Chapter 1

Technology, Trade, and the Future of the U.S. Housing Construction Industry

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While technical change in the U.S. construction industry has proceeded more slowly than forecasters once predicted, the past two decades have witnessed significant progress in the technology of the house itself, and in that of the appliances installed. These improvements have made structures easier and less expensive to build, and reduce energy and other operating costs. New equipment and housing designs can make interior spaces more comfortable, can permit greater control over the quality of indoor air, and can offer a variety of other amenities. New information technologies can integrate the network of diverse firms involved in construction. Such innovations can make it easier for prospective homeowners to **find** housing commensurate with their individual tastes, and may even allow them to participate in the design of the house to be purchased.

Has the U.S. housing industry taken adequate advantage of technologies that have improved quality and reduced costs in other industries? Might a shift to modern production technology reshape the domestic housing industry, change economies of scale and scope for individual businesses, and affect the number and nature of the jobs offered by the industry? If the industry comes to resemble other U.S. manufacturing industries, the potential for international trade in construction increases; how will the domestic industry fare against competition from sophisticated foreign producers of housing components and production equipment?

This report explores these questions in order to determine whether changes in public policy maybe needed to keep pace with technical change, particularly for smaller residential units. As home building comes to resemble other manufacturing industries, and as it grows from a local enterprise to one with regional, national, and international concerns, it is necessary to consider whether policies regulating home production should be commensurate with regulations that guide other types of factory production. Programs to subsidize home purchases, to conduct technical research, to establish fire and safety regulations and government procurement, and more, have a significant effect on the housing that reaches the American public. At present, however, housing policy in the United States is fragmented and lacks central coordination. It does not respond to the changing needs of the housing construction industry.

Technical change in the U.S. housing industry has not taken the form of a revolutionary shift from craft-based field erection techniques to factory-based production. Change has instead followed a complex and diverse course that is virtually impossible to document with precision. Most new homes built in the United States today use prehung windows and doors, and factory-made roof trusses or floor joists Wall panels and large three-dimensional modules are shipped to construction sites and assembled rapidly. Traditional "manufactured" (mobile) homes are constructed in factories that operate with improved production equipment. While statistics are confusing and often contradictory, it appears 10 to 35 percent of all new single-family homes built in the United States were constructed in factories—25 to 50 percent, if "manufactured" (mobile) homes are included. In many cases, however, the "factory" construction techniques used in the United States do not take advantage of the mass-production devices employed in the manufacture of products ranging from toasters to automobiles. These housing factories typically employ semiskilled workers in facilities where capital investments per worker fall below the standards of other production industries.

A number of foreign firms have moved aggressively into the business of producing housing components. Imported homes and joint ventures with foreign housing producers already exist in Texas, Florida, Massachusetts, Maine, New York, Rhode Island, Michigan, Minnesota, and Wisconsin. The Scandinavian nations and Japan lead in this area. while most foreign techniques do exist in the United States, many of these foreign producers have more experience in the use of modern production equipment for housing. Several foreign firms are large and efficient by U.S. standards. Some are parts of manufacturing concerns with access to elaborate research

facilities and huge engineering staffs, and with experience in production engineering. In particular, Japanese and Swedish firms benefit from both highly automated factories and substantial government-sponsored research programs. Swedish, Finnish, British, Norwegian, and other foreign firms also have extensive experience in exporting their products to the Middle East and elsewhere. These firms may soon penetrate U.S. markets with housing components, and may license technology to domestic producers, Foreign firms have already penetrated domestic markets for kitchen equipment, especially appliances. Japanese air-conditioners and refrigerators, and components of these appliances, have moved rapidly into domestic markets, while U.S. exports of appliances have stagnated.

THE IMPACT OF FACTORY CONSTRUCTION

Factory-based home construction technologies could affect both housing production techniques and the nature of the homes produced. Specifically:

- Improvements could be made in both uniform quality standards and energy efficiency for homes. Written guarantees of quality can be provided more easily.
- Computer-assisted design methods could give prospective purchasers greater control over the products they buy, and a greater ability to understand the relationship between added amenities and added costs.
- Overall construction times could be reduced. Factory-made components place a finished house on a foundation in 1 to 10 days. Among other things, this savings in construction time might reduce seasonal variations in construction rates.
- The role of large firms could be increased. Smaller firms can serve as independent site-assemblers of manufactured products, or as franchised agents of major producers.
- The overall labor productivity of construction could be increased, thereby reducing net labor requirements.
- The skill levels of workers could be upgraded in order to operate complex production equipment. On the other hand, skill requirements might also be reduced if firms opt to design production around minimum wage workers.

Changes in the construction industry are extremely difficult to document because of the way that statistics are maintained. For example, some data on factory construction of housing components are combined with information on several other manufacturing industries, under the general area of “fabricated wood products.” While anecdotal evidence supports statements about changes in such areas as skill levels in construction and the quality of different types of construction methods, reliable statistics are almost nonexistent.

BARRIERS TO THE ADOPTION OF NEW HOUSING TECHNOLOGY IN THE UNITED STATES

U.S. firms have been slow to adopt innovations in the production of housing for a variety of reasons:

. Wide swings in the demand for housing, resulting from the business cycle, changes in mortgage rates, and seasonal variations in home construction rates, make it difficult to justify large capital investments. It is far easier to maintain flexibility by laying off workers during slack periods.

- The regulation of housing in the United States developed in an environment where most builders were small firms operating in local markets. Housing regulation remains a State and local prerogative. Thousands of local code variations make it difficult for a single firm to oper-

ate in a market large enough to justify "economy of scale" production facilities. Interestingly, similar fragmentation in the appliance industry has led manufacturers to support strict Federal preemptive standards, which would negate the effects of conflicting State and local codes and would facilitate industry expansion.

- The industry is so fragmented and diverse that little research is conducted to improve the technology of either the structures produced or the manufacturing process. Government support of construction-related research is virtually nonexistent.
- The economic advantages of factory construction have not been clearly documented in the United States, although a number of anecdotes suggest that significant savings in labor and materials may be attained through improving construction techniques. But competition with conventional construction techniques has proven difficult in regions where conventional costs have remained low because employees will work for modest wages, with little job security. Also, the U.S. housing market has not put a premium on the quality that can be offered by factory construction.
- Housing markets in the United States have traditionally associated factory production with low-cost, low-quality, "prefab" units. In Sweden and Japan, however, factory construction has been marketed successfully because of its association with high reliability and high quality, as well as with advanced production techniques.
- Most homebuilders in the United States are too small to make the capital and engineering investments necessary to automate production.

INTERNATIONAL COMPETITION

Foreign penetration of the U.S. housing and manufactured building industries is most likely occur in the following areas:

- Panelized *Building* Systems.—Some foreign companies, especially the Scandinavians, will find profitable market niches, particularly in the Northeast and in areas of the country where high-quality material finishes, competitive prices, high insulation levels, and the "Nordic" mystique will prove salable. Substantial overall market penetration in the next few years is improbable. However, foreign technological developments—especially in Japan and Sweden—should be monitored closely, as should American market attitudes and trends.
- *Appliances*. —While the United States has enjoyed a favorable trade balance in residential appliances for many years, the terms of trade may be reversing. In fact, between 1979 and 1984, U.S. real dollar exports of household appliances declined by approximately 30 percent, while real dollar imports increased by over 67 percent. The Japanese are beginning to sell products ranging from room air-conditioners to refrigerators to high-efficiency light bulbs. Competition is likely to increase as living standards in Europe and Japan change in ways that make domestic markets for appliances more similar to those of the United States. At present many imported appliances have qualitative advantages over competing U.S. products, particularly in the area of energy efficiency.

  The impact of these developments is already being felt. Many appliances produced in the United States now contain high-value components, such as compressors, that are manufactured abroad. General Electric, the largest domestic producer of room air-conditioners, has announced that it will phase out operations at its main Louisville factory, and Carrier has drastically curtailed production in New York.
- Wet Cores.—While foreign wet core modules that combine plumbing, wiring, bathroom and kitchen fixtures, appliances, cabinets, electronic space conditioning, and communications controls have not yet made a significant appearance here, they would be cost-effective products for many foreign manufacturers. Custom cabinetry, bathroom fixtures, and electronic gadgetry are some of the housing components that have already proven attractive to U.S. homeowners. It may make economic sense for foreign manufacturers to combine these elements into "smart" modules with exotic designs and finishes.

- *Materials, Components, and Equipment.—For*eign building-related products, including windows, kitchen cabinets, mechanical equipment, roof and floor tile finishes, and accessories, will gain an increasing share of the U.S. market. Although it is not within the scope of this report to provide research in this particular area, the potential impact on U.S. markets of foreign manufacturers may be significant. Several U.S. manufacturers assert that little organized or industrywide research has been conducted in this area.
- *Investors/Developers.* –A significant amount of foreign money has come into the United States for real estate development, most recently for the purchase of U.S. construction and design firms by foreign companies. In fact, heavy foreign investment has contributed significantly to the growth of the U.S. economy, despite the enormous balance of payments deficit. This trend will continue.

In some cases the purchase of a U.S. company has facilitated the entry of foreign companies into American markets by providing valuable insight into business trends. This purchase also allows the U.S. firm—and as a result, the foreign owner—to compete for U.S. Government projects nominally set aside for American companies.

Currently, few opportunities exist for U.S. firms to compete in overseas markets; the overall international construction industry has decreased in size over the past several years. Even within this restricted market, the relative share of U.S. firms has fallen. Factors affecting this trend include:

- increased competition from foreign contractors,
- lack of knowledge and experience in international trade,
- problems concerning building materials and building codes,
- trade restrictions,
- volatile political conditions in many foreign countries,
- corruption of foreign officials,
- distance from the United States to potential markets, and
- lack of U.S. Government support for trade initiatives.

Raw materials, such as wood and lumber, represent the only significant building-related export opportunity on the horizon for the United States. The only possibility for exporting U.S. manufactured buildings would be through assembling packages that combined buildings with project financing. Given appropriate investment in production and product design, U.S. firms could regain export markets for advanced appliances, controls, and other electronic equipment.

POLICY ALTERNATIVES

This document examines several possible remedies for the problems of the U.S. housing construction industry.

Improving the Fragmented System of Housing Regulation and Its Enforcement in the United States

At a recent conference hosted by the National Association of Home Builders, the major U.S. codemaking organizational concluded that:

> while there had been significant improvement over the years in administering and enforcing building codes, there were still disparities from one jurisdiction to the next in the way in which model building codes were adopted, interpreted, amended and enforced, which tends to defeat the primary purpose of creating uniform model building codes in the first place . . . the lack of reciprocity among regulatory jurisdictions and even the poor coordination among enforcement authorities within the same jurisdiction created unnecessary and costly delays in construction and thwarted the timely acceptance of new, cost-saving technologies.[2]

[1] The National Conference of States on Building Codes and Standards, the Council of American Building Officials, the Building Officials and Code Administrators International and the International Conference of Building Officials, and the Southern Building Code Congress International.

[2] Council of American Building Officials, News Release, March 1986, Falls Church, VA.

Furthermore, some housing producers have complained about discrepancies between State transportation codes concerning truck loads, which discourage industry expansion.

Regulation can be made more uniform in several ways. First, the Federal Government could play a more active role. This might be done through a modification or expansion of the existing national HUD code system for regulating the production of "manufactured" (mobile) homes,[3] although this system should be examined carefully before it is applied to other categories of housing. Second, a new system of uniform national standards could be devised, which could be either mandatory or constructed so that States would voluntarily elect to enter the Federal framework. Third, a series of State compacts and reciprocal agreements could be established, and encouraged by the Federal Government. Fourth, private systems could be implemented.

The meeting of home builders and code officials cited above endorsed a plan that would be administered by the States. A single code would be adopted by each State, and a uniform program of enforcement would be developed. "The code would be mandatory for all factory produced housing and all site-built housing constructed in jurisdictions currently using building codes."[4] A key element would be reciprocity, in which each State would accept the inspections of housing components conducted by other States.

Other options for action by regional groups or by the Federal Government include: developing systems in which third-party inspectors, such as Underwriters Laboratories, could undertake a larger share of the burden of inspection; providing support or guidance in training local inspectors and regulatory officials; providing assistance in the creation of new standards; and developing testing equipment to monitor these standards.

Any action that reduces the fragmentation of U.S. housing markets is likely to benefit large American construction firms, and may make domestic markets more comprehensible, and thereby more attractive, to both foreign and domestic companies. However, a "least common denominator" code could result, which may reduce the quality of housing regulation, or may create incentives to "build down" to minimum standards.

Revising the Current Process of Inspection for "Manufactured" (Mobile) Homes

Serious questions have been raised about the adequacy of the HUD inspection system even in its present form. A recent HUD-sponsored survey of "manufactured" (mobile) homes covered by HUD regulations found:

> ... an average of approximately 6.5 reported and/or observed problems per house which were identified in 78 or 96 percent of the houses inspected ... Sixty-five (65) or approximately 80 percent of the houses had additional problems which were observed by the field inspectors and had not been, in most cases, reported in the earlier [telephone] survey ... The number of problems reported in the survey raised questions regarding the integrity and quality of the houses which were produced during the 1977-1981 time period covered by this sample. The concern raised is validated by the number of affected houses and the number of problems *observed* by the field inspectors.[5]

The report concluded that "HUD should consider revising the Federal Standards to address long term requirements for material performance ... [Inspectors] should increase the attention given to workmanship on the production line, and increase their observations of in-plant testing."[6] If a national strategy is developed to improve regulation and enforcement systems for factory-built housing, it may be necessary to integrate regulation of "manufactured" (mobile) homes into the new system.

Labeling Building Quality

Labels that provide specialized information about the housing construction industry to potential buyers, bankers, and insurance firms can lead to technical

[3]The Housing and Community' Development Act of 1980 (Public Law 96-399) required that the term "mobile home" used in the statute establishing HUD's current mobile home inspection system be changed to "manufactured " This congressional intervention in semantics is admittedly confusing See ch. 2 for a discussion of the nomenclature used to describe factory-built homes

[4]CABO, op cit , 1986

[5]Resources Applications, Designs & Controls, Inc (RADCO), "Final Report for Durability' in Manufactured Homes," HUD Contract H-1 0992, Dec. 27, 1985, p. 77

[6]Ibid., p. 4.

improvements without mandating proscriptive regulation in areas not essential to health and safety. Labels might indicate that structures or components meet a fixed threshold of performance, much like the home energy rating systems now in place in a number of States and cities, or like the Japanese "Better Living" label that qualifies building components for group insurance. Energy efficiency labels could help purchasers make choices about houses in much the same way that miles-per-gallon stickers on automobiles or energy efficiency labels on refrigerators assist consumer decisions.

Increasing Government Support of Research in Building Technology

Despite the importance of research to the national economy, and its role as a major employer, neither the U.S. housing industry nor the U.S. Government have supported major research efforts to improve housing products or to upgrade the methods by which houses are built. While many component manufacturers have conducted significant studies, there is little support for an examination of how the house operates as an integrated unit to enhance human comfort. Misawa Homes of Japan spent 1.5 percent of its 1984 sales on research. Sweden, with a population of 9 million, spends more on housing research than the United States.

Several methods may accelerate technical progress in housing. Research alone will not automatically lead to a more productive, competitive industry, but it is an important ingredient for success. The National Conference of States on Building Codes and Standards (NCSBCS) notes that:

> Progress cannot be made in the use of new safe technologies in the building field without adequate funding of generic research, such as that done by the National Bureau of Standards.[7]

Reducing Excessive Changes in Housing Demand

Several techniques have been proposed for providing a "countercyclical" stimulus to the industry through counter-cyclical incentives and other methods. These include temporary interest reduction for housing loans and permanent interest reduction for loans to low-income families; tax credits for buyers of new or renovated homes, and for mortgage firms that encourage housing development; and buyer subsidies via tax-exempt mortgage revenue bonds.

While this issue will be addressed, a comprehensive examination of counter-cyclical alternatives is beyond the scope of this report.

[7]Comment of the National Conference of States on Building Codes and Standards, Inc., May 25, 1986,