

Prefabrication vs. Conventional Construction in Single Family Wood Frame Housing

Dr. Avi Friedman
 Director of the Affordable Homes Program
 McGill University
 Macdonald-Harrington Building
 School of Architecture
 815 Sherbrooke Street West
 Montréal, Quebec
 H3A 2K6

1. Introduction

The 1980's saw important changes in the North American homebuilding industry. New economic realities affected production cost and retail-prices, while demographic changes affected the cross-section of clientele in most markets (Fig. 1 & 2). As a result, some builders are considering prefabricated wood-frame low-rise housing as an alternative to stick-built on-site construction. At present, prefabricated housing accounts for approximately

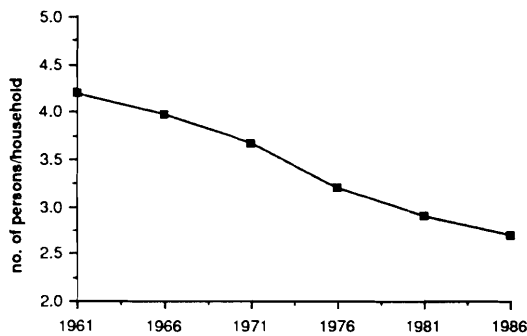


Fig. 1: Average Household Size in Quebec
 (Source: Census of Canada)

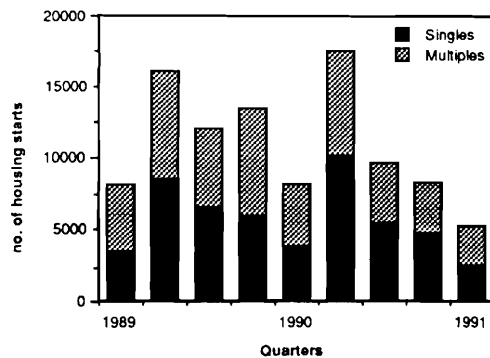


Fig. 2: Housing Starts in Quebec
 (Source: CMHC)

3% of housing production in Canada¹ compared with over 90% in Sweden² and 54% in the U.S (Fig. 3)³. However, over 95% of the

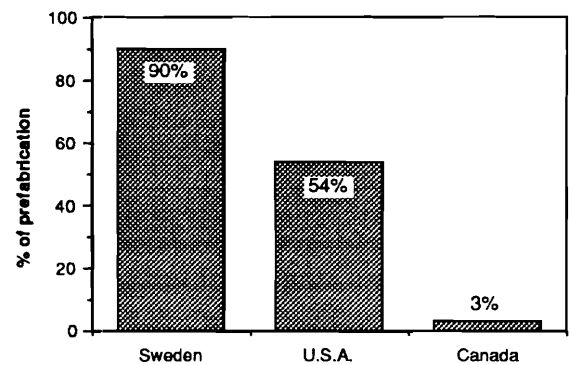


Fig. 3: Percentage of Prefabrication in the Housing Industry

components being used at present in the construction of a stick-built house are prefabricated. In a conservative industry such as homebuilding, a convincing argument is always based on cost benefits. We therefore set out to compare the cost of conventional and prefabricated homes in the provinces of Quebec and Ontario and the length of time required to produce such homes. We have also examined some aspects of construction quality. Prior to the presentation of findings and their analysis, some recent changes that have brought the idea of prefabrication to the interest of builders at present are discussed.

The recent affordability crisis has had a far-reaching effect on the industry: housing prices have doubled in most North American urban centers since the mid 1980's. As some fore-

casts show, large future buyer groups will be first-time buyers, seniors trading large homes for smaller ones, and “baby boomers” planning to purchase a vacation home. Many builders envision trends towards small size lower-cost units for which prefabrication is well suited.

The present economic slowdown is sending shock waves throughout the industry. The small building firm⁴ is further trying to reduce overhead. The option of becoming a dealer/broker rather than a general contractor is quite appealing to small builders. Being associated with a large manufacturer who can deliver a home on relatively short notice and even guarantee after-sale service is convenient. Most builders wonder how competitive they will be if they purchase a prefabricated home and compete with a “conventional builder” in the same region.

In their realization that the current (early 1990’s) economic slow down may last 2 to 4 years, some builders are exploring the option of building in other geographical markets. Exporting prefabricated houses to foreign markets is a direction that many builders are considering. Some builders are currently examining possible export from factories in Eastern Canada to such locations as Germany, USSR, and Israel, for example, and are examining the merit of using prefabricated houses.

First-time buyers who want to be homeowners are also ready to try new techniques and directions⁵. It also seems that the preconceived image of the prefabricated home as boxy and cheap-looking is changing. Buyers are examining the qualitative advantages of industrialized production compounded by the fact that many manufacturers are investing more in new attractive designs. These changes have generated openness to prefabrication at present by buyers and builders.

2. Research Method

Prior to the introduction of findings, I would like to explain briefly the main differences between various fabrication methods. Researchers tend to divide the systems into three main groups: *Modular*, *Components* and *Mobile houses* (Fig. 4)⁶. *Modular* refers to three-dimensional elements that can be either part of or form the entire home. *Components* are elements such as wall sections (panel) or even pre-cut elements (studs). Despite the fact that *mobile homes* are three-dimensional, they are considered a separate sector.

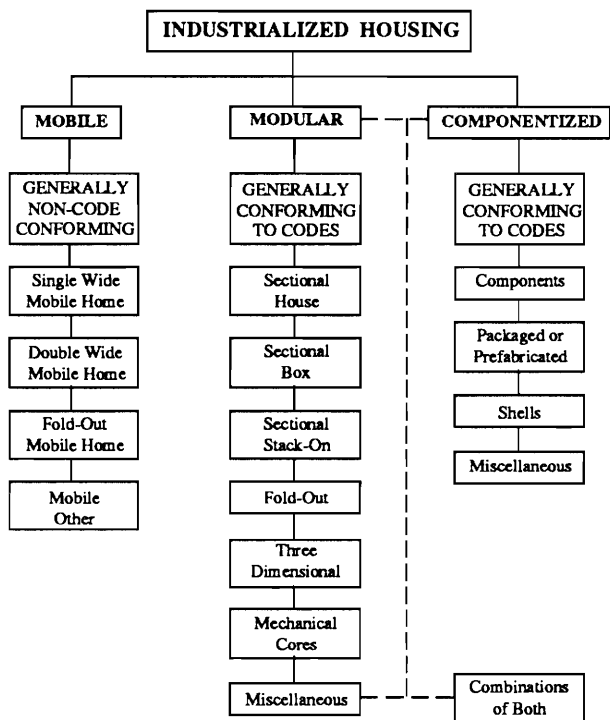


Fig. 4: The main groups in the industrialized housing industry (Source: Dietz 1971, p.315)

We have selected at random 15 (fifteen) manufacturers from Quebec and Ontario who were ready to collaborate with us and allow us to visit their facilities⁷. We studied the retail cost (i.e. cost to conventional builder) of two models from each manufacturer. We then gave the architectural set of plans of a single-family house to 6 (six) conventional builders for pricing. We compared the results from the two industries in terms of cost per square foot of habitable space, production time and quality.

3. Findings

3.1 Cost

We found that the cost per square foot of single-story modular homes is \$63.96. Panelized prefabricated homes averaged \$66.54 per square foot. Pre-cut prefabricated structures averaged \$66.84 per square foot. The conventional industry's average is thus \$7.46 per square foot below the least expensive prefabricated option (Fig. 5).

	Modular	Panelized	Pre-cut	Conventional
Cost per sq. ft.	\$63.96	\$66.54	\$66.84	\$56.50
Difference per sq. ft.	\$7.46	\$10.04	\$10.34	0

Fig. 5: Average construction cost per sq. ft. by category.

3.2 Production Time

Production time is influenced by factors such as time of the year (i.e. production will take longer in a busy construction season) and management. The following information was provided by the manufacturers and builders, and indicate production time in peak season (Fig. 6). The prefabricated industry has between 10-15 days overall advantage over the conventional building industry.

	Modular	Panelized	Pre-cut	Conventional
Time in factory	52	30	45	-----
Time on site	10	40	45	95
Total production time in days	62	70	90	95

Fig. 6: Production time (in days) of manufactured and conventionally built single family homes.

3.3 Quality

Our assessment of quality was based on site observations and examination of typical construction details and manufacturing techniques such as exterior wall sections. We did not find major evidence demonstrating that prefabricated housing has a significant quality advantage compared to conventionally built homes. We found that the use of power tools and techniques that prepare the modular home or the panel for transportation have in some cases a slight quality advantage.

4. Analysis

Examination of the results and interviews with manufacturers can further explain the above findings. Most manufacturers made a large initial investment that must be amortized over the life of the factory (i.e. investment of between 5-10 million dollars is needed to set up a small to medium-sized factory). Because a conventional builder is not bound by the economic liability of a factory, he will try to reduce his inventory to a minimum in a soft market as a strategy for survival and thus have a competitive edge over a manufacturer. We also realized that due to the cyclical nature of the industry, manufacturers cannot keep up the high production volume necessary to create economies of scale--the average number of units produced is 250 units per manufacturer/ per year in a "good" year.

Most manufacturers had an average of 100 full-time employees. About half of them were seasonal employees and the rest are year-round that must be kept. A conventional builder has only a handful of permanent "on payroll" employees, mostly in administration, and thus, lower operating costs⁸. We also found that the notion that factory employees earn much less than trained sub-contractors or laborers on-site is also not fully correct. Key quality employees earn as much as trained sub-contractors. In addition, due to union regulations, manufactured houses have to be

finished on-site by union members; this further cuts potential savings.

We found that the "production-line" image, where all manufactured units look alike and where the trades do the same repetitive work does not exist. In fact, all the manufacturing facilities we visited would be willing to custom produce one unit only. Thus, the time and the cost saving advantage is greatly reduced by the fact that every production task has to be thought of prior to execution.

5. Future

There is no doubt that there are indirect inherent advantages to prefabrication. The notion of doing most of the work in a physically and quality controlled environment can be relevant to some builders. Given the harsh Canadian winter and the idea of reducing on-site production and selling houses all year round might be appealing to builders. The price difference is not high if one considers the indirect monetary advantages (e.g. no thefts or vandalism on-site).

Several steps must be taken by the prefabricated home industry to further lower prices. In order to increase production, new markets must be explored. More goal-oriented marketing strategies that see foreign markets such as the U.S. and Europe have to be initiated. The prefabricated industry must also educate builders about the advantages of using prefab houses in relation to the builder's mode of operation (i.e. reducing on-site management, leaving more time for marketing). Concentration on the lower end of the market (i.e. small, affordable units) which has high-volume potential for prefabrication can be a strategy for a small manufacturer. If these measures are taken, the manufactured industry stands a chance to close the price gap and become more attractive to conventional builders.

References

¹Adair Jim, "Panel Power," *Canadian Building*, September 1990, p. 30.

²Swedish Housing: Has Factory Construction Come of Age? Inside *Housing*, Vol.1, No.2, Jan/Feb 1990.

³*Automation in Housing & Manufactured Home Dealer*, March 1988, p. 37.

⁴The overwhelming majority of building firms build less than 20 housing units a year.

⁵The housing shortage of the 1940s and 1950s generated openness to a large number of innovations such as drywall and prefabricated trusses that were accepted by the buyers.

⁶Dietz A., Cutler L., *Industrialized Building Systems for Housing*, MIT Press, Massachusetts 1971.

⁷Wiedemann et al., *Modular Prefabrication versus Conventional Construction Methods as an Affordable Option in the Development of Single Family Detached Housing*, Research Paper No.1, McGill University, July 1989.

⁸Friedman A., *A Proposed Decision Making Model for Initiators of Flexibility in Multi-Unit Housing*, Unpublished Ph.D. dissertation, University of Montreal, July 1987.