TECHNOLOGY ROADMAPPING FOR MANUFACTURED HOUSING

U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

PD&R

PATH
PARTNERSHIP FOR ADVANCING TECHNOLOGY IN HOUSING

TECHNOLOGY ROADMAPPING FOR MANUFACTURED HOUSING

Prepared in cooperation with:
U.S. Department of Housing and Urban Development
Affordable Housing Research and Technology Division
451 7th Street S.W.
Washington, DC 20410

Prepared by:
Manufactured Housing Research Alliance
2109 Broadway
New York, NY 10023

March 2003

ACKNOWLEDGEMENTS

The Manufactured Housing Research Alliance wishes to acknowledge the assistance, advice, and guidance of a number of people without whose help this publication would not have been possible.

The following people contributed to this Roadmap:

Ed Bryant, *Champion Enterprises*, Project Chair
Michael D. Blanford, *U.S. Department of Housing and Urban Development*
Rick Boyd, *Clayton Homes*
Kevin Clayton, *Clayton Homes*
James A. Clifton, *Manufactured Housing Institute*
Elizabeth A. Cocke, *U.S. Department of Housing and Urban Development*
Terry Dullaghan, *Senco*
Chris Early, *U.S. Department of Energy*
Dave Engel, *U.S. Department of Housing and Urban Development*
Charles Fanaro, *Hi Tech Housing*
William Farish, *Fleetwood Enterprises*
Russ Fournier, *Virginia Mobile Homes*
William E. Freeborne, *U.S. Department of Housing and Urban Development*
Dennis Jones, *R-Anell Housing Group, LLC*
Michael A. Kinard, *Kinro Windows*
Ronald V. LaMont, *Alpine Engineered Products*
Carlos E. Martin, Ph.D., *U.S. Department of Housing and Urban Development*
William Matchneer, *U.S. Department of Housing and Urban Development*
Barry McCabe, *Hometown America*
Brian E. McKinley, *Atlantis Homes, LLC*
Terry W. McIntosh, *Tennessee Valley Authority*
Rick A. Mendlen, *U.S. Department of Housing and Urban Development*
John Mikel, *Skyline Corporation*
Irv Neltner, *Cavalier Homes*
Mark Nunn, *Manufactured Housing Institute*
Michael Slifka, *PFS Corporation*
Thomas Sheppard, *USG Corporation*
Dr. Anne Sweaney, *University of Georgia*
Frank Walter, *Manufactured Housing Institute*
Donald C. Westphal, *Donald C. Westphal Associates*

Project coordination staff and consultants:

Emanuel Levy, *Manufactured Housing Research Alliance*
Jordan Dentz, *Manufactured Housing Research Alliance*
Dean Evans, *New Jersey Institute of Technology*
Sandra Ho, *Manufactured Housing Research Alliance*
Valerie Kennedy, *Manufactured Housing Research Alliance*

DISCLAIMER OF WARRANTIES AND LIMITATION OF LIABILITIES

This report was prepared by the Manufactured Housing Research Alliance (MHRA) for the U.S. Department of Housing and Urban Development, Office of Policy Development and Research. The contents of this report are views of the contractor and do not necessarily reflect the views or policies of the U.S. Department of Housing and Urban Development, the U.S. Government, or any other person or organization.

PREFACE

This document, *Technology Roadmapping for Manufactured Housing*, is one in a series of technology roadmaps created to serve as guides to help the housing industry make decisions about research and development investments.

The Partnership for Advancing Technology in Housing (PATH), administered by the Department of Housing and Urban Development, is focused on improving the affordability and value of new and existing homes. Through public and private efforts, PATH is working to improve affordability, energy efficiency, environmental impact, quality, durability and maintenance, hazard mitigation, and labor safety. To accomplish this, PATH has identified research and established priorities for technology development that will enable the home building industry to work toward the PATH mission. This priority setting process, known as "Roadmapping," has brought together many industry stakeholders, including home manufacturers, retailers, builders, remodelers, community owners and managers, trade contractors, material and product suppliers, financial industry representatives, codes and standards officials, power suppliers and public agencies. To date, the group's work has led to the development of four technology roadmaps: *Technology Roadmapping for Manufactured Housing, Information Technology to Accelerate and Streamline Home Building, Advanced Panelized Construction,* and *Whole House and Building Process Redesign*.

This document focuses specifically on manufactured housing. The Roadmap offers a vision of how the factory built housing industry, already the nation's primary supplier of affordable homes, will continue to create and apply new technologies that increase home value and performance. The document summarizes the situation today, describes major industry challenges and opportunities, and suggests activities and milestones that will lead to the fulfillment of the vision.

Backed by a robust program of research responsive to the nation's future housing needs, the manufactured home building industry will continue to play a key role in providing affordable, durable housing for America's families.

CONTENTS

EXECUTIVE SUMMARY 1

1 INTRODUCTION 3

2 THE HOME 13
BUILDING SYSTEM OPTIMIZATION 13
MATERIAL AND COMPONENT PERFORMANCE 15
ENERGY EFFICIENCY 16
INDOOR ENVIRONMENTAL QUALITY 17

3 THE FACTORY 19
PRODUCTION PROCESS ENGINEERING 19
ADVANCED MATERIAL AND METHODS OF CONSTRUCTION 21
THE DESIGN AND ENGINEERING PROCESS 22

4 THE SITE 25
SITE PREPARATION 25
TRANSPORTATION TO THE SITE 26
INSTALLATION AT THE SITE 27

5 THE MARKET 29
DESIGN FOR AN EVOLVING MARKETPLACE 29
FINANCING 31
REGULATORY ENVIRONMENT 32

6 THE CONSUMER 35
CONSUMER PERCEPTIONS 35
OPERATION AND MAINTENANCE 36

END NOTES 39

LIST OF FIGURES AND TABLES

Figure 1 Single-family site-built, modular and HUD-Code homes constructed/shipped 4
Figure 2 Property classification of new HUD-Code homes placed for residential use 5
Figure 3 Average home sales price and total retail sales for HUD-Code homes 5
Figure 4 Population sizes of markets where HUD-Code homes are sited 6
Figure 5 Multi-section vs. single-section HUD-Code home shipments 6
Figure 6 Household incomes of HUD-Code home owners 7
Figure 7 Average sales price (excluding land) of new site-built and HUD-Code homes 8
Figure 8 Average cost per square foot (excluding land) of new site-built and HUD-Code homes 8

Table 1 Reported problems in new manufactured homes 9
Table 2 Tornadoes, Floods, and Tropical Storms: 1990 – 2001 10

EXECUTIVE SUMMARY

This document provides a roadmap for a research program that will generate the knowledge and innovations necessary to accomplish two objectives considered crucial to the future of the manufactured housing industry: continually improving the industry's core product, the single-family home; and expanding the benefits of manufactured housing to other housing types. It is also intended to serve as a framework for cooperative research between the private and public sectors.

To develop this Roadmap, the Manufactured Housing Research Alliance brought together people working in the public and private sectors, individuals with a breadth of manufactured housing experience and a wide range of views. This group directed, advised and informed the Roadmapping process: their perspectives shaped proposed research directions, the Roadmap goals, and vision.

The Roadmap goes to press at a time when the manufactured housing industry is experiencing turbulent change. Companies within the industry are realigning or entirely reformulating their business strategies in response to changes in market conditions, financing, the regulatory environment and the profile and demographics of the industry's customer base. Within the next decade, the confluence of these forces will alter the housing landscape, not just the manufactured housing business. The factory built housing industry will be propelled beyond its current affordable housing niche to a more central position in fulfilling the nation's housing needs. In this environment, research will play an outsized role in shaping the industry in the future.

The Roadmap contains five broad topic areas—the Home, the Factory, the Site, the Market and the Consumer—each with a set of key challenges. For each challenge, the Roadmap lays out a vision, and potential research and development focus areas. The individual topic areas and major challenges within each area are summarized below:

The Home

- **Building Component and System Optimization:** To create the next generation of housing, manufacturers will move beyond their role as product assemblers to become true system integrators.

- **Material and Component Performance:** The industry will redouble their efforts to optimize the lifetime strength, durability and overall performance of manufactured homes.

- **Energy Efficiency:** Factory built homes will be among the most energy efficient choice of housing, and viewed by the public as such.

- **Indoor Environmental Quality:** The industry will ensure that the design and operation of its homes promote and contribute to occupant health.

The Factory

- **Production Process Engineering:** Building on its factory advantage, manufacturers will radically improve the efficiency with which it produces homes.

- **Advanced Materials and Methods of Construction:** The industry will continue to respond and adapt to new materials of construction, and aggressively explore systems and assemblies that specifically exploit the advantages of factory production.

- **The Design and Engineering Process:** The industry will transform how homes are designed and engineered by fully exploiting information technology and computer simulation to increase design flexibility and production efficiency.

The Site

- **Site preparation:** The manufactured housing industry will ensure that the sites and foundations on which its homes are placed achieve the same levels of performance and quality as the homes themselves.

- **Transportation to the Site:** Factory-built homes will arrive at their sites in virtually the same condition as when they left the factory.

- **Installation at the Site:** The manufactured home installation process will be equivalent to the factory production process in terms of construction quality and lack of defects.

The Market

- **Design for an Evolving Marketplace:** While continuing to be the premier provider of high quality, highly affordable entry-level single family homes, the manufactured housing industry will aggressively expand its product offerings across the housing spectrum.

- **Financing:** Financing for HUD-Code homes will become more stable, flexible and transparent in its structure and implementation.

- **Regulatory Environment:** The industry will adopt a proactive stance with respect to an evolving and potentially volatile regulatory environment.

The Consumer

- **Consumer Perceptions:** The home-buying public will have a new understanding of, and appreciation for, HUD-Code housing and its high value.

- **Operation and Maintenance:** The manufactured housing industry will be at the forefront of efforts to improve the affordability, durability and maintainability of the nation's housing stock.

INTRODUCTION

THE ROAD AHEAD: A ROADMAP

Following a period of robust growth, the HUD-Code business has been in recession since 1999. The financing environment, in particular, has been shaken: Lenders that, a few years ago, dominated loan originations have significantly reduced their portfolios of asset-backed financing, or have exited the business entirely. Manufacturers are altering the design of new homes to appeal to a more diverse customer base; and the regulatory environment is in flux with important changes in the standards, on-site construction approvals and, in the not-too-distant future, installation procedures are expected. Rarely is it so apparent when an industry is at an inflection point: a cross roads that will redefine the industry to its core.

In such an environment, research can be a particularly potent catalyst for positive change. The pace of change experienced by manufactured housing over the past three decades will be eclipsed by the developments expected within the next decade. Many of the changes will be driven or supported by technological innovation created by public or private sponsored research and development (R&D). This document will help define key areas where collaborative research can shape the future of the manufactured housing industry.

Change will occur on several fronts, the most important of which include the following:

- **Home Design and Production:** The emergence of more price competitive pre-engineered building materials and components, as well as advances in information technology and the sophistication of manufacturing processes.
- **Marketing:** The diversification of design to meet more upscale buyer demands and new uses for manufactured homes, such as attached construction.
- **Regulations:** The convergence of building codes containing similar standards for home construction.
- **Financing:** The rapid growth in real estate lending in place of traditional asset-backed financing.
- **Home Installation:** The development and promulgation of nationwide installation standards and a host of initiatives designed to help installers take advantage of exemplary installation practices.
- **Consumer Acceptance:** The improvement of the image of the product encouraging consumers to select this method of construction.

These factors, and other forces, together will propel the manufactured housing industry well beyond its current affordable housing niche to a position of providing the dominant share of the nation's housing needs. In the future, the manufactured housing industry will be far more diverse and more fully integrated into the fabric of the larger housing industry than it is today.

Defining Manufactured Housing Construction

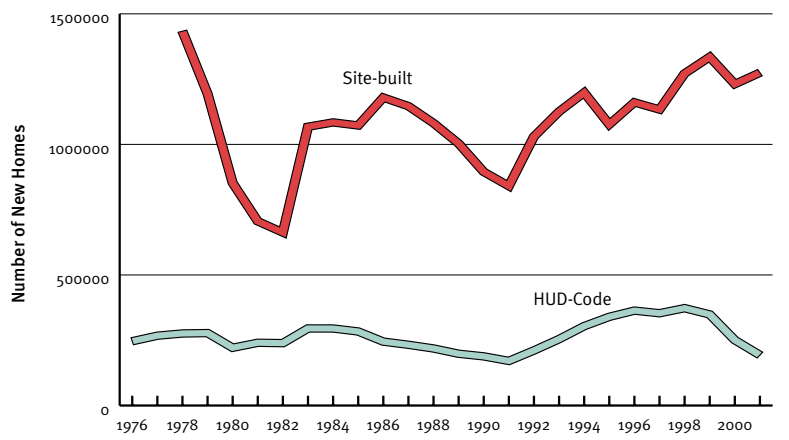
This report includes a research and development plan for both HUD-Code and modular housing types. While houses built under the HUD-Code are legally defined as manufactured homes, this term is used more broadly in this report to encompass modular homes as well.[1] Both of these construction types share the characteristics that the majority of the construction work is performed in a factory remote from the building site, and that the home is then transported to the site where it is installed on a foundation or other support system. The most significant commonality between HUD-Code and modular homes, and the factory, is the driving force behind many of the research areas discussed in this report. Both types of housing are often built by the same company; hence, the inclusion of both in the same technology research roadmap makes sense for the industry. This roadmap does not address panelized, precut or other forms of semi-industrialized building in which the majority of the work is performed at the jobsite.

Modular and HUD-Code homes, while sharing many technological and production-related characteristics, differ in the manner in which they are regulated. Modular homes are built in factories to the state, local or regional codes where the homes will be located; HUD-Code homes are built to the federal building code (Manufactured Home Construction and Safety Standards, commonly referred to as the HUD-Code) administered by the U.S. Department of Housing and Urban Development (HUD). These preemptive standards were promulgated in June 1976. The standards regulate design and construction, strength and durability, transportability, fire resistance, energy efficiency and quality. On-site additions for HUD-Code homes, such as porches and garages, must meet local or state building codes.

In recent years, the line between modular construction and homes built to the HUD standards has begun to blur. Increasingly, companies in the factory housing business build both modular and HUD-Code homes, often on the same assembly lines. As building codes across the nation become more uniform, modulars become more cost competitive with HUD-Code construction. This trend may become a major force in the manufactured housing industry over the next decade.

STATE OF THE INDUSTRY

The publication of this document comes at a critical juncture in the manufactured housing industry. While the site-built home industry has been robust in recent years and modular production also has been growing (33,500 estimated units in 2001[2]), HUD-Code housing has experienced a sharp decline in sales since its most recent peak in 1998 (**Figure 1**). HUD-Code housing has gone through similar boom and bust cycles in its history. This most recent cycle is primarily attributed to financing issues. During the mid-to-late 1990s, liberal credit terms allowed many buyers with questionable credit to purchase homes. This was followed by a flood of loan defaults and home repossessions from which the industry is still recovering. This crisis has led to a wholesale restructuring of the financing side of the HUD-Code housing industry.



SOURCE: *U.S. Department of Commerce, Bureau of the Census (site-built and HUD-Code); Leo J. Shapiro & Associates, Inc. State of the Industry Report for 2001, as published in Automated Builder Magazine, Januuary 2002 (modular)*

Figure 1 Single-family site-built and HUD-Code homes constructed/ shipped

Among the important steps taken by the industry to reform lending practices is the Lenders Best Practices (LBP) program. Developed under the Manufactured Housing Institute (MHI) umbrella, the LBP program establishes professional standards and practices for financial lenders involved in the HUD-Code housing industry. The shake-up in the lending community also reinforces the ongoing trend toward increased use of real estate financing as opposed to personal property financing for HUD-Code homes (**Figure 2**).

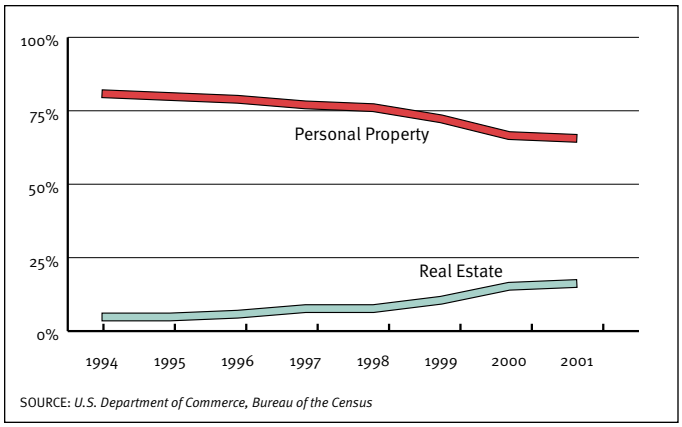


Figure 2 Property classification of new HUD-Code homes placed for residential use

The slump in HUD-code home shipments has also spurred a number of manufacturers to begin or expand modular production, a sector in which sales have remained strong, as well as to explore new markets for HUD-Code homes, such as two-story and single family attached homes. These housing types are expected to play an increasingly significant role in manufactured housing, as described in this roadmap.

Over the last decade, the manufactured housing industry has evolved to deliver a higher quality product.[3] The HUD-Code industry's capacity to provide value in housing exists on many fronts. Increasingly, the industry is taking advantage of the controlled building environment to improve construction quality and durability, and to add amenities more readily associated with much higher priced site-built homes. Homebuyers can routinely order an array of features, such as vaulted ceilings, walk-in closets, fireplaces, state-of-the-art appliances, and energy efficiency features. Spacious floor plans, customization packages, two-story models, on-site additions, (such as porches and garages), and exterior designs compatible with almost any neighborhood are attracting consumers, as well as builder-developers who are using HUD-Code housing in their subdivisions in increasing numbers. Indeed, the average sale price of HUD-Code homes continues to climb, even in the current market downturn (**Figure 3**).

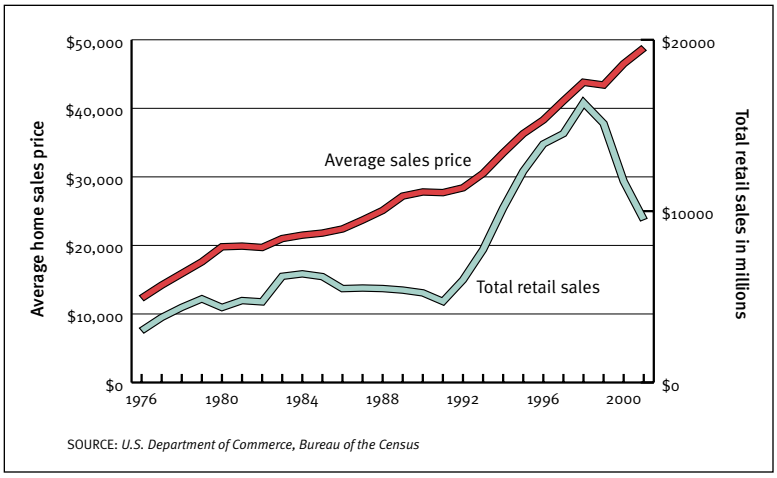


Figure 3 Average home sales price and total retail sales for HUD-Code homes

Traditionally, rural and suburban markets have been the stronghold of the HUD-Code industry. While this remains true today, HUD-Code homes are being used increasingly in more urban areas. Since 1993, the portion of HUD-Code homes located in rural areas of less than 100,000 has decreased to 41% from 46%, while the portion located in markets with a population between 100,000 and 500,000 has increased to 21% from 18% (**Figure 4**). Two converging factors are driving the growth of HUD-Code and modular homes in urban neighborhoods: the escalating cost of new site-built housing in these areas; and the increasing diversity of manufactured designs and design configurations.

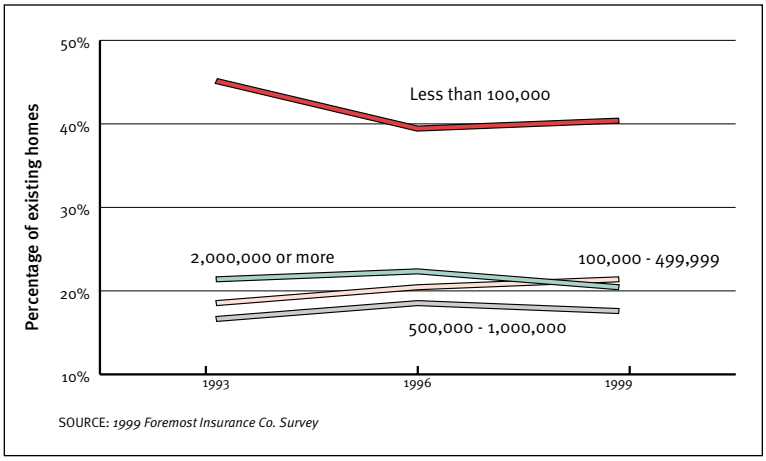


Figure 4 Population sizes of markets where HUD-Code homes are sited

The increase in the variety of home types and home designs for both HUD-Code and modular homes is engendering a diversification of the manufactured home industry. Some manufacturers are venturing into the new markets, and moving their product line upscale, while others are focusing on increasing value in the traditional entry-level HUD-Code home. These two segments of the HUD-Code housing industry are becoming increasingly distinct as more expensive multi-section homes increase in market share (**Figure 5**).

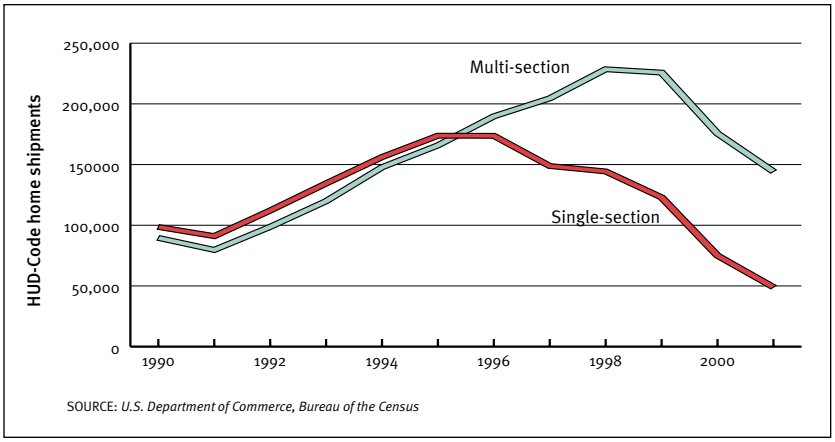


Figure 5 Multi-section vs. single-section HUD-Code home shipments

While the entry-level home will remain central to the HUD-Code housing industry for the foreseeable future, there is no doubting that manufactured homes will capture a growing share of the middle-income market. The share of manufactured home owners with household incomes in excess of $30,000 grew to 44% from 30% over the period from 1990 to 1999, while over the same period the share of households with incomes less than $30,000 fell to 56% from 70% (**Figure 6**).

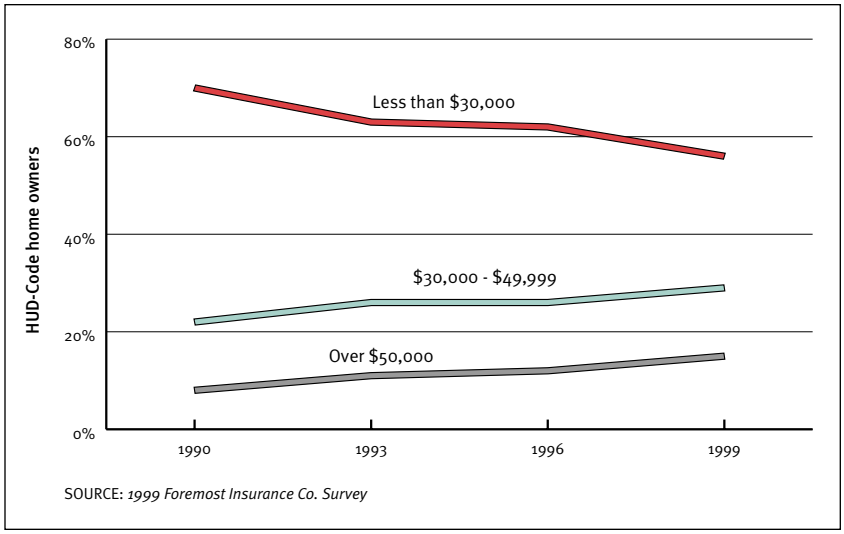


Figure 6 Household incomes of HUD-Code home owners

FACTORY BUILT CONSTRUCTION IS INCREASINGLY THE ONLY AFFORDABLE HOUSING OPTION

Housing prices continue to rise across the country. In 2001, the increase in house prices outpaced general inflation for the eighth consecutive year.[4] Inflation-adjusted house prices have increased 16% since 1993, compared with 14% during the last major run-up between 1984 and 1989.[5]

Over 14 million American households—one in eight—spend more than 50% of their income on housing. Three in 10 pay more than 30%.[6] At today's fair market rental prices, two-worker households earning the minimum wage cannot afford a typical two-bedroom apartment.[7] Between 1997 and 1999, more than 200,000 unsubsidized rental units affordable to extremely low-income households were lost from the nation's stock of affordable housing.[8] Housing affordability problems are becoming more pervasive and are affecting a small but growing number of moderate-income households earning between 80% and 120% of the area median income.[9]

In the United States, only 58.6% of households can afford a home that costs $100,000, including land. When the price rises to $155,000, (slightly more than the average cost for a site-built home without land), only 37.6% can afford to buy. And at $212,300 (the national average cost of a site-built home, with land, in 2001) the percent drops to 24.1%. That is, over three-quarters of the households in the country are priced out of the market for the average site-built home, assuming a 30-year, 7% mortgage with a 10% down payment.[10]

The urgency of this affordability crisis has been reinforced by the findings of the Bipartisan Millennial Housing

Commission. In its recently released report to Congress, an introductory letter from the two co-chairs summarizes the two key findings of the report as follows: "First, housing matters. Second, there is simply not enough affordable housing."[11] The Commission report noted that from 1997 to 1999, HUD-Code housing accounted for 72 percent of new units affordable to low-income homebuyers.[12]

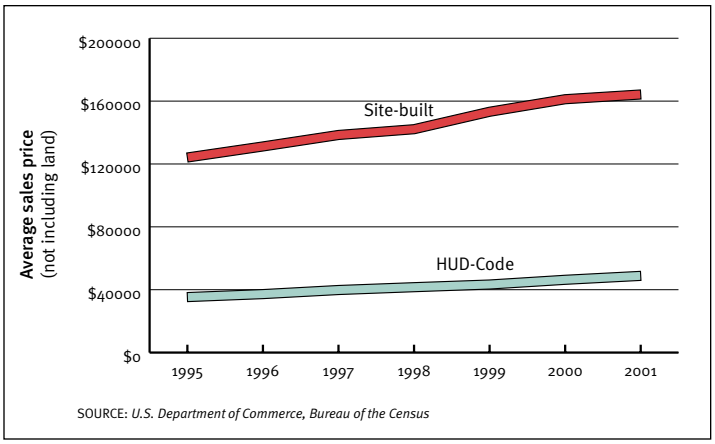


Figure 7 Average sales price (excluding land) of new site-built and HUD-Code homes

HUD-Code housing is central to solving the housing affordability crisis. The average price of a site-built home (without land) in 2001 was $164,217. The average home price without land for HUD-Code housing was $30,700 for a single-section home, $55,100 for a multi-section home, and $48,800 for all HUD-Code homes (**Figure 7**). On a per square foot basis, the average HUD-Code home cost 54% less than the average site-built home in 2001[13] (**Figure 8**). When comparing identically sized units on similar foundations, the estimated price of a double-section HUD-Code home is 25% less than for a site-built home.[14]

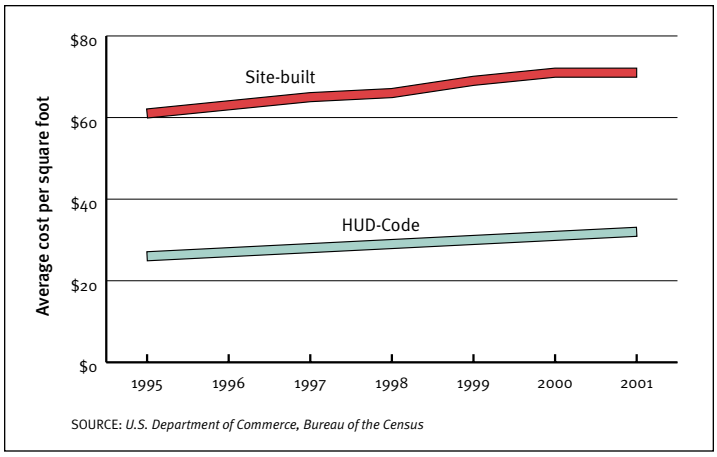


Figure 8 Average cost per square foot (excluding land) of new site-built and HUD-Code homes

As the data suggests, manufactured homes, in particular HUD-Code homes, are the engine of homeownership growth. HUD-Code homes accounted for over one sixth of the total growth in homeownership between 1993 and 1999, and were particularly important in promoting homeownership among very low-income households, households in the South, and in non-metropolitan areas.[15] HUD-Code housing represented 63% of the growth in homeownership for very low-income homeowners in the non-metro South, as compared to 17% for the nation as a whole, and 35% in all non-metro areas.[16]

While HUD-Code home prices are rising more slowly than site-built home prices, increases in both sectors are outpacing the general level of inflation. As a consequence, housing affordability, already a pervasive problem among extremely low-income and very low-income households, is beginning to affect moderate-income households as well. Demand is growing for housing products that drive down first costs while maintaining quality.

The manufactured housing industry is uniquely positioned as the most promising solution to the affordability crisis, primarily because of the inherent efficiencies of the factory process. The controlled environment and assembly-line techniques remove many of the problems of the site-built sector, such as poor weather, theft, vandalism, and damage to building products and materials stored on site. Also, factory employees are trained, scheduled and managed by one employer, as opposed to the system of contracted labor in the site-built sector. In other words, the factory building process is a much more cost and resource efficient method for delivering housing than site-building is.

Factory-built home producers also benefit from the economies of scale that result from being able to purchase large quantities of building materials and products. As a result, they are able to negotiate the lowest possible price for items that are invariably more expensive in a site-built house.

Finally, the factory process builds the home from the "inside out," which results in ease of installation for interior walls, plumbing and electrical systems. The house and materials travel on an assembly line to the workers, with scaffolds, tools and materials within easy reach. Computer-assisted design (CAD) programs also offer speed and flexibility for manufacturers.

Over the coming decade, these key industry advantages—the aggregation of production, the availability of semi-skilled labor, bulk purchasing of materials, and a single, uniform national building code—will strengthen the factory's position as the only viable option for providing modestly priced homes. In addition, improvements in the long-term performance and durability of manufactured housing—improvements achieved through a concerted, industry-wide research, development and dissemination initiative—will systematically drive down the costs of owning a manufactured home.

The key challenge facing the industry, going forward, will be leveraging these initiatives so that the affordability of its core product—the single-family home—is maintained, even as value is added and quality is enhanced. Also, it will be important for the industry to present these advantages in ways that people will easily recognize their value.

GAUGING THE PERFORMANCE OF NEW HOMES

One of the most revealing ways of identifying opportunities for improving manufactured homes is to examine service records and warranty reports. To be useful as feedback to the research process, such information must be carefully scrutinized to determine the nature and size of the problem and its underlying causes.

As an example of how such information is reported, **Table 1** below lists the top 20 areas for which problems were reported by HUD-affiliated inspectors.

Table 1 **Reported problems in new manufactured homes**[1]

Top 20 Problems identified by HUD-affiliated inspectors	
1 Electrical	11 Exterior doors
2 Miscellaneous	12 Plumbing – drain, waste, vent
3 Roof	13 Windows
4 Floors	14 Frames
5 Plumbing – fixtures	15 Plumbing – distribution
6 Appliances	16 Ceilings
7 Interior walls	17 Floor covering
8 Exterior siding	18 Interior doors
9 Furnace (heating)	19 Exterior walls
10 Setup	20 Regulatory

[1]Consumers Union Southwest Regional Office, Paper Tiger Hidden Dragon, November 2001

REDUCING RISKS ASSOCIATED WITH NATURAL HAZARDS

Risks from natural hazards can be classified as loss of life, injury, and property destruction. Types of natural hazards include tornadoes, floods, hurricanes, tropical storms, and earthquakes.

An overview of recent experience in the US with these events (except earthquakes) is given in Table 2. These figures are broad brush indicators of severity of damage and number of fatalities. Not all of the data on injuries and deaths relate to housing, nor is the estimated property damage restricted to residential property.

Table 2 **Tornadoes, Floods, and Tropical Storms: 1990 – 2001**

Weather type	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Tornadoes, number[2]	1,133	1,132	1,298	1,176	1,082	1,235	1,170	1,148	(NA)	(NA)	(NA)
• Lives lost, total	53	39	39	33	69	30	25	67	130	(NA)	(NA)
• Most in a single tornado	29	17	12	7	22	6	5	27	34	(NA)	(NA)
Floods and flash floods: Lives lost	142	61	62	103	91	80	131	117	136	(NA)	(NA)
North Atlantic tropical storms and hurricanes[3]	14	8	7	8	7	19	13	7	14	12	15
• Number of hurricanes reaching U.S. mainland	0	1	1	1	–	2	2	1	3	3	–
• Total direct deaths from tropical storms and hurricanes	123	17	28	273	1,175	121	138	4	(NA)	(NA)	(NA)
• Direct deaths on U.S. mainland	10	17	26	9	38	29	33	4	23	(NA)	(NA)
• Property loss in U.S. (mil. dol.)	57	1,500	26,500	57	973	3,729	3,600	100	7,299	(NA)	(NA)

SOURCE: U.S. Census Bureau, Statistical Abstract of the Unites States: 2001

[2] A violent, rotating column of air descending from a column of air descending from a cumulonimbus cloud in the form of a tubular- or funnel-shaped cloud, usually characterized by movements along a narrow path and wind speeds from 100 to over 300 miles per hour. This type of weather event is also known as a "twister" or "waterspout."

[3] Source: National Hurricane Center, Coral Gables, FL, unpublished data. Tropical storms have winds of 39 minimum to 73 maximum miles per hour; hurricanes have winds of 74 miles per hour or higher.

REGULATORY CHANGES

The passage of the Manufactured Housing Improvement Act of 2000 has improved the status of HUD-Code homes as a vitally important part of the nation's housing stock.

The Act requires that the Federal Manufactured Home Construction and Safety Standards that regulate HUD-Code construction be updated on a timely basis, and that each state institutes an installation program. States are required to implement installation standards, create programs for the training and licensing of home installers, and for the inspection of home installations. The Act also clarifies the scope of federal preemption, provides HUD staff with additional resources, and requires dispute resolution programs to resolve disputes between manufacturers, retailers and installers for any customer complaints during the first year after a home is installed.

Continuing the momentum, several voluntary programs have been implemented in the HUD-Code housing industry since 2001. These include the aforementioned Lenders Best Practices program, and the Manufactured Housing Energy Star® program, the latter administered by the Environmental Protection Agency (EPA). In cooperation with the EPA, the Manufactured Housing Research Alliance (MHRA) has developed guidelines for manufacturers to meet Energy Star requirements, giving HUD-Code homes a competitive feature that many homebuyers desire. Energy Star

certification is awarded to those homes that are at least 30% more energy efficient than a comparable home built to the Council of American Building Officials (CABO) 1993 Model Energy Code (MEC).

These activities and initiatives clearly point to an industry on the move, an industry that is central to the production of affordable housing in this country, and one that is committed to extending the benefits of factory production to all segments of the US housing market.

STRUCTURE OF THE ROADMAP

The chapters that follow are organized into five distinct topic areas that generally correspond to the core sections of the MHRA's Strategic Plan[17]:

- **The Home**
- **The Factory**
- **The Site**
- **The Market**
- **The Customer**

Each chapter is divided into subsections, areas that are currently envisioned as the major building blocks for organizing research. Each subsection begins with a statement of the challenge that the manufactured industry now faces. Each challenge has been culled from discussions with industry leaders. Collectively, they constitute a distillation of industry leader's thinking on the key societal, economic and demographic forces that will impact the future of housing in the US.

Accompanying each challenge discussion is the industry's vision of how these challenges will be met over the coming decade, and what consequences for manufactured housing may result.

Finally, each chapter concludes with a technology-oriented research plan developed in response to the challenges and visions articulated in that chapter. These plans represent tactical strategies for harnessing the power of technology to successfully move the manufactured housing industry forward over the coming decade.

THE HOME

This chapter focuses on the manufactured housing industry's core product: the single-family detached home. Most homes consist of one or more factory built sections, with a two section home currently the most popular configuration. The entire industry—from manufacturers and suppliers to dealers and installers—is committed to continuously improving the quality and performance of this core product, primarily through the application of advanced technology.

In order to focus Research and Development (R&D) activities related to the single-family home, industry representatives have identified four key challenges facing the industry today:

- **Building System Optimization**
- **Material and Component Performance**
- **Energy Efficiency**
- **Indoor Environmental Quality**

Each of these challenges deals with issues that are currently confronting the industry and that are deemed to be critical for the future quality and performance of the single-family manufactured home. These issues are described in more detail below, together with the industry's vision of how it intends to respond to—and benefit from—these challenges over the coming decade.

- The energy cost burden is greatest on lower income homeowners, many of whom live in HUD-Code homes. In 1997, the average annual household energy expenditure for households with incomes over $50,000 was $1,696. For those earning $10,000 to $24,999, it was $1,155. This means that low income families paid a much higher percentage of their incomes for energy.[18] Reducing monthly energy costs will have a positive impact on home affordability and will enable low-income homeowners to more easily meet their monthly mortgage burden.
- Liability suits are a fact of life for both the site-built and manufactured home-building industries. They may be associated with a specific building material or product, such as hardboard siding, polybutylene water lines, water heaters, particle-board substrate, or fire-retardant plywood.
- In a recent survey by the Consumers Union of HUD-Code homeowners, 79% of new homeowners reported having had at least one problem with their home.[19]
- Homeowners will continue to locate their homes in areas vulnerable to natural hazards, especially floods and high winds, and expect them to perform as they would in more benign locations. This continues despite the fact that insured losses from damage by natural hazards to buildings in the US reached $22 billion in 1999, second in the 1990s only to the $26 billion in losses in 1992, when Hurricane Andrew devastated parts of Florida and Louisiana.[20]
- Americans spend about 90% of their time indoors, where concentrations of pollutants—many of which are known to have significant health impacts—are often much higher than those outside.[21,22]

BUILDING SYSTEM OPTIMIZATION

Challenge

The US home-building industry—manufactured and site-built—currently assembles finished homes from an incredibly wide range of individual materials, products and subassemblies, and as many as 30 different categories of materials are used in a single, 2,000 square foot home.[23]

While many of these individual materials and subassemblies may be optimized for their specific functions, finished homes are not. These homes may meet, or even exceed, applicable building codes, but they do not attain the high

levels of integrated performance associated with many of the products they contain, such as low-e windows, high efficiency dishwashers and programmable thermostats.

The key factor in obtaining these high levels of performance is systems integration. Many of the products and subassemblies in a home have been designed and engineered—from the outset —as integrated systems. The result is a product or subassembly that functions as an optimized, integrated whole, not simply an assembly of individual components. The need for systems engineering has also been recognized by the site built home industry in their Whole House and Building Process Redesign Roadmap.[24]

To create the next generation of housing in the U S, home builders will need to take the same approach: moving beyond their role as product assemblers to become true system integrators.

Vision

The manufactured housing industry will lead the nation in adopting a systems integration approach to designing, engineering and constructing homes. The industry is uniquely well positioned to assume this leadership role by virtue of its core strengths: the ability to produce and inspect homes in a factory; the capacity to provide consistently high quality homes by virtue of national standards of construction and regulatory oversight; the power to make new technologies cost-effective through bulk purchase of materials and products; and the flexibility—through centralized design, engineering and construction operations—to seamlessly envision, test and implement system-wide decisions.

The industry will aggressively exploit these advantages to help create the next generation of integrated, systems-based housing in the US.

R&D Focus Areas

- Developing fully integrated structural systems that more effectively resist the forces applied during home transport and site installation, and that might result from natural events (e.g., tornadoes, earthquakes).
- Developing new building envelope (roof, wall and floor) systems that maximize integrated performance.
- Exploring the integration of plumbing and mechanical systems with each other, and within the home as a whole.
- Exploring the range of functions that next-generation control systems may offer.
- Developing new wiring and cabling systems that optimize whole-house performance.

Discussion

The dream of creating truly integrated, optimized, systems-based housing has been alive—and dramatically unfulfilled—for decades in the US. A variety of initiatives, from Operation Breakthrough to the Smart House concept, have come and gone with little appreciable impact on the way homes are designed, engineered and constructed, whether in a factory or in the field. There are good reasons for this. Current practice allows a great deal of flexibility in both design and construction, particularly on site. It also allows relatively unskilled workers to put together a complete home which, while not truly optimized, meets the basic shelter needs of the American people. Home builders also have become quite skilled at delivering this form of component-based housing and, as a result, home prices exclusive of land, while rising, have not spiraled out of control.

Nonetheless, the dream of doing better persists, and a systems integration approach seems to be the key. Such an approach may now be within reach, due primarily to the astonishing advances made over the last decade in both information technology and production engineering. Companies across all industry sectors routinely optimize systems design by an integrated process that:

- Systematically analyzes current design, production and delivery processes.

- Investigates alternative approaches not only from a design/engineering perspective but also from multiple other perspectives, including cost, constructability and market acceptance.

- Performs cost and performance trade-offs among alternative approaches to determine which approaches produce a net improvement in the value and performance of the entire system.

- Incorporates the most beneficial changes into the production/delivery process.

Such an integrated process could greatly benefit the housing industry by improving the performance and increasing the value of a new generation of systems-based homes. The factory is the ideal location to implement such a process, due to a greater degree of control over the production process.

MATERIAL AND COMPONENT PERFORMANCE

Challenge

The material and component performance of manufactured homes will become an increasingly important concern for the industry and its customers. Liability and warranty service issues will be important drivers, as will the overall relationship between the expected performance and the perceived value of the homes the industry produces. To meet these concerns, and turn them to its advantage, the industry must recognize those issues that have the potential to blossom into large problems early on and proactively address them. In addition, the industry must set continuous performance improvement as a central goal to remain competitive, innovative and progressive.

Vision

The industry will continuously strive to optimize the lifetime strength, durability and overall performance of manufactured homes.

The underlying causes of building performance failures—such as moisture problems, damage during transport and installation, material failures over time, termite damage, homes shifting after installation, and natural hazards—will be well understood, and steps will be taken to eliminate such possible modes of failure. In addition, research into the behavior of materials, components and systems will improve the industry's ability to predict and optimize material and component performance.

R&D Focus Areas

- Understanding the reasons for premature failure of materials and systems due to manufacturing or installation problems.

- Understanding the causes of warranty claims, and developing manufacturing, transportation and installation techniques, and new component designs to minimize them.

- Testing and evaluating the performance of new materials and building systems under extreme conditions, including accelerated aging.

- Improving the life expectancy and in-place performance of the materials, products, systems and assemblies that go into manufactured homes, beginning with the exterior envelope (walls and roof).

Discussion

Buildings of all kinds continue to suffer performance failures, even as consumer expectations concerning performance continue to rise. The sources of these failures fall into two general categories:

- Failures of building components or systems due to their being designed and/or specified with incomplete or inaccurate knowledge, such as a new piping material that cracks over time, or moisture damage in an otherwise properly designed, constructed and installed home. A lack of understanding of material properties and moisture dynamics can lead to these kinds of problems.
- Failures of building components or systems due to poor quality workmanship or installation, such as weather damage due to missing or poorly installed set up materials.

Consumers do not want to hear about either type of failure. They continue to demand and expect higher and higher levels of performance from their homes, particularly in the new, higher-end markets that the manufactured housing industry has targeted for future growth (see The Market chapter below). A basic expectation is that the home itself will not experience a catastrophic failure, even if located in an area vulnerable to natural hazards.

Beyond such basic assumptions, however, consumers increasingly expect that individual materials and components within the home will perform flawlessly, with little or no maintenance on their part. Whether or not such expectations are fully justified, they are part of manufactured housing's new marketplace and going forward, will need to be addressed systematically and proactively by the industry. Doing so will ensure that the strength, durability and long-term performance of manufactured homes continues to improve, benefiting the industry, its customers and the nation.

ENERGY EFFICIENCY

Challenge

Conservation of energy resources will increasingly be a national priority and national security issue. Consumers will increasingly demand homes that are more energy efficient and cost less to operate.

Vision

Manufactured homes will be viewed by the public as the most energy efficient choice of housing. Annual energy costs of these homes will be as low, or lower, than comparable site-built homes. New modes of construction and more economical application of current energy efficiency measures will make it not just technically feasible, but cost-effective, for buyers to purchase homes that are 50 or more percent more efficient than current construction.

R&D Focus Areas

- Developing and deploying new and existing energy conservation technologies and strategies.
- Collaborating in industry-wide programs (such as Energy Star®) to improve whole house energy performance, and disseminating the benefits to consumers.
- Developing next generation mechanical equipment and air distribution systems.
- Exploring the potential for renewable energy technologies, such as photovoltaics and solar thermal energy.
- Understanding the energy benefits and revenue opportunities of distributed generation strategies.

- Analyzing financial strategies that can be used to improve energy performance, such as real-time metering and pricing, and bulk-purchase agreements between power providers and communities or groups of communities.

Discussion

Energy efficiency will grow in importance as home prices rise, and as new energy codes continue to raise the performance bar for site-built homes in competing markets.

The industry's core market of low-income homeowners will become increasingly impacted by higher energy costs. Reducing these costs through more energy efficient design and construction—thus reducing a homeowner's monthly out-of-pocket expenses—will allow the manufactured home to maintain its affordability advantage in this critical market.

In addition, attention to energy issues will benefit the industry as it looks to build market share with more affluent buyers, the group that has historically placed more importance on conservation. This group will not view energy conservation features simply as cost-effective amenities; rather, they will consider them necessary features in a high quality home. The industry will need to respond by making energy efficiency one of the cornerstones of its quality improvement programs for the future.

Research should recognize the tradeoff between energy efficiency and indoor environmental quality. Energy efficiency improvements must be implemented with consideration of the affect they have on air quality. One should not be improved at the expense of the other.

Finally, the industry and the nation will benefit by looking beyond incremental improvements, and by tapping the potential for radical transformation of the energy profile of the single-family home. Within 10 to 15 years, a zero-energy manufactured home will be technically and economically feasible, as will the capacity to cost-effectively incorporate alternative power sources that sell power back to the grid. The industry needs to position itself to take advantage of these opportunities as they emerge, and to help develop zero-energy technologies that take maximum advantage of factory production. Doing so will ensure that the industry continues to provide new and existing housing products that will meet the energy efficiency demands of the next two decades.

INDOOR ENVIRONMENTAL QUALITY

Challenge

Indoor environmental quality—and its impact on health and well being—is a growing topic of interest and concern among homeowners across the country. Looking forward, American consumers will increasingly expect and demand superior indoor environments in their homes.

Vision

The manufactured housing industry will maintain a current and comprehensive knowledge base on all aspects of indoor environmental quality as it affects housing. The industry will also be proactive in ensuring that the design and operation of all its homes promote and contribute to the health of their occupants.

R&D Focus Areas

- Developing and deploying methods for controlling sources of contamination.
- Developing and deploying techniques for improving ventilation.
- Developing and deploying systems and procedures for controlling moisture.

Discussion

Awareness of and concern about the quality of the indoor environment are growing nationwide, driven most recently by the media focus on mold.

Improvements in energy efficiency are driving homes to have increasingly tighter envelopes, thereby reducing the natural air leakage rates that have historically provided homes with fresh air ventilation. A minimum air change rate in the home is required to provide a healthy environment as well as to expel moisture that can lead to degradation of the structure and finishes in the home. In the future, the design and operation of whole-house ventilation systems will consistently provide adequate ventilation rates to resolve indoor environmental quality and moisture issues.

THE FACTORY

This chapter focuses on the core engine of innovation in the manufactured housing industry: the factory. Factory production provides unique opportunities to improve performance and reduce the costs of housing. First, the factory process provides quality control and inspection levels that cannot be easily matched at the site. Construction accuracy is enhanced while inventory is controlled, resulting in added value without added cost. At the same time, the factory setting provides opportunities to utilize new materials and fabrication techniques that are simply not feasible in site building. Capitalizing on the inherent advantages of industrializing the building process is a main theme within the Whole House and Building Process Redesign Roadmap developed for and by the site building industry. That report has as one of its main goals the sifting of more of the homebuilding process into the factory.[25]

The manufactured housing industry recognizes these inherent advantages and is committed to exploiting them by continuously improving its factory production processes. The objective is to foster incremental improvement in existing processes, and to investigate, through a sustained research and development program, completely new ways of creating housing inside a factory.

As a means to organize and optimize R&D activities related to the factory, all successful R&D programs must meet the following three challenges:

- **Production Process Engineering**
- **Advanced Materials and Methods of Construction**
- **The Design and Engineering Process**

Each of these challenges deals with issues that are currently confronting the industry and that are deemed to be critical to creating the housing factories of the future. These issues are described in more detail below, together with the industry's vision of how it intends to respond to—and benefit from—the challenges it faces over the coming decade.

PRODUCTION PROCESS ENGINEERING

Challenge

While construction techniques utilized in manufactured housing today have evolved over the past fifty years, many of the core techniques used in the plant vary only slightly from those employed in traditional site-built housing. Opportunities abound for applying production efficiency strategies in the plant that cannot be replicated at the building site, thereby expanding the already substantial advantage of factory building over site assembly.

Vision

The industry will build on its factory advantage to radically improve the efficiency with which it manufactures homes. By adopting innovative production technologies grounded in lean manufacturing, automation, and information technology, the industry will extend its efficiency advantage over site-built methods and remain the most cost-effective form of housing production in the US.

R&D Focus Areas

- Evaluating ways to improve plant output through the application of lean production and automation technologies, drawing on models from other industries.
- Rethinking the levels at which economies of scale are reached for specialty home plants targeting niche markets, such as satellite plants serving inner-city housing.
- Developing more efficient methods for warehousing, inventorying and accessing products in the plant.
- Assessing opportunities for building more subassemblies remote from home production facilities.
- Developing strategies to reduce construction waste, including recycling.
- Developing ways to improve communication across the production process, a goal shared by the site building industry in its Information Technology Roadmap.[26]

Discussion

While factory facilities have gotten bigger to accommodate larger homes, little has changed in the way of basic production processes, storage of materials, management of production processes, or the materials used in home construction. To remain competitive, the industry will need to move well beyond the "site-building-under-a-roof" that characterizes much manufactured housing production today.

In the future, the industry will extend its efficiency advantage over site builders by adopting innovative production technologies such as lean manufacturing, automation, and information technology. First steps will be taken in the coming years in exploring how lean production principles will shape the home-building factory of the future. Lean thinking has the following implications for manufactured home builders: 1) flexibility in design and production, providing the capability to produce what the homebuyer wants and is willing to pay for; 2) zero defects; 3) elimination of waste in all forms, including cycle times, building materials and labor; and 4) use of first-tier suppliers to provide additional value for the homebuyer.

The factory environment facilitates technological improvements to home design and construction. Within five to ten years many labor intensive functions performed in manufactured housing facilities will be performed by equipment-using processes that are somewhat more automated. Application of robotics and sophisticated manufacturing methods used in other industries is a longer-term possibility but not likely to prove cost-effective in the near term. The pace of change will be dictated, in part, by product mix and price point. As in the case of automobiles, diversification of the product might justify more automation to achieve a greater degree of manufacturing flexibility.

The steps toward increased automation may include delivering materials to the point of production by conveyors and other mechanical methods, and using crane systems in production. Materials will be developed that take advantage of the capabilities of the plant to build and assemble large components. In the near term, gypsum board walls, a design option that has a large impact on plant configuration, the number of work stations, and space allocation, will be pervasive in HUD-Code homes, as is currently the case in modular construction.

As a strategy to improve production efficiency, many components already pre-assembled and ready to install will be delivered to the plant from nearby suppliers. Other components will be developed that take advantage of the fact that many homes are built to the same floor plan and specification. Wiring harnesses that allow lights, fixtures and

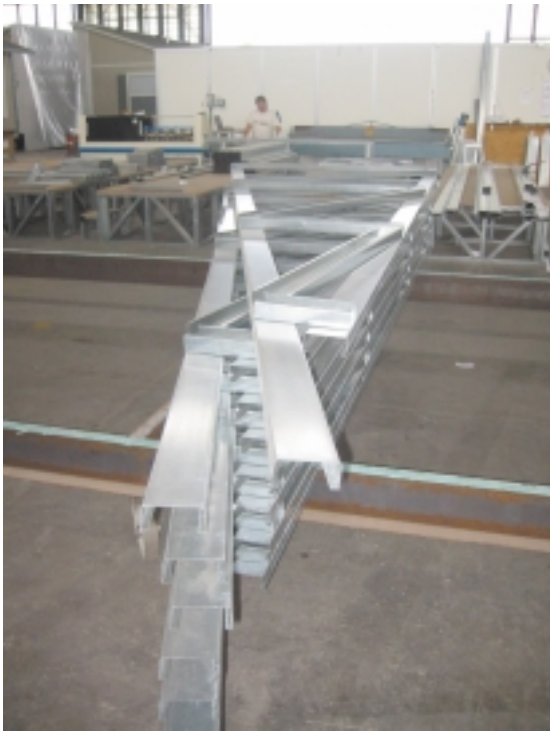
appliances simply to be plugged in will also be available. Computer programs will be developed that allow the production manager to constantly monitor production processes and reallocate resources to respond to bottlenecks.

Unlike in the site-building sector, few changes are anticipated in the availability and composition of the labor pool. Currently, labor is a relatively small component of HUD-Code housing construction cost, and most plants are located in rural areas where labor rates are relatively low. Automation is commonly looked at as a way to offset increasing labor costs; however, there may be other benefits of automation, such as increased flexibility and quality. Nevertheless, if labor costs do not increase significantly in real terms, plants are not likely to make significant new investments in automation. There will be contravening trends. For example, as the industry gains market share in urban areas and plants are opened to serve these markets, labor costs will increase, creating an environment ripe for labor saving technologies.

ADVANCED MATERIALS AND METHODS OF CONSTRUCTION

Challenge

Although the quality of the materials used in the construction of manufactured homes has improved significantly, little progress has been made to develop materials specifically designed to take advantage of the factory setting.



Vision

The industry will continue to respond and adapt to new materials of construction as they become available. In addition, the industry will aggressively explore systems and assemblies that specifically exploit the advantages of factory production. These explorations will be undertaken in close collaboration with product suppliers, will involve rethinking and reengineering whole building systems, and will include computer-based simulations that help predict performance. The result will be a new generation of manufactured homes that incorporate the most cost and value-effective construction materials and products available, combined into assemblies and systems specifically adapted to, and optimized for, factory production.

R&D Focus Areas

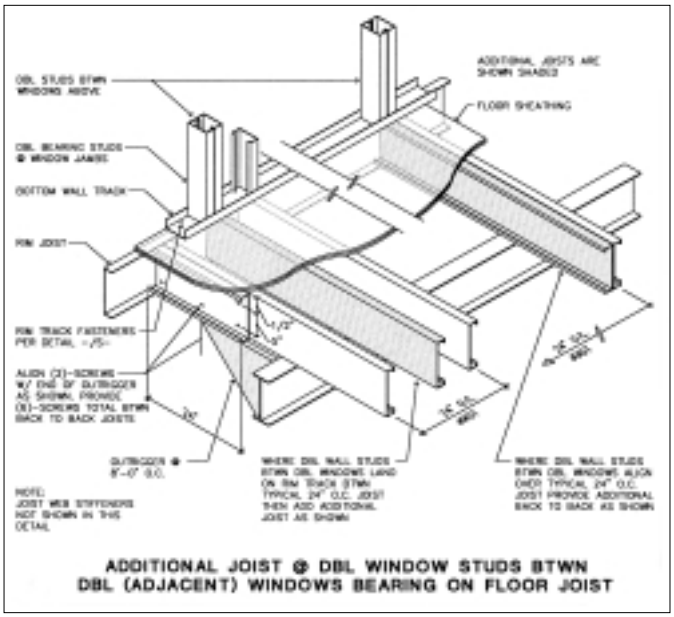
- Exploring ways to use materials that are not appropriate or feasible for site-built housing, but that may have applications in the plant environment.
- Investigating new models for collaboration and risk-sharing between manufacturers and suppliers of construction materials and assemblies.
- Developing new assemblies and subassemblies that improve performance and could only be applied in a factory setting.

Discussion

The materials traditionally used in manufactured housing will continue to change. For example, solid sawn wood products will lose market share as concerns over environmental and other factors increase their relative costs. In the same fashion, as cost and performance moved the market to oriented strand board (OSB) from plywood, alternatives such as cold-formed steel, wood and plastic fiber composites, synthetics and polymers, all of which are

high strength and light weight, will emerge as viable and competitive alternatives to solid lumber. Technical challenges, such as developing viable adhesives and pin connections for steel framing, will be developed as these technologies mature.

Trends toward using finish materials that are more common in site building will continue to bring the appearance level of manufactured homes up to the level of site-built homes. For example, gypsum wall board will take market share from vinyl wall coverings. These changes, in turn, will alter the production process, just as the space needed to perform certain types of production tasks will dictate plant size and layout.



Finally, home manufacturing technology will become more diversified, allowing innovative companies to develop and bring to market building systems and subassemblies that owe little to the current production paradigms.

THE DESIGN AND ENGINEERING PROCESS

Challenge

The process of designing and engineering manufactured homes has advanced only marginally over the last several decades. As a result, manufactured housing has yet to completely fulfill the promise of building in a controlled environment, and HUD-Code housing has not taken full advantage of the preemptive, performance-type building standard it operates under. In addition, the limitations of some of the existing system designs, developed in an era when decisions were principally cost driven (particularly for HUD-Code housing), are becoming a drag on innovation. In response, the manufactured housing industry will need to rethink, redesign and reengineer its products from the ground up.

Vision

The industry will fully exploit information technology and computer simulation to completely transform how homes are designed and engineered in a factory. The result will be levels of cost-effective design flexibility unimaginable even a few years ago. The industry will be unique in its ability to combine the cost advantages of mass production with individualized customization so clearly desired by the home-buying public.

R&D Focus Areas

- Incorporating systems-integration thinking into the design and engineering process, i.e., redesigning whole building systems rather than individual subparts.
- Developing interactive simulation software capable of routinely performing sophisticated design and engineering analyses, such as dynamic modeling of wind, flood and seismic effects.
- Enhancing communication between engineering and the plant floor.
- Creating opportunities for direct involvement of consumers in the design process, perhaps through retailers.

Discussion

In the near future, the manufactured housing industry will routinely use information and design and engineering technologies that are major leaps beyond current practice. These new technologies will be developed specifically to leverage one of the industry's key assets: the almost complete control and mastery of the building process. Among the innovations that will be leveraged by home manufacturing in the future are the following:

- Computer-based simulation and other tools that better predict how homes will perform under normal or extreme loading conditions. These will be developed and incorporated into the home engineering process. This new ability to understand and model the performance of the home will forge a stronger link between the design of the home and the selection and design of the foundation system.

- The use of analytical software for assessing large component assemblies and the interactions of their constituent components.

- Advances in communication technology that seamlessly link design and engineering changes to the plant floor, thereby enhancing the manufacturers' ability to mass customize their homes.

- Greater emphasis on systems integration thinking. Building systems, including roof, wall and floor systems, will be rethought, and will become less constrained by methods and materials that are currently common in the industry. A systems approach may even eliminate some current technologies—such as duct systems—that may prove to be suboptimal.

- Research aimed at reinventing the home will challenge the existing ways of building, as demonstrated by advances resulting from cooperative ventures between auto makers and the federal government.

THE SITE

This chapter focuses on an often overlooked component of the manufactured housing production and delivery process: the sites where manufactured homes are placed. Considerable opportunities exist to add value to the manufactured home once it leaves the factory. Opportunities exist for improving strength and durability through enhanced installation procedures and implementing a variety of site-built amenities that expand the quality and functionality of the home. The manufactured housing industry is committed to exploiting these opportunities as a means to enhance the overall performance of its core products and increase customer satisfaction. The Manufactured Housing Improvement Act of 2000 is a major step towards providing clear and consistent guidance to work performed at HUD-Code home installation sites.

A sustained program of R&D is central to this commitment. The following areas are key to adding value to the home after it leaves the manufacturing facility:

- Site Preparation
- Transportation to the Site
- Installation at the Site

SITE PREPARATION

Challenge

Site preparation—from foundation systems for individual homes to essential infrastructure for land-lease communities and/or planned-unit developments—can have a major impact on the long-term performance of manufactured homes. To create true value for consumers and continue to drive down the overall costs of home ownership, the manufactured housing industry must begin to think differently and address site-related issues and opportunities. A holistic approach that optimizes not only the individual unit, but also the foundation on which it rests and the external infrastructure on which it depends, will be necessary if manufactured housing is to continue to be a key source of high-value, low-cost housing in the US.

Vision

The manufactured housing industry will ensure that the sites and foundations on which its homes are placed achieve the same levels of performance and quality as the homes themselves.

4.1.3 R&D Focus Areas

- Developing advanced foundation systems that qualify for real property financing and are less costly than traditional crawl, slab and/or basement systems.
- Exploring innovative site services that can help drive down the costs of homeownership.
- Integrating the design of the home with the design and layout of the site services.
- Developing site planning guidelines that help planners and installers recognize how their decisions impact quality, home durability and performance.

- HUD-Code home insurers' second largest source of losses is wind damage linked to poor installation, specifically movement of the home due to insufficient anchoring. The top loss category, moisture damage, also largely stems from inadequate installation, which leads to pooling of water under the home, bottom board damage and freezing pipes.[27]
- According to the CASA National Database, the number one recurring post-production service issue is "set up/installation—footings, piers, strap anchors, water system."[28]
- Many states have lax installation standards that are poorly enforced. Training and licensing requirements for home installers are cursory or non-existent in many states.

Discussion

Measures taken to assure that the building site is properly prepared when the home arrives for installation will play an important part in assuring that the home is installed properly and performs well over time. Several factors in site preparation are particularly critical, including proper grading, appropriate location of services, and a foundation that marries well with the design of the home. Among these considerations, the foundation design offers the greatest opportunity for innovation. Whereas site-built homes are built to a pre-existing foundation, foundations for manufactured homes are often built prior to the arrival of the nearly complete home. Home and foundation are mated together at the site. Therefore, the installer must precisely size and configure the foundation design to match the home. Dimensional coordination is particularly critical when installing the home on a basement or perimeter-bearing system.

Foundations will continue to receive considerable attention in the future as real property financing grows, and the definition of what constitutes a permanent foundation is further clarified. Developing and refining foundation systems that conform to an evolving definition of "permanent" yet are cost-effective will be a major research focus in the next decade.

Community developments will increasingly dictate home design and installation, thereby seeking to take advantage of the opportunities afforded by planned-unit development. For example, efficient central systems will replace individual unit services (heating and cooling systems), and distributed power generation will become increasingly popular as a hedge against increased energy cost.

TRANSPORTATION TO THE SITE

Challenge

Major structural stresses are imposed on the home during transport, potentially resulting in damage that can undermine some of the quality built in at the factory. This may require repairs at the site contributing to a negative perception among consumers. Despite these concerns, transportation issues have received relatively little research attention in the past.

Vision

Manufactured homes will arrive at home sites in virtually the same condition as when they left the factory.

R&D Focus Areas

- Developing and deploying technologies for defect-free transportation of manufactured homes.
- Analyzing transportation practices and the modes of failure associated with particular approaches and methods.
- Developing and testing alternative transportation system components that are high performance, low cost and potentially more fully integrated into the home's structural system.

Discussion

Home quality is a function of the weakest link in the process leading up to occupancy. Therefore, improving the total performance of the home requires assessing and continually improving every stage of construction—whenever opportunities exist for quality to be compromised—including transport of the home from the plant to the retail

center and/or the building site. Generally, the home is exposed to structural stresses during transport that are different from, and in many ways exceed, what the home experiences after occupancy. The manner in which these loads are transferred through the structure will impact home quality, durability and, ultimately, consumer satisfaction.

The current typical transportation system—a wooden framed structure sitting atop a steel chassis—has been continually refined by manufacturers for the past 50 years. Still, opportunities exist for improving the design of the transport system. In particular, solutions that treat the home's frame and the transport system as a whole, integrated structural component will be important. New and innovative approaches to the design of the transport system could have other advantages, such as lower transport profile, which would allow higher pitched roofs; developing new approaches to perimeter bearing, which would expand foundation system options; and elimination of structural redundancies, which would reduce overall costs.

INSTALLATION AT THE SITE

Challenge

While manufactured homes arrive at the site nearly complete, siting and setting the home on its foundation play a major role in determining construction quality, performance and durability. Proper installation procedures will preserve the quality built in at the plant; poor installation quality can lead to a host of structural and other home performance failures.

Installation is potentially the weakest link in the manufacturing/construction process. Therefore, it's increasingly the focus of industry, government, homeowners and insurance companies intent on continually enhancing quality and safety, and further minimizing warranty and repair costs.

Unlike manufacturing, the installation industry is fragmented, and consists mainly of a large number of small companies. This makes it exceedingly difficult to introduce new methods and procedures into the installation process. In addition, lacking nationally-accepted installation standards, practices vary widely. As a result, an industry that draws much of its competitiveness from uniformity and standardization of manufacturing methods across state and regional boundaries is severely limited in its ability to bring the same efficiencies to the methods of installing the home at the site.

Largely intended to establish more controls, oversight and standardization of installation practices, Congress passed the Manufactured Housing Improvement Act of 2000. Steps taken in the implementation of the Act, particularly the recommendations of the HUD Manufactured Housing Consensus Committee, will be the major impetus for improving installation practices in the future.

Vision

The manufactured home installation process will be equivalent to the factory production process in terms of construction quality and lack of defects. This will be the result of two factors: first, new procedures, methods and controls will be instituted that assure that the home will be properly set at the site; second, manufacturers will make changes in the home that minimize the opportunities for errors during the installation process.

R&D Focus Areas

- Examining existing databases to analyze sources and types of installation problems.
- Preparing pre-engineered designs to cope with simultaneous multiple natural hazards, such as winds and flooding.
- Developing and promoting user-friendly installation guides that conform to the new national installation standards.
- Developing and promoting a training and certification system for installers. Creating incentives targeted to homebuyers and retailers to buy into this system.
- Investigating how the installation process, including site preparation, transportation, foundation construction, connection to the foundation, and connection of services affects the durability of the homes.
- Devising a system to better track the performance of homes.

Discussion

Installation is a key issue that is currently confronting the industry, and is critical to optimizing the overall delivery system for manufactured housing. Among the trends anticipated to positively impact the installation process in the near future are the following:

- New and more efficient communication channels will be available linking the home manufacturer with the site installers. This will provide a ready avenue for installers to understand manufacturers' intentions with regard to construction method and design practices and will, therefore, quickly and effectively resolve issues that arise during home installation.
- The methods of placing and securing the home to the ground will diversify and become more economical. In an effort to balance cost effectiveness and performance, the industry will develop a greater array of foundation and support systems that are both economical and durable. The definition of what constitutes a permanent foundation will evolve as ways to gauge foundation performance are better and more flexibly defined.

THE MARKET

This chapter focuses on the socioeconomic environment within which manufactured homes are designed, constructed, sold and installed; in other words, the manufactured housing market.

While there is growing acceptance of manufactured housing for single-family detached homes, barriers still remain to the widespread, cost-effective use of this type of construction. At the same time, substantial opportunities exist to extend the benefits of factory production to other housing types beyond the traditional single-family home.

The manufactured housing industry is committed to both overcoming current barriers within its traditional market, and aggressively exploring new markets where the benefits of factory production can be applied to other housing types.

In order to focus R&D activities related to the market, industry representatives have identified three key challenges facing the industry today:

- **Design for an Evolving Marketplace**
- **Financing**
- **Regulatory Environment**

Each of these challenges deals with issues that are currently confronting the industry and that are deemed to be critical for the future of the industry as a whole. These issues are described in more detail below, together with the industry's vision of how it intends to respond to—and benefit from—these challenges over the coming decade.

- Lending practices across the industry, recognized as problematic in the past, are under new scrutiny, with industry-led solutions, such as HUD-Code housing's now emerging LBP2[29] program.
- The trend of titling and re-titling HUD-Code homes as real estate appears to be rising,[30] indicating an increased use of real estate mortgages to finance HUD-Code housing.
- While traditional, stick-built housing has weathered the recent economic downturn well, actually acting as a bulwark against recession,[31] HUD-Code housing sales and shipments continue to languish, in part due to the large spreads between mortgage rates for site built verses HUD-Code housing.
- Titling of new HUD-Code homes as real estate stands at 22% of all homes and is growing, while titling as personal property (chattel) is used for about 74% of homes.[32]

DESIGN FOR AN EVOLVING MARKETPLACE

Challenge

As housing prices continue to rise across the country, demand continues to grow for housing products of all types that drive down first costs while maintaining quality. The manufactured housing industry has traditionally led the nation in providing such housing in its core market: the modestly priced, single-family detached home. The industry's challenge for the next decade will be twofold:

- Continuously improving service to its traditional market: the modestly priced single-family home in both land-lease and private property settings.
- Extending the advantages of factory production to other single-family markets and to other forms of housing such as housing for seniors, new Americans and urban infill.

Vision

While continuing to be the premier provider of high quality, highly affordable entry-level single family homes, the manufactured housing industry will aggressively expand its product offerings across the housing spectrum. As a consequence, within the next decade manufactured housing will be utilized in a growing proportion of the total single-family detached market—including markets traditionally served only by site builders—and increasingly in non-traditional markets, such as attached housing.

R&D Focus Areas

- Exploring the role and impact of land-lease communities on housing affordability in the US.
- Developing and deploying hybrid home designs that combine manufactured and site-built components.
- Analyzing and creating prototype designs for specific housing applications, e.g., attached single-family, urban infill.
- Analyzing and creating prototype designs for specific niche housing markets, e.g., assisted living housing, special needs housing, accessible housing.
- Developing methods, such as information technology and simulations, for providing increased design flexibility to customers, particularly site-built developers, as a means to expand the manufactured housing product line and its customer base, i.e., designing to meet the market, including regional variation.
- Enhancing the accessibility and visitability of all manufactured homes.
- Developing a recycling program to encourage the replacement of older homes with energy-efficient affordable homes.
- Creating more upscale designs of high-quality homes.

Discussion

The core market for the manufactured housing industry has been, and continues to be, buyers of modestly priced, single-family detached homes located in suburban and rural areas. Well into the foreseeable future, this part of the housing market will provide a foundation for the industry. In fact, competitive pressures and increasing labor costs will increasingly make manufactured housing the only option for moderately priced homes.

But the market will also fragment in more fundamental ways. Manufactured housing's pricing advantage and increasing design diversity will spur industry growth into the lower end of what is today mainly site-built housing. Developers will recognize the compelling advantages of buying homes built in a plant. Within ten years, a much larger proportion of homes under the median home price will be manufactured, either as HUD-Code or modular. Site-building practices will be pushed out of the bottom of the housing market. This trend, already well under way, will accelerate. What will emerge is a manufactured housing industry consisting of two increasingly distinct parts: a low-end, highly affordable home mainly comprised of single-section and low-cost double section designs; and higher priced multi-section designs with a greater percentage of work completed at the building site. Cost and loan qualification (i.e., chattel versus real estate financing) will continue to be the impetus in design decisions and product choice.

The lower cost homes, in many respects, will be similar to homes built today, with cost-effective enhancements. In contrast, the upscale segment of the future manufactured housing market will be distinct in the way the home is designed (i.e., away from the boxy look), marketed, purchased, financed, and sited. This represents a movement away from a commodity orientation that tends to view all housing products as interchangeable.

Coupled with this trend will be an evolution in the typical profile of buyers of manufactured homes. The demographics of the typical manufactured home buyer will change, with an increasing proportion of middle-income households purchasing manufactured homes in subdivisions. While the industry will continue to serve homebuyers at or below the median local income, an increasing proportion of middle class households will purchase manufactured homes. In addition, manufactured homes will increasingly be located in metropolitan and suburban

areas where buyers have higher incomes but are still at the low end of the regional market.

To serve these markets, industry will perfect two- and three-story house construction methods and foundation designs. In particular, more emphasis will be placed on innovations in the designs of the floor system, the vertical connection between home sections, and tilt up roof systems. The trend toward multi-story homes will lead to the use of manufactured homes in older, redeveloping communities.

In the realm of home sales, marketing and development, retailers will be joined by companies that are, today, small volume stick builders (fewer than 100 homes per year) and public-private partnerships, the latter playing a larger role in the provision of urban infill housing. Nonprofits, in particular, could play a significant role in community development, and might be major customers for manufactured housing. For the most part, production builders are already using off-site subassemblies, and are less likely to gravitate to manufactured housing.

Other important markets for manufactured homes include land-lease communities and subdivisions. Communities will play a larger role in controlling home aesthetics. Home sites will become smaller with consumer financing governing growth. Strategic partnerships between community developers and manufacturers will drive new product technologies. The current crisis in chattel lending will drive more land-lease community owners into subdivision development.

Industry will also make every home accessible. Homes will have visitability, (i.e., at least one entrance with no steps), and building homes around universal design practices will be commonplace.

Finally, programs for recycling old homes that are antiquated will become more popular as a nationwide effort to get people in affordable, efficient, highly functioning homes takes hold. This might take the form of a centralized repurchase/recycling program supported by low cost loans from public agencies.

FINANCING

Challenge

The financial landscape for HUD-Code housing is experiencing fundamental, systemic change. To move forward effectively over the coming decade, the HUD-Code housing industry needs to work with financial institutions across the country to ensure increased stability and flexibility in the HUD-Code home loan market, for new homes and existing homes.

Vision

Financing for HUD-Code homes will become more stable, flexible and transparent in its structure and implementation, as it is now for site built housing. It will be focused on serving the customer—the HUD-Code home owner—and on increasing the customer's ability to create value and equity through owning a HUD-Code home. Lenders, in general, will more fully embrace manufactured housing. Broader secondary market support from Fannie Mae, Ginnie Mae and Freddie Mac will be forthcoming. Real estate loans will become prevalent; however chattel lending will remain significant in major segments of the industry.

R&D Focus Areas

- Investigating the impact of alternate types of foundations on financing.
- Analyzing the future of chattel loans.

- Exploring the financial barriers to affordable manufactured housing.

- Evaluating Fannie Mae's, Freddie Mac's and the USDA Rural Housing Service's knowledge about financing of manufactured housing.

Discussion

Financing of HUD-Code homes is undergoing a natural evolution in response to a tightening of underwriting standards. Traditional lenders are leaving the industry or substantially altering their business models. In response, new initiatives, such as MHI's Lender Best Practices program, are emerging to help rationalize and stabilize the financial side of the industry.

While the trend toward increased levels of real estate financing for HUD-Code homes will likely continue, total HUD-Code housing shipments continue to be low relative to the levels maintained in the late 1990s. This comes at a time when traditional stick-built housing—and the mortgage markets that support it—has enjoyed solid growth, primarily as a result of continued low interest rate mortgages. The shift towards real estate mortgages for HUD-Code homes is being driven by high loan delinquency and repossession rates which have raised the asset-backed securities market's cost of funds to the industry. This trend is expected to top out when 50-65% of HUD-Code homes are real estate financed.[33]

To move beyond this period of structured change, the industry needs to remain on top of, and be quickly responsive to, shifts within the financial sector. For example, lending institutions will continue to give preferred rates to homes built on permanent foundations, and will increasingly emphasize the quality of installation and finishes and the design appeal of the home when making financing decisions. One emerging trend is the increasing involvement of land-lease community owners with subdivision development. Community owners are looking to subdivision development as a way of reducing their dependency on the troubled chattel loan market and converting more of their business to real estate financed sales. The industry will need to accommodate these and other concerns if it hopes to reach and serve middle-income buyers.

REGULATORY ENVIRONMENT

Challenge

Federal standards and enforcement procedures are the benchmark for the design and construction of all HUD-Code homes. The revamping of the standards updating process, currently underway, may lead to far-reaching changes in standards and enforcement procedures. Regulation of modular and site-built construction will follow a different path shaped by the national trend to standardize building codes, and the willingness of states to allow reciprocity with other state building statutes. The future of HUD-Code housing will be strongly influenced by both these trends.

Vision

The industry will adopt a proactive stance with respect to an evolving and potentially volatile regulatory environment. This will include active attention to, and participation in, regulatory developments outside the traditional boundaries of the HUD-Code, specifically in modular and site-built construction.

R&D Focus Areas

- Evaluating the evolving Manufactured Home Construction and Safety Standards in relation to International Residential Code.

- Evaluating how the regulatory environment, including zoning covenants, stifles or restricts innovation.

- Clarifying how far the HUD-Code home definition extends with respect to site-built construction, particularly components added or homes finished on-site.

- Exploring innovative alternatives to Alternate Construction letters, and other opportunities for site work, to be more explicitly part of the HUD standards and enforcement regulations.

Discussion

Change will continue to alter the regulatory environment for manufactured housing. In the first place, states will begin to assume a larger role in the regulatory and enforcement process, particularly with regard to oversight of the HUD-Code home installation process. Additionally, individual states will continue to play a large role in what gets built and installed in that state. This will impact zoning in a positive way as city and county officials recognize HUD-Code housing's intrinsic value. There will also be more reciprocity of codes among jurisdictions.

In a different arena, the regulations that govern HUD-Code construction will be impacted by the Manufactured Housing Improvement Act and the recommendations of the reconstituted HUD Consensus Committee. This will impact the coverage of the standards and the frequency of updates to the standards. In the near future, the HUD standards and enforcement procedures will adapt far more rapidly to changes in industry practice and new directions in home manufacturing, design and installation.

Changes in enforcement procedures will also help clarify oversight responsibility and encourage innovation. Alternate construction letters will only be required when the product finished on site does not meet the HUD standards. This will place more responsibility on the Design Approval Primary Inspection Agency (DAPIA) and the Production Inspection Primary Inspection Agency (IPIA) to inspect on site and expand their responsibility to work with local officials.

The mid- and long-term future will see more fundamental changes in manufactured housing regulations. Currently, by virtue of the preemptive nature of the standards, the HUD-Code housing industry views itself as independent and self-contained, separate from other building codes. When a national model code begins to emerge, however, the industry is likely to be caught up in the trend within the site-built industry to adopt more uniform, international, standards. The justification for having nationally preemptive standards may diminish as the code bodies continue to consolidate and regional regulations give way to national statutes (a parallel can be seen in the demise of the FHA code when HUD recognized that the model codes were equivalent to the Minimum Property Standards).

Some of the specific changes that may be in store include the following:

- Driven in part by the fact that manufacturers will be producing both types of homes, HUD-Code, modular design and construction will be increasingly similar. There will be increasing interest in creating uniformity between HUD-Code and modular requirements as the two sectors intermingle and merge.

- One of the more speculative scenarios has HUD standards as part of the International Residential Code (IRC), perhaps with requirements specific to HUD-Code homes in an annex. Such a document would have special sections covering transportation criteria for modular and HUD-Code construction. Alternately, the HUD-Code might reference the IRC and contain only the differences between the two codes until those differences become minimal. Because state and local authorities ultimately will determine local interpretation and implementation of the IRC, federal preemption of the HUD-Code, a cornerstone of industry cost competitiveness, will need to be maintained.

- Separate requirements might be developed for certain unique constructions and applications, such as single-wide homes or rental communities, the latter being differentiated by type of financing.

- With these changes, the need for the permanent chassis will be questioned. This change will accelerate innovation in floor system design, in the development of multistory designs and in the use of permanent foundations.

THE CONSUMER

This chapter focuses on the people who underpin the ultimate success or failure of the manufactured housing industry: the home-buying and home-owning public. Considerable opportunities exist for both increasing customer satisfaction with current manufactured housing products, and for extending the benefits of manufactured housing to new customers. The manufactured housing industry is committed to pursuing a vigorous program of research and development along both these tracks.

As a means of organizing and optimizing these R&D activities, industry representatives have identified two key customer-related challenges currently facing the industry:

- **Consumer Perceptions**
- **Operation and Maintenance**

Both of these challenges deal with issues that are currently confronting the industry, and that are deemed to be critical to maintaining and expanding manufactured housing's customer base going forward. These issues are described in more detail below, together with the industry's vision of how it intends to respond to—and benefit from—these challenges over the coming decade.

- One survey of community residents who lived in site-built homes in eight non-metropolitan counties in Virginia found that the strongest negative perceptions of HUD-Code homes were as follows: (1) they did not increase property values; (2) they did not promote a better social image; and (3) they did not increase neighborhood satisfaction. This study found that older HUD-Code home parks and single sections, in particular, fueled negative perceptions of HUD-Code homes.[34]
- Other issues cited in the Virginia survey that draw negative perceptions include: concerns about safety, quality, appearance and appreciation; prejudice against all types of low-income housing; and the crowded, poorly maintained, improperly managed state of many HUD-Code home parks.
- Several studies have established that HUD-Code housing buyers are attracted by affordability, low maintenance costs and less upkeep, desire to own as opposed to rent their home, expediency of purchase, and ease of design changes.[35,36]
- The industry generally believes that the public harbors the following negative perceptions of HUD-Code homes when compared to other types of single-family housing: They are more prone to fire and less energy efficient; they have greater concentrations of indoor pollutants; they are not as long lasting or durable; and they do not appreciate in value. Arguments rebutting these perceptions have been made widely available within the industry itself.[37]
- Maintenance and repairs accounted for roughly one quarter of total home remodeling expenditures in 1999.[38]

CONSUMER PERCEPTIONS

Challenge

Among all the various methods to construct housing, HUD-Code homes may elicit the strongest preconceived reactions from homeowners, homebuyers, public agencies, and the industry itself. Notions about quality, value and other attributes of HUD-Code housing are commonly outmoded, and are often based on old design, construction and installation practices. Public perception, often shaped by older, poorly maintained or abandoned pre-HUD-Code mobile homes, has not kept pace with the rapid changes in home design that have dramatically transformed the industry over the last decade. And, as HUD-Code homes continue to improve, the gap between perception and reality will widen without concerted efforts to educate potential consumers.

Vision

Within the next decade, the home-buying public will have a new understanding of, and appreciation for, HUD-Code housing and its high value, relative to other modes of construction. They will recognize that HUD-Code homes are a good investment; they will understand the benefits associated with building homes in a factory; and they will have a true basis for comparing HUD-Code and other types of homes based on objective criteria and accurate information. They will also appreciate the role HUD-Code housing plays in serving the nation's housing needs.

R&D Focus Areas

- Developing an industry-wide initiative for recycling older, HUD-Code homes that have outlived their useful life. Also, offering incentives to communities for their efforts in this area.
- Exploring cost-effective techniques for upgrading the performance and appearance of land-lease communities.
- Obtaining consumer input and reaction to industry research and technological developments.
- Educating community leaders and government officials about manufactured housing.

Discussion

Among the many changes that will characterize the manufactured housing industry in the future, none will be more profound than the recognition among the general public of the importance of the industry in serving the nation's housing needs, and the benefits associated with building homes in a factory.

Appearance is a major factor in a home buyer's selection process. Home buyers traditionally oriented only toward site-built products will perceive manufactured housing as a viable, and even preferable, residential alternative. With a greater variety of architectural styles, and the addition of more site-installed elements, the physical appearance of most HUD-Code homes will provide few signs that they are built in a factory and based on a rectangular geometry.

Among the consequences of this change in perception is that people living in manufactured homes will have a different attitude toward their homes, including a high level of pride. The industry will continue to develop a better understanding of their homebuyers and the key features that convey value, and that create a sense of pride in home ownership. Community leaders will also share in understanding the value of manufactured housing. The use of demonstration projects will expand as an effective means for illustrating the ability of industry to provide high quality, affordable housing.

People will also recognize that manufactured homes are a good investment because they are inherently among the most energy efficient housing options, have low maintenance costs, are durable, and often appreciate rather than depreciate. The relative economies of factory production will generate cost savings that are plowed back into the quality and finish of the home.

OPERATION AND MAINTENANCE

Challenge

Americans who owned their own homes spent over $24 billion on maintenance and repairs in 1999. While some ongoing expenses to operate and maintain a home are to be expected, driving down these costs as much as pos-

sible—by constructing more durable homes and by developing cost-effective preventive maintenance programs—will benefit consumers across the country. At the higher end of the manufactured home price spectrum—particularly homes that are financed as real estate—consumers will benefit from less out-of-pocket expenses and from the reinforced perception that they have, indeed, purchased a higher quality home. At the lower end of the spectrum, where money for even modest repairs is often tight, consumers will benefit from durable homes that will not deteriorate, even if some maintenance is deferred.

Vision

The manufactured housing industry will be at the forefront of efforts to improve the durability and maintainability of the nation's housing. By developing methods to reduce homeownership life-cycle costs, the industry will improve the overall affordability of manufactured homes.

R&D Focus Areas

- Developing guidelines for remodeling and refurbishing existing, older manufactured homes as a means to extend their lifetimes.
- Exploring the role of community owners in remodeling/refurbishing manufactured homes.
- Exploring the role of third-party organizations in remodeling/refurbishing manufactured homes.
- Analyzing and characterizing the size, scope and activities of the manufactured housing repossession and resale industry.
- Developing home designs that are less expensive to remodel or refurbish.
- Developing a process for qualifying older homes under the current HUD-Code standards.
- Developing guidelines for operating and maintaining manufactured homes.
- Developing and deploying a preventive maintenance program specific to manufactured housing—an owner's manual for optimizing a home's performance.
- Analyzing the major drivers of manufactured home operation and maintenance costs, investigating ways to minimize these costs when designing new homes, and taking preventative actions in old homes.
- Developing models to improve the level of pride that consumers experience.

Discussion

While not traditionally a concern of the manufactured housing industry, cost-effective operation and maintenance is increasingly important to the industry's key constituents: homeowners and potential homeowners. Developing strategies and guidelines to help these constituents better operate and maintain their homes will reap the twin benefits of better long-term housing performance and, as a consequence, increased customer interest in, and loyalty to, manufactured housing.

The consumer holds a unique place in the industry. If consumers are hesitant to accept manufactured housing or have questions about issues such as durability and appreciation, then manufactured housing will be slower to gain market share.

END NOTES

[1] Much of the statistical information in this report pertains to homes built under the HUD Standards due to the dearth of reliable statistical data on modular housing.

[2] Hallahan Assoc., Fred C. Hallahan.

[3] *Report of the Bipartisan Millennial Housing Commission,* Washington, DC, May 30, 2002.

[4] *The State of the Nation's Housing 2002,* Joint Center for Housing Studies of Harvard University, 2002.

[5] ibid.

[6] ibid.

[7] ibid.

[8] ibid.

[9] ibid.

[10] *The Truth About Regulatory Barriers to Housing Affordability,* National Association of Home Builders, 2002.

[11] *Report of the Bipartisan Millennial Housing Commission,* Washington, DC, May 30, 2002.

[12] ibid.

[13] *2003 Quick Facts,* Manufactured Housing Institute, Arlington, VA, 2003.

[14] *Factory and Site-Built Housing: A Comparison for the 21st Century,* National Association of Home Builders-Research Center, Washington, DC, October 1998.

[15] *State of the Nation's Manufactured Housing,* Apgar, W., M. Duda, and M. Pill, Joint Center for Housing Studies of Harvard University, 2002.

[16] ibid.

[17] *Strategic Plan for Manufactured Housing R&D: Innovation Through Collaboration,* Manufactured Housing Research Alliance, New York, NY, January, 2002.

[18] *Forms EIA-457 A-G of the 1997 Residential Energy Consumption Survey*, Energy Information Administration, Office of Energy Markets and End Use, 1997.

[19] *Paper Tiger Missing Dragon,* Consumers Union, Austin, TX, November 2002.

[20] *The Ten Most Wanted: A Search for Solutions to Reduce Losses From Recurring Natural Hazards,* The American Society of Civil Engineers and The Institute for Business and Home Safety, 2001.

[21] ibid.

[22] *Healthy Buildings, Healthy People: A Vision for the 21st Century,* U.S. Environmental Protection Agency (EPA 402-K-01-003), October 2001.

[23] Materials Used in Building a Single Family Home, National Association of Home Builders, http://www.nahb.org/generic.aspx?genericContentID=516, accessed on January 23, 2003.

[24] *Technology Roadmap: Whole House and Building Process Redesign Year One Progress Report,* Partnership for Advancing Technology in Housing, 2002.

[25] ibid.

[26] *Technology Roadmap: Information Technology to Accelerate and Streamline Home Building Year One Progress Report,* Partnership for Advancing Technology in Housing, 2002.

[27] Conversation with State Farm Insurance, May 31, 2002.

[28] CASA National Database, 2001.

[29] *Lender Best Practices Program.* Manufactured Housing Institute, 2002.

[30] *Quarterly Economic Report,* Manufactured Housing Institute, Vol. 1, No. 2, October 2001.

[31] *Safe at Home: The New Role of Housing in the U.S. Economy;* Buchholz, Todd G.; Homeownership Alliance; 2001.

[32] *Just the Facts,* Manufactured Housing Institute, Arlington, VA, May 27, 2002.

[33] *Trends and Issues in the Economics of Manufactured Housing,* Clifton, James A., Presentation before NAHB Construction Forecast Conference, Washington, DC, April 25, 2002.

[34] *Not a trailer anymore: Perceptions of manufactured homes,* Beamish, J, et. al., Housing Policy Debate, Volume 12, Issue 2. Fannie Mae Foundation, Washington, DC, 2001.

[35] *Manufactured Homes, The Market Facts,* Foremost Insurance Company, Grand Rapids, MI, 1999.

[36] *Focus Group Study Shows Old Prejudices Still Prevail,* Manufactured Home Merchandiser, pp. 20-26, November, 1994.

[37] *Perceptions versus Reality,* Tennessee Manufactured Housing Association, 2002.

[38] *Housing Facts, Figures and Trends,* National Association of Home Builders, Washington, DC, June 2001.

PATH (Partnership for Advancing Technology in Housing) is a private/public effort to develop, demonstrate, and gain widespread market acceptance for the next generation of American housing. Through the use of new or innovative technologies the goal of PATH is to improve the quality, durability, environmental efficiency, and affordability of tomorrow's homes.

PATH is managed and supported by the U.S. Department of Housing and Urban Development (HUD). In addition, all federal agencies that engage in housing research and technology development are PATH partners including the Departments of Energy and Commerce, as well as the Environmental Protection Agency (EPA) and the Federal Emergency Management Agency (FEMA). State and local governments and other participants from the public sector are also partners in PATH. Product manufacturers, home builders, insurance companies, and lenders represent private industry in the PATH partnership.

To learn more about PATH, please contact:

PATH
Partnership for Advancing Technology in Housing

451 Seventh Street, SW
Washington, D.C. 20410
202-708-4250 (phone)
202-708-5873 (fax)
e-mail: pathnet@pathnet.org

Visit PD&R's Web Site
www.huduser.org
to find this report and others sponsored by
HUD's Office of Policy Development and Research (PD&R).
Other services of HUD USER, PD&R's Research Information Service, include listservs;
special interest, bimonthly publications (best practices, significant studies from other sources);
access to public use databases; hotline 1-800-245-2691 for help accessing the information you need.