaller, and more affordable, homes and away from the historical suburban development trends of large houses on big lots. Another important lesson for planners is the potential modular housing has to be used in the construction of multi-family homes, such as apartments and condos.

Independent of the cost of land, Clover Ridge homes ended up being roughly the same price as other similarly sized homes with comparable amenities in Chaska. The cost savings for Clover Ridge didn’t come from the modular housing itself, but rather from the use of the smaller lot sizes as part of the TND planning model. In some instances, modular homes achieve admirable results in terms of cost savings and affordability. In other cases, they end up being roughly the same price as a stick built home. By being open to alternative zoning practices, planners have the potential to incorporate a range of modular housing into new developments without sacrificing a sense of place or disregarding the existing fabric of their communities. Planners can use design decisions, like reducing setbacks or increasing density in certain areas, and alternative zoning to help reduce infrastructure costs, and ultimately overall costs, for new developments in their communities as well.

Relevance to Manufacturers

When considering a modular home, potential home buyers need to be told up front by the manufacturer about anything that could potentially add cost or delays in construction, such as third party inspections. Manufacturers also need to educate home buyers on the specific process of building a modular home. This includes the amount of planning that happens on the front end of a modular home building project and how that directly affects the bottom line. In essence, the planning stage is where the home buyer needs to fully understand how a change later on in construction can delay the project and increase the cost exponentially. By helping home buyers through this process, home buyers will end up with the home they wanted at a price that was initially agreed upon. The manufacturers need to explain the whole process to potential home buyers and how the up front decisions can help to limit cost overruns.
Also, factory built housing manufacturers need to focus some of their education efforts on professionals, such as architects and planners. During one of the interviews conducted as part of this study, a planner specifically mentioned the steep learning curve they had experienced in regard to fully understanding the construction process and limitations of modular housing and what that meant to potential home buyers (Interview March 11, 2011). Many manufacturers have engineers and designers, but not necessarily licensed architects, on their staff. By involving architects on the manufacturing side of factory built housing, design has the potential to increase the market share for those manufacturers willing to make that investment in their business. By partnering with industry organizations such as the Manufactured Housing Institute (MHI) and Modular Building Systems Association (MBSA), manufacturers could see the benefits a national organization could provide to the industry and related professionals versus limiting efforts to more of a regional or statewide basis.

Manufacturers have a unique opportunity to showcase their products to a larger market when they are part of a large scale, high profile project like the Clover Ridge development. Unfortunately, being involved in a well received and widely acclaimed project like that does not necessarily guarantee heightened or continued success in the future. The modular home builder, Norse Building Systems, who built the homes for Clover Ridge, went out of business when the project neared completion. This is most likely a result of the economic climate and overall decline in the housing market, rather than solely a reflection of the factory built housing industry as a whole.

Manufacturers of factory built housing need to attempt to change how they have set up their factories and manufacturing processes to be more conducive to a home buyer who wants to personalize and customize their home before it leaves the factory. Having that ability alone would certainly attract more potential home buyers to the factory built housing market, ultimately increasing the market share of single family homes that are built in a factory and placed on a site. Of the manufacturers spoken to, there was a vastly different range to how much customization is allowed or that can be done in an affordable manner by each of the respective factories.
A trend that may be somewhat responsible for home buyers being hesitant or unwilling to spend a little more or even the same amount of money necessary to get a quality home is that the nature of our highly mobile society these days results in a very different connotation of what ‘home’ means to individuals. Until attitudes shift back to placing more value on what constitutes ‘home,’ home owners will continue to treat their homes more as a commodity that is to be bought and sold rather than a dwelling place for their most cherished memories. Discussed earlier in this text, Kurokawa described this very phenomenon taking place in United States where we have become much more of a mobile society. That being the case, there could be an opportunity for factory built housing to tap into and capitalize on the shift to a mobile society. Much like Tim Pyne’s M-House that was shown and discussed previously, housing to fit that niche could be designed that has a look, features and finishes not normally found in a manufactured home, along with the mobility afforded by that style of housing.

The expectations for being able to customize and personalize one’s home, beyond things like paint colors and furniture layouts, decreases in attached housing (i.e. apartments and condos). Because of the drawbacks mentioned earlier with single family home buyers expectation for being able to individualize and customize, I recommend architects and planners explore modular construction as a potentially viable option when building multi-family housing, such as apartments and condos, rather than solely single family homes that will be placed on individual lots. Also, modular construction has the ability to react much quicker in an emergency situation than can traditional construction techniques.

An oft overlooked technological change is how homes are actually distributed to home buyers today. Much like Sears did with their catalog homes back in the early 1900’s, IKEA now sells their BokLok line of homes through their chain of retail stores in Europe. Through creative supply chain advances like these, there will be a requisite increase in the exposure the general public has to modular housing from advertising it in places that might be slightly different to what is considered traditional and normal, therefore, educating consumers on the many benefits of factory built housing.
Due to the nature of the assembly line techniques used for constructing modular housing, there is ever changing potential for new technology to affect that part of the equation as well. Sustainable design practices are more than likely going to play an increased role in factory built housing in the future. Completely assembled homes loaded with green features, like photo voltaic panels and grey water collection systems, may be the future of the industry.

The larger question remaining is where does the industry itself want to go? Rocio Romero may have summed this up best in a recent interview. When “asked how big she wanted her business to become, and how many prefabricated houses she would like to produce, without hesitation she immediately said ‘Oh, millions and millions, the more product you can push through, the better you can be’” (Goldberger 2005, 180-182). Nevertheless, the future of modular housing and the factory built housing industry will be interesting to watch.
APPENDIX A

CLOVER RIDGE NEIGHBORHOOD DESIGN GUIDELINES

Purpose & Intent

The purpose of these guidelines is to allow for the development of a compact, mixed-use, pedestrian-oriented residential neighborhood.

The intent is to increase the sense of community, increase pedestrian movements, minimize traffic congestion, decrease suburban sprawl, decrease infrastructure costs, increase affordable housing, and decrease environmental degradation.

Its provisions are adaptations of urban conventions, which predominated residential neighborhood development in the United States from colonial times until the 1940's and historically were based on the following design principles.

- Neighborhoods that have an identifiable center and edge.
- Neighborhoods where the most important and visible property is utilized by some public use (i.e., public buildings, parks, plazas, etc.).
- Neighborhoods whose size is limited by the distance from the edge to the center, generally a five to ten minute walk (¼ to ½ mile radius).
- Neighborhoods that consist of an integrated network of walkable streets.
- Neighborhoods that contain diversity in land uses, building types, building sizes, building prices, and styles of ownership.
- Neighborhoods whose name links it directly to the activity that is occurring at its center.
**Development Objectives**

Staff has identified several development objectives for the concept plan. These objectives are:

A. Provide 15-20 acres for the construction of a new elementary school at the center of the neighborhood.

B. Provide the school district a 15 to 20 acre site for the new elementary school utilizing park dedication requirements, that will include a “neighborhood park quality” outdoor playground complex as part of the school.

C. Commence construction of the new elementary school in the year 2000.

D. Directly link the new elementary school with Community Park.

E. Provide uses adjacent to the new elementary school site that would complement and enhance the focus of this area as this neighborhoods center (i.e., church, daycare, transit stop, neighborhood commercial, etc.).

F. Define the limits of the neighborhood by the greenbelt to the west, Pioneer Trail to the north, existing Victoria Drive to the east, and the future corporate office/industrial park to its south.

G. Develop the concept plan so that the neighborhood and its streets are pedestrian friendly (walkable).

H. Provide housing densities consistent with the 2020 Comprehensive Plan that are between three and five dwelling units per acre (gross density).

I. Provide housing that has a wide variety of styles, densities and price ranges for both renters and owners.

J. Provide an inspiring name for the neighborhood that directly links it to its major feature(s).

K. Provide space for the future Chaska-Victoria regional trail that will be built by the City, County, or Metropolitan Council.

L. Provide space for a municipal water tower within the neighborhood.

M. Encourage the inclusion of this development into the Jonathan Association.
N. Study the relationship of the neighborhoods interface with the corporate office/industrial park to its south.

General Design Statements

A. Relationship of House and Street
Historic communities, such as Chaska, have many enduring qualities, but one of the strongest is the spatial relationship formed by interplay of the residential homes and the public street. The relationship consists of three zones: the public zone (street, the boulevard and the sidewalk); the semi-public zone (front yard and front porch); and the private zone (house and backyard). These relationships are particularly strong in lower Chaska because its development occurred prior to the automobile era, when communities had a strong pedestrian scale to their developments. The stronger the interrelationship of these factors is, the more opportunities exist for a strong sense of community. The factors that make this interrelationship strong are:

- Residential streets that are designed first to accommodate pedestrian and then to allow for vehicles, making pedestrians feel safe in this space.
- Residential streets that allow for on street parking, which slows traffic on the street and provides a physical separation for the pedestrian adjacent to the road.
- Residential streets with boulevard trees planted close to the street to cool the street pavement and provide shadows on the street that helps to slow traffic.
- Residential streets with sidewalks that allow for neighbor-to-neighbor interaction.
- Homes built close to the street, which help reduce speed on the street and formalize the semi-public space.
- Provide homes the ability to accommodate front porches to delineate the semi-public and private edge and to extend the living space into the semi-public area to allow for neighbor-to-neighbor interaction. The provision of front porches on all single-family homes is highly encouraged. It is expected that at least twenty five percent (25%) of the single-family homes will be constructed with functional front porches.
B. Street Pattern & Transportation System

The streets will be designed to accommodate the needs of all modes of transportation. The neighborhood will consist of an interconnected network of walkable streets. The street pattern will be designed to afford as small of blocks as practical, thereby providing multiple routes, diffusing automobile traffic and shortening walking distances. This street pattern keeps local traffic off regional roads and through traffic off local streets. Neighborhood streets of varying types are designed to provide equitably for pedestrian comfort and automobile movement. Slowing the automobile and increasing pedestrian activity encourages the casual meetings that help form the bonds of community. The street design considerations that assist these making these casual meeting possible are:

- Provide narrow pavement widths to reduce vehicular speeds.
- Encourage on street parking.
- Reduce street radiiuses at intersection to slow traffic and accommodate pedestrians.
- Provide a ten-foot wide boulevard adjacent to the street.
- Provide for boulevard trees every 40 to 50 feet along each side of the street.
- Provide concrete sidewalks on both sides of public streets.
- Sufficient room will be allocated for the placement of a regional trail through the development.
- Design buildings such that their main entrance is onto a street or square.
- All streets physically terminate at other streets within the neighborhood and connect to existing and projected through streets outside the development.
- Streets are designed such that their long axis visually terminates with either open space vistas, specifically designed building facades, or gateways to the ensuing spaces. Streets that terminate across from single family homes are inappropriate.
- Build-to setback lines are established along all streets.
C. Mix of Land Uses and Diversity of Housing Types

The neighborhood will be designed to contain: a balanced mix of residences; civic uses; recreation; shops; and workplaces. The integration of multiple land uses will allow residents the opportunity to meet more of their daily needs through shorter and less frequent vehicular trips. The neighborhood will be designed to provide a variety of housing types, prices, and ownership styles. This includes single-family residential (detached and attached), duplex, town home, condominium, and apartment. The needs of varied age and income groups will be more easily accommodated with these varieties of housing choices. The neighborhood also contains a small commercial corner. It is the intent that this area be reserved for uses that would complement and enhance the focus of this area as a pedestrian-oriented neighborhood center (i.e., house of worship, daycare, transit stop, neighborhood commercial, etc.). It is anticipated that a formal square will be included in this center to serve as a gathering point for the shoppers/neighbors. Uses that are automobile dominated (i.e., drive-thru uses, etc.) will not be permitted in the center, nor will 24-hour businesses or those that generate high levels of lighting, noise or traffic when compared with adjacent residential development patterns.

D. Open Space

Formal, informal, public, and semi-public open spaces will be located throughout the neighborhood. The design of the neighborhood gives priority to open space. These spaces enhance community activity, identity, and civic pride. The neighborhood plan will create a hierarchy of useful open spaces: a formal square incorporated in the neighborhood commercial node, new elementary school with associated neighborhood park with playground, sidewalks on both sides of the two main public streets and off-street trails that promote walking and encourage informal meetings, semi-public green spaces, greenbelts and buffers.
E. Civic Buildings and Landmarks

Important civic buildings that are open to the public will be located on the most prominent site in the neighborhood. These uses can include schools, houses of worship, churches, libraries, community buildings, or museums, which will serve as focal points and landmarks for the community.

Single Family Standards and Provisions (Small Lot, Standard, and Large Lot)

A. Use
   1. Single Family Residences are permitted.
   2. An accessory building is permitted on each lot.
   3. A minimum of 30 percent of the neighborhood shall be designated for small or standard lot sizes (52 feet or less in width). It is intended that the lots that comprise said 30 percent shall be affordable with an initial sales price (lot, home and garage) that is less than $195,000 in year 2000 dollars (annual inflation factor is the Consumer Price Index).
   4. A maximum of 30 percent of the neighborhood shall be designated for large-lot (70 feet or more in width) single-family homes.

B. Small Lot Single Family (30 and 42 foot lots)
   1. Maximum lot width is 50 feet, except corner lots where 60 feet is permitted.
   2. Minimum lot depth is 100 feet.
   3. Maximum height is 35 feet for principal structures and 20 feet for accessory structures.
   4. Properties adjacent to wetlands shall have all buildings and parking setback a minimum of 30 feet from the wetland/water edge.
   5. Front yard setbacks shall be a minimum of 23 feet.
   6. Rear yard setbacks shall be a minimum of 20 feet for a principal structure and six feet for accessory structures and attached garages.
7. Side yard setbacks (interior lots) shall be a minimum of five feet, except for lots that are less than 35 feet in width, where the minimum setback shall be three feet.
8. Side yard setbacks (corner lots) shall be a minimum of 15 feet.
9. Building facades shall be varied and articulated to provide visual interest.
10. The primary entry and frequent window openings shall face the street.
11. Unenclosed porches may encroach into the front yard setback a maximum of eight feet.

C. Standard Single Family (52 foot lots)
1. Maximum lot width is 80 feet, except corner lots where 90 feet is permitted.
2. Minimum lot depth is 100 feet.
3. Maximum height is 35 feet for principal structures and 20 feet for accessory structures.
4. Properties adjacent to wetlands shall have all buildings and parking setback a minimum of 30 feet from the wetland/water edge.
5. Front yard setbacks shall be a minimum of 26 feet.
6. Rear yard setbacks shall be a minimum of 20 feet principal structure and five feet accessory structures.
7. Side yard setbacks (interior lots) shall be a minimum of five feet.
8. Side yard setbacks (corner lots) shall be a minimum of 26 feet.
9. Building facades shall be varied and articulated to provide visual interest.
10. The primary entry and frequent window openings shall face the street.
11. Unenclosed porches may encroach into the front yard setback a maximum of six feet.
12. Garage walls that face a street may be no closer to the street than the longest wall of the house that faces the street, excluding front porches and side loaded garages on corner lots.
13. The length of the garage wall facing the street, for attached garages, may not be greater than 60% of the length of the entire facade of the house.
14. Garages are encouraged to be recessed twenty feet behind the front porch or be located to gain access via an alley, if one is located at the rear of the lot.
D. Large Lot Single Family (70 foot lots)

1. Minimum lot width is 70 feet, except corner lots where the minimum shall be 80 feet.
2. Minimum lot depth is 120 feet.
3. Maximum height is 35 feet for principal structures and 20 feet for accessory structures.
4. Properties adjacent to wetlands shall have all buildings and parking setback a minimum of 30 feet from the wetland/water edge.
5. Front yard setbacks shall be a minimum of 26 feet.
6. Rear yard setbacks shall be a minimum of 20 feet principal structure and ten feet accessory structures.
7. Side yard setbacks (interior lots) shall be a minimum of five feet.
8. Side yard setbacks (corner lots) shall be a minimum of 26 feet.
9. Building facades shall be varied and articulated to provide visual interest.
10. The primary entry and frequent window openings, at least twenty percent of the front façade, shall face the street.
11. Unenclosed porches may encroach into the front yard and side yard (street) setbacks a maximum of six feet.
12. The following ratios will be utilized with respect to positioning of the garage on the lot:
   - A minimum of 40 percent of the homes will be required to have garages that are flush, or are setback from the front wall of the house;
   - A maximum of 30 percent of the homes will have garages that protrude no more than six feet from the front wall of the house; and
   - A maximum of 30 percent of the homes will have garages that protrude in excess of six feet from the front wall of the house.
13. Garages that protrude in excess of six feet beyond the front wall of the house, shall be side loaded, and:
   - Dormers, bays and other architectural elements are utilized to break up the mass of the garage and the roof line;
   - The depth of the garage shall not exceed 25 feet; and
• Other side loaded garages are not adjacent nor directly across the street.

14. The following criteria shall be used to review the house plans:

• No more than 20 percent of the front elevation can be vinyl or aluminum siding, except vinyl shakes, which are excluded from this calculation. Side and rear elevations may be all vinyl or aluminum siding.

• The main portion of the front elevation (at least 80 percent, not including windows or doors, etc.) shall be cedar, cultured or real stone, brick, stucco, or cement siding.

• All details, such as shutters, window trim, window boxes, etc., shown on plans submitted and approved by the City shall be installed.

• Side loaded garages shall have windows on the front elevation (i.e., street) as well as brick and stone so as to match that which is provided on the front of the house.

• All gables facing the street shall be 8/12 pitches or better, except if the building designs are for “Prairie-Style” or “Frank Lloyd Wright-style” homes.

• All roof shingles shall be Horizon shingles or better.

Multi-Family & Apartment Standards and Provisions

A. Use

1. Multiple family dwellings including duplexes, patio homes, townhouses, quads, manor homes, condominiums, and apartments are permitted uses.

2. A minimum of 30 percent of the “for-sale” multi-family units in the neighborhood shall be affordable with selling prices (lot, home and garage) from $100,00 to $195,000 in year 2000 dollars.

B. Lots & Buildings, Except Apartments

1. Setbacks from public right’s-of-way shall be a minimum of 25 feet for properties with direct access to a public street.

2. Setback from exterior project property lines shall be a minimum of 20 feet.

3. Building height shall not exceed 35 feet.
4. Properties adjacent to wetlands shall have all buildings and parking setback a minimum of 30 feet from the wetland/water edge.
5. Building facades shall be varied and articulated to provide visual interest.
6. The primary entry and frequent window openings shall face the street (public/private).

C. Lots & Buildings, Apartments
   1. Setbacks from public right’s-of-way shall be determined by project.
   2. Setbacks from exterior project property lines shall be a minimum of 20 feet.
   3. Properties adjacent to wetlands shall have all buildings and parking setback a minimum of 30 feet from the wetland/water edge.
   4. Building height shall not exceed 50 feet.
   5. Building facades shall be varied and articulated to provide visual interest.
   6. Buildings that are adjacent to public right’s-of-way shall face their front towards the right-of-way.
   7. The primary entry and frequent window openings, at least twenty percent of the front façade, shall face the street.

Commercial Standards and Provisions

A. Use
   1. Pedestrian-oriented neighborhood commercial retail/service uses are permitted to serve the day-to-day needs of neighborhood residents including, but not limited to, small grocery, branch bank, laundry/cleaners pick-up, barber/beauty shop and similar personal services, small restaurant, medical and veterinarian clinic.
   2. Day Cares are permitted uses.
   3. Houses of Worship are permitted uses.

B. Lots & Buildings
   1. Setback (building) from public right’s-of-way shall be zero feet.
2. Buildings shall have the facade built directly on the build-to line along at least 70% of its length. The design of the center shall provide for a public plaza at the intersection of Hundertmark Road extended and the new residential collector street that encourages public gatherings and interaction. The uses adjacent to this space should complement this primary purpose of the center.

3. The maximum height shall be 50 feet, except for church steeples, which shall be a maximum height of 60 feet.

4. The minimum building height shall be 30 feet.

C. Parking

1. Parking spaces shall comply with the requirements of the City’s Zoning Ordinance, except that the following requirements also apply:
   a) Parking lots shall not abut street intersections or occupy lots, which terminate a vista of a public street;
   b) Adjacent parking lots shall have internal vehicular connections;
   c) Any on street parking directly enfroniting a use shall count toward fulfilling the parking requirement of that lot on a one to one basis;
   d) Demonstrating the possibility of shared parking may reduce the required number of parking spaces; and
   e) The parking requirements may be reduced for select retail uses of 2,000 square feet or less, that portion of restaurant seating which is outdoors and adjacent to the street.
APPENDIX B

LIST OF INTERVIEW QUESTIONS

1) Chaska has several unique developments, including the Jonathon Neighborhood and Clover Field, within its city limits. Has the City pushed for these types of projects or has it been due to other factors?
2) How does the City’s code define manufactured housing versus modular housing?
3) Are modular homes restricted as to where they can be built within Chaska?
4) The Clover Field development in Chaska, MN was the first TND (traditional neighborhood design) community to use modular housing. What was the reason(s) for using this style of construction?
5) Why was Chaska selected to be the location for using modular housing?
6) In regards to the approval process for Clover Field, was it controversial?
7) Did the approval process differ in any way from the typical approval process?
8) Are there minutes of planning commission or city council meetings concerning the Clover Field development and the discussions that took place?
9) Were there any preconceived notions about modular housing that hindered the approval process?
10) Was Clover Field done as a PUD (planned unit development)?
11) Clover Field has higher density than the neighborhoods that surround it. Was this a concern in the planning process?
12) How do the homes in Clover Field compare, price wise, to other developments in Chaska, MN?
13) Was the modular construction technique, used in the Clover Field development, promoted in the sales literature?
14) Has the Clover Field development led to any other similar type projects for your company?
15) Has the Clover Field development sparked any other similar types of development within Chaska?
16) Do potential home buyers have difficulty in obtaining financing for modular housing?
17) Have you wanted to or attempted to build modular housing in other communities and faced code restrictions?
18) What is the average square foot cost for a single family home in the Clover field development?
19) Where do you see modular housing in ten years?
20) Has your city pushed for modular housing projects or has it been due to other factors?
21) How does your city’s code define manufactured housing versus modular housing?
22) Are modular homes restricted as to where they can be built within your city?
23) Does the approval process for a modular house or development differ in any way from the typical approval process?
24) What is the average cost of a single family home in your city?
25) What are the advantages/disadvantages to using modular construction versus more traditional or “stick built” construction techniques?
26) How do you distribute your modular homes? (i.e. thru independent distributors or by direct contact with the clients throughout the process)
27) Do you transport the modular units to the building site using your own carrier or do you contract with a third party for this service?
28) Are the transportation costs figured into the base price of your homes?
29) What is the average square foot cost for one of your modular homes?
30) How does the quality of a modular home compare to that of a traditional or “stick built” home?
31) What codes do your homes have to comply with? (i.e. International Building Code, IBC, International Residential Code, IRC and or state/local codes)
32) Do your homes use any green building materials or techniques in the manufacturing process?
35) Barring natural disasters, fire, and so on, do you have a range for the life expectancy of your homes?
36) Do you have a range of floor plans that potential home buyers choose from?
37) Do you offer the ability for customization in your homes?
38) How much customization do you offer in your homes?
39) Do you feel that the general public [and/or city governments] distinguish between modular housing versus mobile homes? (i.e. do they understand the differences between these two types of housing)
40) Are you aware of any difficulties/restrictions concerning modular homes based upon city codes? If so, how frequently are you encountering difficulties/restrictions?
41) What sort of construction technique or techniques do you use for wall assemblies?
42) Has your design process changed since you purchased a manufacturing facility for modular housing?
43) Do you experiment with various construction techniques in your factory, in hopes that you may be able to incorporate new techniques into the construction of your homes?
44) What sort of warranty do you offer for your homes?
45) What is a structural insulated panel or “SIP?”
46) What are the advantages/disadvantages to using a SIP wall system?
47) Is this type of wall system used in residential construction?
48) What is the cost of a SIP wall system versus a more typical stud framed wall with batt insulation?
49) How does the thermal performance of a SIP wall system compare to that of a more typical stud framed wall with batt insulation?
50) What materials are used in a SIP wall system?
51) How are openings for doors, windows, and so on put into a SIP wall system?
52) Is a mechanical ventilation system required for a building that uses a SIP wall system?
REFERENCE LIST


City of Minneapolis. 2010. Community Planning and Economic Development Planning Division. “Administrative Site Plan Review For Single- And Two-Family Dwellings And...
Multiple-Family Dwellings Having Three (3) Or (4) Dwelling Units Application.” City of Minneapolis, 2010. 1.


census.gov/servlet/GCTTable?_bm=y&-geo_id=04000US27&-_box_head_nbr=GCT-PH1&-ds_name=DEC_2000_SF1_U&-format=ST-7.


ACKNOWLEDGEMENTS

I would like to take this occasion to convey my sincere appreciation to everyone who helped me with the compilation of this thesis. From research to writing, I could not have completed this without the tremendous support of my patient and understanding committee members. First and foremost, I thank Dr. Susan Bradbury for her encouragement, guidance, and wisdom throughout the course of this endeavor. This has been an incredible journey and because of her perseverance and prodding, I offer a truly heartfelt thank you to her for never giving up on me. Secondly, I also owe a huge thank you to my other committee members: Thomas Leslie and Dr. Riad Mahayni. Thomas has a knowledge and passion for architecture that comes through in his teaching. This helped guide my research to areas I hadn’t considered on my own. Dr. Mahayni’s enthusiasm for teaching engaged and challenged me throughout our many discussions.