AN ANALYSIS OF PREFABRICATED HOME CONSTRUCTION FOR BUYER'S ACCEPTANCE OBJECTIVES

by

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TABLE OF CONTENTS

AN ANALYSIS OF PREFABRICATED HOME CONSTRUCTION FOR BUYER'S ACCEPTANCE OBJECTIVES

CHAPTER I

INTRODUCTION

The housing problem, one of the greatest economic and social problems of the day, is becoming more complex as a result of a twentieth-century product -- prefabricated houses.

Today there are over three hundred manufacturers of prefabs, offering factory produced houses in a wide variety of styles and room arrangements. This multiplicity of choice may be confusing to the prospective owner of such a house, and there are many pitfalls in making a selection. What suits one family will not serve another, and finding reliable bases for comparison is difficult for the layman. Furthermore there are many hidden snags in acquiring a house of this type -- and the land on which to put it -- without the benefit of an architect's advice.

Prefabricated houses have suffered from the wartime use of substandard materials, a practice that has aroused widespread prejudice against them. This prejudice, unwarranted in the case of present-day products, has led to local ordinances barring them from certain districts. In other cases the houses may not meet the Federal Housing

Administration standards so that the purchase of a prefabricated house may be difficult to finance. In some cases it may be better to invest in a speculative or custom-built house.

Purpose of the Study

The primary purpose of this study is to provide needed information about prefabricated houses. It is designed to tell the prospective house purchaser or builder what he may expect in a prefabricated house -- the advantages and disadvantages of prefabrication from the owner's point of view. It shows how to choose a house and the lot it is to be erected on, and inquires into maintenance and what the builder calls extras.

The secondary purpose of this study is to provide consumer information in conformity with the objectives of industrial arts as stated in "A Course Of Study In Industrial Arts For Secondary Schools Of Oregon." Since the home is the largest single purchase that the average individual makes, it is believed that the secondary schools could well consider the value of consumer information in this field.

Limitations of the Study

This study is limited to certain phases of consumer

information regarding prefabricated home ownership which is included under the following headings: explanation of prefabrication and prefabricating methods, advantages and disadvantages of prefabrication, selecting the house and the site, and maintenance costs as compared with similar costs for houses constructed by other methods.

Methods and Procedures Employed in the Study

In order to obtain adequate information concerning the prefabrication industry, the historical method of research was used. This included a critical examination of reference materials, books and periodicals on architecture, carpentry and building construction; also many periodicals and portfolios supplied by the manufacturers of prefabricated homes.

Definition of Terms and Objectives

The term "prefabrication" as used in this study is: (16:1)

> A prefabricated home is one that is designed, manufactured and distributed through the integration and use of the most up-to-date industrial principles of mass-production and mass-distribution as contrasted to a home that is built and sold under unintegrated handicraft methods commonly known as conventional building.

This definition brings out a point that may need clarification. Manufacturing by mass-production methods

will not permit the erection of the entire house in the plant. To manufacture by assembly-line methods, three types of construction are used. Some manufacturers use the sectional system of fabrication. By this system, the factory produces complete sections of houses, of one, two and three sections, which are transported to the site and assembled. Other manufacturers employ the panel type of prefabrication. Materials for the panels are pre-cut and moved to another part of the plant where they are assembled into large roof, floor, wall and ceiling panels. Each panel is a solid unit and may be as large as 8 feet high by 20 feet long.

Another method used extensively in present day construction is the stressed-skin or sometimes referred to as the stressed-cover panel. This method was adapted from the airplane type of stressed-skin construction. In this type of panel the surface material must be of good tensile strength or in other words offer resistance to stretching. The sheet material, usually of plywood, is either glued or glued and nailed to the studs of a 4 x 8 foot panel. The glue is then set in hot presses in much the same manner as plywood. Some manufacturers use the standard 2 x 4 inch studs but usually smaller studs (1 x 3) are used and spaced 12 inches on centers. This makes a hollow, flat box that, when placed on edge,

is tremendously strong yet extremely light for the load it will support.

The plywood coverings used in panel construction are classified according to intended use. The Douglas Fir Plywood Association uses the term PLYCORD for the exterior grade of plywood. Plycord is an unsanded utility panel of unusually rigid construction, designed to withstand the rigorous service of sheathing on walls, roofs and subfloors. Interior plywood is labeled "PLYWALL", and is designed for interior finishing such as walls, ceilings, cabinets, built-ins, partitions and a variety of uses where one or both surfaces are to be exposed and finished.

The objectives of industrial arts have been stated in many ways. In a report by the Committee on the State Course of Study for Industrial Arts in Oregon, 1937 (17:8), the following were some of the objectives stated:

> To develop in each pupil the ability to select wisely, care for, and use properly the things he buys or uses.
>
> To develop in each pupil an appreciation of good workmanship and good design.

Further objectives in the industrial arts program in Oregon, dealing directly with the carpentry trades, as stated in Carpentry and Building Construction, a supplement to the State Course of Study (18:5), are

as follows:

> It is believed that, properly presented, building construction in miniature will focus the attention of young people on trends in housing design, on construction methods, and on the utilization of native building materials which nature has so abundantly bestowed upon the Pacific Northwest. This should lead to increased "building consciousness" and to a consideration of the following "consumer values".
>
> 1. Appreciation of the value and limitations of wood as a construction material.
>
> 2. Appreciation of construction methods appropriate to the building requirements under consideration.
>
> 3. Acquaintance with materials and terminology used in plans, specifications, and building construction.
>
> 4. Appreciation of <u>good</u> construction; ability to detect poor construction, either in purchasing a home or in supervising the construction of a new home.
>
> 5. Acquaintance with the general procedure of home planning, financing, construction, and maintenance.

In view of the generally accepted objectives of industrial arts, and specifically in view of the statement immediately above, it is believed that a study of prefabricated housing, including comparisons of construction costs, quality limitations, maintenance problems, and over-all <u>real</u> values will be valuable alike to prospective home owners and to those teachers who may wish to include such information as a part of the industrial arts program for the secondary schools.

CHAPTER II

HISTORICAL DEVELOPMENT OF THE PREFAB

Centuries have passed since Noah and his three sons felled the Cypress trees, hewed them into planks and timber, whittled out innumerable pegs and undertook the slow and laborious task of constructing the Ark.

The mass-production age has little in common with the age of Noah. We wear mass-produced clothes, eat mass-produced food, drive mass-produced automobiles; but when it comes to the construction of homes, we are almost back to Noah again. Building materials have changed. Nails have replaced the wooden pegs, lumber yards, by means of modern equipment, supply us with smooth surfaced material in uniform lengths, and science and industry have contributed a myriad of new materials. But basically the methods of construction have changed little from ancient times. Lumber is still hauled to the building site, where each piece is carefully measured, cut, fitted, and nailed by hand by about the same methods as those used centuries ago.

There has been much improvement of materials since the earliest homes, when it was necessary for the builder to fell the trees and hew out the timbers; but building industry still makes little use of mass-production on a

scale comparable with that used in other industries.

Specialized Prefabrication

Specialized prefabrication, a division of labor which develops and produces certain parts of a house such as nails, lumber, roofing and many other materials, which are sold to others, who assemble the parts together into a complete house. It is estimated that it takes 88 separate industries to produce the 30,000 odd types of products and parts that make up a house.

Ready-Cut Prefabs

Closely following the "specialized prefabrication" was the "ready-cut" house which was a form of prefabrication. More than half a century ago a few companies began to pre-cut lumber to the exact sizes and shapes required by local contractors. Large mail-order firms took up the distribution of pre-cut homes, from which the product became known as the "mail-order house".

Under this method all the lumber was pre-cut to the exact size and labeled for easy assembly at the building site.

Unit Prefabrication

Next in line, following the "ready-cut" method,

was the prefabrication or factory assembly of such items as doors, window frames, and louvers. This was the prefabrication of units that could be incorporated into the finished home.

During the same time "pre-cut" houses and "unit prefabrication" were developing, the early antecedents of the panel type of prefabrication were being introduced. Irving W. Wilder (21:28) says:

> Before the Civil War (in 1859), Louis Bossert & Sons, of Brooklyn, N. Y., was founded. Even then Bossert made a prefabricated house and, believe it or not, it was demountable.
>
> In 1892 Mr. E. F. Hodgson first developed the idea of building houses in sections that could be erected quickly with bolts without sawing or nailing.

The early manufacturers of this type of factory construction confined their production to small structures such as children's play houses, chicken houses, garages and cottages. It was not until the introduction of plywood, fiberboard, plaster board and gypsum board that the panel method developed into its present form.

Portable Houses

From factory assembled units prefabrication moved into the portable house stage. In this stage whole sections of the house were prefabricated in the plant. Finishing and installation of numerous items were left

to field operations.

Current Stages of Prefabrication

The current stage of the evolution of house building came with what is now called "prefabrication". Here the object is to produce as much of the house as possible in the plant, leaving as little work as possible to be done in the field.

Fortune Magazine (13:52) offers this conception of a prefabricated house:

> The conception of the prefabricated house was of a building which should be made out of standard, factory-built units which could easily be assembled, in whatever pattern the owner wished, at the site. It would, first of all, be cheap. There would be no expensive field labor and field materials; savings would come from the proved economies of factory production. It would be a superlative good house, a more "efficient" house than the world had ever seen, offering all the benefits of scientific research.

These houses are not the houses of the early builders. They are the result of invention which translated the early frame house, an affair of individually shaped, large, widely spaced timbers, carefully notched, fitted and pegged, into radically different terms suited to the power saw, the hammer, and the common nail. In 1840 these houses were something new.

Douglas Haskell (9:52) says that the traditional

methods of building houses are on the way out and will be replaced by newer methods of construction. Quoting Haskell:

> The 1940 and 1941 "defense" houses set the carpenter's saw to power and put the modified 1840 frame on the jig-table, thus giving our traditional "prefabrication" its ultimate speed-up. The next step, . . . is to leave traditional methods behind altogether and to produce houses entirely by modern engineering.
>
> Engineering, unlike prefabrication, completely disregards existing methods. It seeks for an exact, comprehensive, and advanced -- even an ideal -- statement of requirements; it seeks to meet them with the most efficient conceivable production; both the process and the product may have to be wholly redesigned.

CHAPTER III

PREFABRICATION AND PREFABRICATING METHODS

Twentieth-century technology has brought about two of the most talked about and least understood products of the ages -- the atomic bomb and the prefabricated house.

For some years people have been asking, "What is meant by a prefabricated house?" It has been said, that prefabrication is "all things to all people." To some it means a completed house, with all facilities installed, rolling off of the assembly line. To others it signifies no more than factory built door and window units ready for installation in traditionally-built homes.

Robert L. Davison, (5:1) director of research for the John B. Pierce Foundation, says: "Prefabrication is the assembling, in varying degrees, of parts or sub-assemblies into sections to be assembled into a structure, as distinguished from the assembling of parts during the erection of the building." The Ministry of Works of the Timber Development Association Ltd., London, England, defines prefabrication as: "The formation of buildings or components for buildings by the assembly of materials or units otherwise than (at

or in) their final position." (20:8)

A strict dictionary definition gives "fabricate" -- to form, make, or manufacture, and "pre" -- before, as in time, place, or rank. By combining the two definitions, to prefabricate means to "manufacture beforehand," which implies that the building or home is manufactured before shipment to the site.

However, prefabrication is more than assembling in degrees, of parts or sub-assemblies into sections and eventually into a structure. What has been overlooked is that the manufacturing process must be preceded by designing and engineering which will permit the most efficient manufacturing. There must be a distributing system capable of supplying materials in sufficient volume to maintain continuous operation at the plant. Prefabricated Homes, (16:1) states that:

> Designing and distribution are as much a part of prefabrication as the process of manufacture. Over all of this is the need for the most modern kind of industrial management integration up-to-date design, manufacture, and distribution.
>
> . . . . . .
>
> A prefabricated home is one that is designed, manufactured and distributed through the integration and use of the most up-to-date industrial principles of mass-production and mass-distribution as contrasted to a home that is built and sold under unintegrated handicraft methods commonly known as conventional building.

This definition brings out the essential fact that the method of construction is not by any means all there is to prefabrication, if the objectives of prefabrication are to be fully attained or even approached. Objectives generally conceded are: 1) to make available better houses, 2) faster, and 3) more economically than is possible by conventional methods of construction.

Designing for Plant Prefabrication

The process of designing a prefabricated house for the mass-market and to be manufactured by mass-production takes several months to complete and to put into operation. It is estimated that the designing of the annual models for prefabricated homes consumes about a year's time. Prefabricated Homes (11:2) gives a typical schedule as follows:

1. In late August the product designer may start on his designs for the following year, first consulting the sales department to find out what features of the current year's models have had the greatest sales appeal and also to find out which requests for new features the salesmen scattered throughout the country have most frequently encountered among their customers.

2. He will then consult the Service Department to find out what "bugs" are developing in the current year's models.

3. He will then meet with the heads of all departments and the executives to get a decision as to what the next year's models will be.

4. He will immediately prepare his rough sketches and standardized panel charts and will have them ready for resubmission to the department heads and the executives by the middle of September. Each department will analyze the designs so far as they affect the work of each particular department and will offer whatever criticism or suggestions as are necessary. Out of this will come final ideas to be adopted.

5. By the middle of October he will have finished and "frozen" complete plans and specifications, the standardized panel charts, a schedule showing the templates required, the cutting and processing operations and also a carefully broken down schedule of materials and man-hours. These must be worked out in minute details and copies are then sent to all the other departments so that they may simultaneously be preparing to get the new models into production and sales. The production designer must work very closely with each of the other departments so that correct interpretation of the plans and specifications may be made.

6. By the middle of December samples of all templates, jigs, tools, etc., would be completed and tested. A few sample houses are hand made and erected to check for final error.

7. On the first of January, let us say, the plant is shut down for retooling. This will require, perhaps, a month. The product designer must follow this work very carefully.

8. By the first of February small quantities of all raw materials should be on hand together with sufficient men to start production in the plant. The conveyors will move very slowly at first to give the workmen a chance to learn the new operations and to test out the correctness of the timed flow schedules and the man-hour budgets. During this period the labor costs will run over the budget but if all the work is properly synchronized while the conveyors are moving slowly, it can be mathematically predetermined if the labor costs will come within the budget when the conveyors are

finally speeded up.

9. By the first of March the production kinds should be all smoothed out and the conveyors should be operating at their normal speed. The new models are then shipped to all dealers who, upon the erection of the houses, will start their demonstration, advertising and sales campaigns.

Time Element

Architects agree very readily on the distinction between "modern" and "modernistic" architecture. Modernistic has come to mean a ribald, faddish sort of design which has no root in anything that might be considered architectually good. "Modern", however, has come to mean the most up-to-date usage of materials and methods available at any time. Architects consider that Classic architecture was modern for that period and Gothic architecture was modern for the period in which it was originated and flourished. Likewise, the time element must be considered in the true usage of the term "prefabrication". The early log cabin builder might be considered a prefabricator, if his logs were cut and hewn to size in the forest and hauled to the building site, ready for erection. By the same token the most efficient portable house builders could be considered as prefabricators of their day.

One of the original reasons for prefabrication was

the belief that there would be a greater demand for very low cost homes. Mass-production seemed to be the logical method of solving that problem. But the proposed method of supplying that market had not been fully thought out. Manufacturing was comparably simple, but selling and distributing such massive objects as houses were unthought of at that time.

In searching for house designs that would permit total prefabrication at low cost, and with a minimum of weight and bulk to simplify transportation, designers from time to time produced a number of odd designs. There were houses like merry-go-rounds, houses like igloos, trailers, corrugated houses, bubble houses of cement blown onto the surface of inflated balloons, egg-shaped, round, hexagonal and octagonal houses, but none of these solved even the major part of the problem of prefabrication.

Concerning the market outlet, Graff (8:24) believes that:

> One major premise of the prefabricators that has had to be abandoned is that there exists a tremendous market for houses among citizens whose income is as low as $1,500 a year. Even families earning up to $2,500 a year are not interested in owning a house. The reason for this seems to lie in the fact that many of them do not have the feeling of financial security necessary to enable them to settle in one spot, and others find the minimum rent considerably less than the

> amount they would have to scrape up to buy a house and run it. And the majority of them, of course, are just not good financial risks.

This sunken market, then, is one of the major factors governing the mass-production of prefabricated houses. The second major factor is the problem of distribution over a large area, with increasing transportation costs. That problem is partially solved in some instances by the spread of factory chains, like "chain stores".

Prefabrication Methods

There are several prefabricating methods as indicated by the Douglas Fir Plywood Association (10:8):

> In general, three types of prefabricated wall units, all 8' high, are used: (a) Full wall size units containing door and window openings, (b) 4' x 8' units, which include stock units for plain wall, door, and window panels, and also filler panels to fit the particular dimensions required, and (c) Plain wall units extending between openings, and from edge of opening to house corner. Window and door frames are inserted between these solid wall units.

Panels of this type consist of a lumber frame with Douglas fir plywood panels fastened to each side. Panels are fastened to the frame with either nails or glue, or both.

The exterior wall panels may have a weather panel of 3/8" or 1/2" exterior plywood applied directly to the studs; or 5/16" "plycord" sheathing is applied on

the studs and covered later with exterior plywood, siding or other material.

Interior walls or partitions are of similar construction except that both faces are covered with "plywall" panels.

Wall and partition units are fabricated on table jigs. Then plywood is glued or nailed to one side and the whole unit turned over to receive plywood on the opposite face.

Hipped roof panels may consist of plycord sheathing nailed to the tops of the rafters. Joints between roof panels are then made weathertight by covering the roof with a roof covering.

Flat roofs are likely to be fabricated from stressed-cover panels, with plywood sheathing on top and plywall on the bottom to serve as the ceiling.

Ceiling panels are also prefabricated whereby the plywood is nailed and glued to parallel 1 x 2 ribs, 16" on centers. Panels are built to full room size so that the joint between two such panels will occur at the center line of the partition wall.

Floor panels are made in 4 foot widths and half the width of the house. Framing of floor panels consists of joists running the full length at each edge with 2 x 4 headers spaced 16 inches on centers, securely nailed and resting on 2 x 3 ledgers nailed to

the joists. Nearly all of the prefabricators use a two inch blanket type insulation which is factory installed. Plywood, Douglas fir, oak, spruce, and other types of flooring may be used.

Framing

Different prefabricators use different sizes of studs for walls and partitions, depending upon the panel construction.

If the plywood is nailed to the framing, studs are likely to be 2 x 4, spaced 16 inches on centers. When panels are glued on, smaller studs are often used, down to 1 x 3, spaced 12 inches on centers. This size reduction is a natural sequel to the adoption of stress-cover construction, since the plywood helps to carry any load and more than compensates for the use of the lesser dimensions.

It is quite common practice to use headers or horizontal "nailing" strips between the studs. Sometimes two or even three rows are used in the eight foot panel height.

Panel Joints

When prefabricated wall units are built to full room length, several methods are employed to join the

several 4 x 8 foot panels required for the wall, according to the Douglas Fir Plywood Association (10:12):

> Some use panels that have been scarf-jointed along the sides to produce any desired width or length up to 20' or more.
>
> Others use a long plywood strip, nailed lightly to the stud under the joint, and glue the abutting panels to the strip. This also produces an excellent joint especially when formed with a hot plate press.
>
> Simple butted joints are also effective, it being common practice to machine the panel edges to produce a perfect fit. This type of joint is employed by many prefabricators using a standard 4' x 8' unit construction, with panels tongue and grooved or with a spline joint.

Experimental Prefab Forest Products Laboratory Model

In December, 1937, the U. S. Department of Agriculture, Forest Service, Forest Products Laboratory designed, engineered, and produced one of the first prefabricated homes developed for mass-production methods. This house was a one-story building, constructed largely of plywood, and containing a living room, kitchen, two bedrooms, and a utility room, as well as adequate closet space.

There is a marked difference between prefabricated construction and conventional building, according to Luxford (12:2), Chief Engineer for the Forest Products Laboratory:

> The difference between the Laboratory's panel system and the conventional type of construction are marked. To choose an example at random, in the conventional type of floor construction the subfloor and finish floor are nailed to relatively deep joists. The subfloor is nailed diagonally in order to stiffen the building, but it is of little benefit to the strength of the floor framework. In contrast to the foregoing, each panel in the laboratory's system has a complete and continuous rigid joint between the plywood and the framework formed by the glue between the plywood and joists. This causes the entire panel to act as a unit like a box-girder and as a result the floor panels will deflect only about one-quarter as much under a given load as the joists acting alone.

Wall Panels

The exterior panels of the Forest Products Laboratory model are 3 inches in thickness and consist of 3/8 inch three-ply plywood on the inside. The framework is made of vertical members of one inch material 2-3/8 inches wide, spaced approximately 12 inches apart and with two end headers to which the plywood faces are glued. The partitions are also 4 x 8 feet. Both faces of the partition panels are, however, of 1/4 inch plywood, and the vertical members are 2-1/2 inches wide, the over-all thickness being 3 inches.

Luxford (12:2) says:

> Experiments indicate that these panels when tested as a beam require a load of more than 200 pounds per square foot to cause a failure. A 60-mile wind has a pressure of about 12 pounds per square foot, which is

approximately one-seventeenth the load required to break the panel.

Floor and roof panels also were built 4 feet wide in conformity with regular mill width of plywood and their length varies from 8 to 14 feet. Because of the inherent strength in this stress-skin type of panel a 2 x 6 inch structural member can be substituted for the usual 2 x 10 inch joist in conventional construction. The upper face consists of 5/8 inch plywood in 5-plies, and the lower face of 3/8 inch 3-ply panels.

"Floor paneling of this type was tested and found capable of sustaining maximum loads of 300 or more pounds per square foot over a 13 foot 6 inch span." (12:4)

Fire Resistance

Fire tests of plywood at the Forest Products Laboratory show that plies of vegetable-glued plywood separate while burning, whereas the plies of resin-bonded plywood do not separate.

CHAPTER IV

ADVANTAGES AND DISADVANTAGES OF PREFABRICATION

ADVANTAGES

Mass-production methods in fields other than house construction have proven themselves superior to other methods of production if quality is not sacrificed for the sake of speed and profit. Through experimentation and engineering, mass-production methods can be applied to the construction of homes. Prefabrication, when employed on a substantial scale, affords a number of important advantages to the home builder when compared with traditional methods of building.

Less Expensive

Prefabricated homes are less expensive, because the prefabricators have eliminated much of the middleman's profit and the waste of labor and materials which occur in the conventional type of construction. A survey (3:11) made in 1943 and 1944 by the Comptroller of United Construction Workers (an affiliate of United Mine Workers) revealed that:

> . . . the material and mechanical equipment for a $5,000 house actually cost $1,200 at the initial source. Approximately $2,500 or half the total cost of such a house is consumed in wholesaler-jobber-

> retailer transactions. Less than $250 worth of lumber at the original mill costs the home owner almost $1,100, trim worth $195 costs $980, $4 worth of glass at the wholesale source ends up with a retail price tag of ten times that amount. The shipping, handling and storing charges and the profits of the various middlemen who are involved in distributing and selling the thousands of parts that go into the ordinary house consume most of the price of the house. The prefabricator, since he buys in mass, is able to make his purchases directly from the producer of the material, and thus bypass the sales and handling costs of numerous middlemen with their pyramiding profits. Thus material costs are reduced by as much as forty per cent.

Another distinct advantage of prefabrication is the more economical use of materials. When figuring material for "on the site" construction, an allowance of at least 20 per cent must be made for waste. Inexperienced workmen and poor management often account for a greater amount of waste. A considerable amount of waste can be eliminated by careful engineering and design in mass-production methods, as a result of precision machine operations.

According to Carr, (3:11) the labor costs on a prefabricated house are less than on a house built by ordinary methods.

> . . . Union labor in the prefabrication factory receives from $.75 to $1.00 per hour as compared to an hourly rate of from $1.00 to $2.00 for carpenters and other skilled workmen in the building trades. This disparity results, in large measure, from the fact that the factory worker is sheltered

> from the elements and can work and earn throughout the year without being dependent on the weather, whereas ordinary building is seasonal and the carpenter and mason are able to work and earn during only part of the year. The result, however, is that the labor costs (even assuming the number of man hours to be the same) for the factory system are about half those of the traditional building system.

The saving in man hours is another important advantage to consider in the matter of prefabricated construction. Individual-built homes necessitates bringing mechanical equipment to the site, setting it up, and then moving it when the job is completed. This does not hold true for the factory, where the equipment is set up only once for the production of many homes. Factory procedure does not require that the tools be gathered up and stored away and materials be put under cover at the close of each day. Here they are always under shelter. Furthermore, electric-powered conveyors and hoists in the plant do many of the slow and laborious tasks which must be performed by hand in conventional construction.

Better Construction

Tests conducted in wind tunnels, laboratories, and in the field provide ample data substantiating the better construction of factory built homes. Carr (3:12) says:

> Some prefabricated houses have demonstrated a capacity to withstand windloads up to 200 miles per hour, as compared with 70 miles per hour for conventional houses. Factory-built floor panels have been tested to withstand a live load in excess of 600 pounds per square foot, while floors of conventional houses have an average strength of approximately 50 pounds per square foot.

A recently developed featherweight material of great strength promises to make a substantial contribution to the prefabrication industry. Monahan (14:186) describes it this way:

> It is a "Sandwich board" with a "honeycomb" of cloth or paper between, and firmly bonded to two thin sheets of wood, or between sheets of aluminum, stainless steel or plastic. A practical method of bonding the sheets to the wrinkled honeycomb makes the new material possible. It is claimed to have greater strength than anything of the same weight now being manufactured.

Laminated wood is of special interest to the prefabricator and to the consumer. Plywood has been used for years for many purposes but the development of new resins and glues for bonding the thin sheets of wood together, and an efficient induction heating method to set the adhesives, now make it possible to build up boards and beams of almost any size, thickness and shape. These laminated woods may be used for outside walls which are exposed to the weather. One of the most important improvements is the development of a panel impregnated and bonded with phenol formaldehyde

resin, which is much stronger than ordinary wood.

Ruth Bugbee, (1:42) gives Deskey's answer to the use of plywood. She says:

> It is engineered wood, eliminating all danger of warping and shrinking. It is light but strong. It is a natural material for panel construction. . . . smooth panels of plywood, or any wallboard material for that matter, joined together to make a house, show the joinings. These joints are not pretty. If you conceal them with strips of wood, the strips of wood have a way of making your house look like a packing case. So Deskey devised a system of taking fir plywood -- the cheapest plywood -- and scratching the soft, coarse grain out of it. The result is a striated wood with a pleasing texture look that can withstand any number of further scratches gracefully. The ridges in the wood conceal joints, making a continuous wall surface possible.

Machine operations contribute to better construction than do the old hand methods. Repetitive tasks in the factory are more conducive to good construction than diverse tasks in the field. Mass-production gives precision and exactness in measurements and fitting which are not found in conventional-built homes.

Flexibility

The windows and doors of a house are similar to the furniture in the house. The housewife often wishes she could move them around like furniture, shifting a window over to the corner of the room and placing a door in the center of the wall. This is possible with

a prefabricated house, but the house of ordinary construction, once completed, is wholly inflexible in its plan. To make these desired changes in the ordinary house would mean cutting into the wall of the house, removing studding, putting in new frames and then replastering and re-siding the area. This procedure involves considerable expense and time. In some prefabricated houses the windows, doors and wall panels may be shifted about, within reason, by a small crew in a matter of a few hours and with a minimum of dirt, waste or inconvenience.

Better Plans and Design

Thousands of people attempt to draw their first plans on wrapping paper, boxes or anything handy. Other thousands leave the planning to people similarly untrained. Most of these are doomed to disappointment. When they go to an architect, builder, material dealer or financial institution, they are told that rooms are out of proportion, not enough space is provided for certain functions, important details are left out entirely, and the house cannot be put together as planned, either structurally or economically. When an architect is employed, it is understood that his fee will range from 5 to 10 per cent of the total cost, depending upon

the size of the house. In the prefabrication industry, major prefabricators employ several architects and engineers who devote months and even years to the designing and perfecting of house plans which will give the maximum in comfort, durability and attractiveness for the lowest possible cost. Prefabricators spend thousands of dollars each year in the designing of homes and construction of experimental models to test their architectural and engineering soundness, spreading this total cost over the total volume of sales. A prefabricated house is the result of research in design far in excess of that which most individuals could afford in planning a single house.

DISADVANTAGES

Some of the problems or disadvantages which confront the prefabricators, such as standardization, transportation and distribution are internal problems which must be worked out by the industry if they are to progress and succeed as prefab builders. They are also faced with external problems which are brought about by the vested interests who see prefabrication as a challenge to their own position in the housing field. It is possible in some instances that these negative factors may outweigh the advantages of pre-

fabrication and make it undesirable to purchase a house produced on an assembly line. It is always advisable that the prospective buyer assay the problems involved before making a purchase.

Transportation

There are several hundred manufacturers of prefabricated houses scattered over the United States. Nearly all of them limit deliveries to distances not in excess of 150 to 300 miles from the plant. Freight or transportation costs beyond these limits rapidly reduce the advantages of other prefabrication savings, thus a great many areas are limited in the number of designs, styles and manufacturers available. Carr, (3:15) in his discussion on transportation costs says:

> Ultimately the prefabrication industry will become decentralized, factories will be strategically located within easy reach of a large percentage of our population and shipping charges will amount to no more than $50 or $75.

Standardization

For many prefabricators, standardized products were not marketable, despite careful planning, design and engineering, and sound construction. The prefabricators are varying their offerings. Many basic

house plans are now available and the appearance of each house can be changed by the type of doors and windows, trim, shutters and other various means. Carr (3:15) states that:

> Communities already exist which are made up entirely of houses produced by a single prefabricator without the drab monotony of standardization. Having said all this, the fact remains that most types of prefabrication do not afford the individuality or variety available in tailor-made houses. Those who want to plan their homes exactly as they choose, without regard for basic plans or existing designs, and are able to afford the extra expense such individual planning entails, will probably continue to look to the traditional building trade for their homes in the future.

Building Codes

Building codes have not kept pace with modern building materials. As a result the codes are hopelessly out of date with present day methods of construction. Carr (3:14) sums up the problem of building codes in this manner:

> The building ordinances in many urban centers are hopelessly out of date and in many respects not adapted to modern construction methods. Some of these codes require the use of old-fashion materials while excluding the use of newer, more desirable materials. Others fixed minimum dimensions for floor joists, roof rafters and wall studs. When originally adopted, many years ago, wood was the only material employed for residential framework and these provisions may have afforded some protection against "jerry-built" houses.

> But today if a prefabricator who uses steel or laminated wood for structural members were to abide by some of the dimensions designated, he could support a skyscraper on the framework of his prefabricated house.
>
> Furthermore, building codes have been notorious footballs for politicians and sometimes are filled with unreasonable restrictions and featherbedding practices dictated by shrewd lobbyists or influential labor groups. As a result, the widespread use of prefabrication is seriously handicapped because in a great many of the larger cities, prefabricated construction is either not permitted or made extremely difficult.
>
> . . . Until building codes are modernized, however, urban dwellers will find it difficult, if not impossible, to take advantage of prefabricated homes and the entire prefabrication industry will suffer from being excluded from the larger metropolitan markets.

Louis Wirth has suggested that all building codes be boiled down to a single sentence: "All structures built in this city must be constructed under supervision of a licensed architect." (19:103)

Opposition of the Building Industry

The era of prefabrication was not met by the welcoming hand of traditional builders, real estate and financial interests. Most of these interests chose to oppose prefabrication. Carr's study of the problem (3:14) led to the following statement:

> Prefabrication has been confronted not only by apathy, but by actual hostility on the part of the traditional building system.

Real estate and financial interests, apprehensive as to the effect of cheaper and better prefabricated houses on old, overpriced, overmortgaged ones, have refused loans and other assistance in connection with mass produced houses. Contractors and building trades unions, fearing that factory construction will supplant many of their jobs, have refused to erect prefabricated houses, or to connect plumbing, gas or electricity, or have exacted exorbitant "work permit" charges which raise the cost of the houses. Jurisdictional disputes between C.I.O. unions in prefabrication factories and the A.F. of L. building trades unions present further areas of difficulty.

Fortunately, the opposition of these various groups and the attending difficulties are not widespread. For the most part they are confined to our larger urban centers. Nevertheless, any one (anyone) planning to acquire a prefabricated house should ascertain whether these conditions existed in his community. If they do, the purchaser would be wise to arrange with the prefabricator for the latter to assume the responsibility for erecting the house and putting it in readiness for occupancy. Many companies maintain their own construction crews for this purpose.

CHAPTER V

SELECTING THE HOUSE TO FIT THE FAMILY NEEDS

When a decision is made to choose a prefabricated house, there are a great many points to be considered. There is the size and style of the house, the size and limitations of the plot it must be located on, and the question of whether or not the interior space and room locations are suitable.

The direction which the house is to face and the views from each window are items which the consumer must decide. The most important items in selecting a prefabricated house are requirements of the family, present and future. Also keep in mind safety, sanitation, convenience, and comfort as well as maintenance and operational costs.

Shelter against the outside world has long been the basis for dwelling design. A new approach to design, to replace the old, outmoded idea should be, "shelter for family living." Callender, (2:1) says:

> Housing is for human beings. It is astonishing how often this self-evident fact is ignored. Housing cannot be scientifically designed without full information on the requirements of the human beings who will live in the dwellings. As individuals, they have certain physiological, psychological and space requirements. But most human beings normally live in family

> groups, and as such they have many additional problems involving group activities and conflicts in space and time. The family then is the primary element in housing design. But before the dwelling can be designed, these human requirements must first be determined for both individuals and families. Nor is it sufficient to state them in general terms, although that is better than nothing. Housing can not be scientifically designed until the human requirements are fully determined and stated in specific and quanitative terms. In this form, they become specifications for dwelling design.

This is why it is advantageous to compare the different makes of prefabricated houses and the various models that each manufacturer offers. Prefabricators have made studies in the past and are now engaged in more advanced research on these problems. Initial cost of new developments may prevent them from adopting some feature that would be invaluable from the owner's point of view.

There is a type of prefab that comes with few or no fixtures, which gives ample opportunity to arrange the house to suit the owner without extra cost. But in a case where the house is delivered complete in all details, any variation in arrangement is usually expensive, if it may be made at all.

The location of the house will determine the size or space of the rooms. A house intended for a rural area will probably need more storage space than a

house for an urban area; probably there will be a great deal more activity in the kitchen -- canning, freezing, laundry and ironing. In urban homes these activities may be reduced to a minimum and small kitchens are often desired.

The size of the house will depend upon the amount of money that the family can afford to put into it. Graff (8:76) says:

> . . . But if it is necessary to choose between a larger house and a smaller one, it is usually good economy to select the larger. There should not be a great deal of difference in cost, unless an extra bathroom is included, because in the smaller house you already have the necessary equipment and services, and an extra room or larger floor area should not involve a directly proportionate increase in cost.
>
> The important thing here is to be sure that the extra floor area goes into usable living space and is not uselessly absorbed by bad designing. If the house is efficiently laid out, there will be a minimum of space devoted to passageways which are useless for anything else. On the other hand, considerations of privacy may well justify such a layout. Even in the smallest houses, no room should be entered through another one.

Room Size and Arrangement

When the approximate size of the house has been decided upon, the next features to be investigated are the sizes and arrangement of the rooms. The size of the family will determine how many bedrooms will be

necessary, and whether they should accommodate a single bed, double bed or twin beds. A kitchen and at least one bathroom will be needed. A living room and a dining room or a combination of the two may be desired. Graff (8:76) writes of these considerations:

> In the majority of cases there is no separate dining room, and the eating space is either in a corner of the kitchen or at one end of the living room. If the dining space is in the living room, the kitchen can be made that much smaller or more space devoted to equipment. Using the kitchen for dining, however, may be objectionable unless there is ample ventilation for carrying off cooking odors and sufficient window space to provide ample light both for cooking and eating by. If the sample prefab that you examine is indoors, as so many of them are, artificial lighting will be in use and this point may easily be overlooked.
>
> In most prefabs these points have all been scientifically worked out, but no house can be perfect in every respect for every family. In some things it is necessary to compromise, sacrificing one feature to obtain another. It is then up to you to decide whether or not the result is what you want. In some of the smaller houses the makers' attempt to combine simplicity and low cost by eliminating all possible interior arrangements has resulted in the kitchen, dining, and living area being crowded into one room, or at least divided only by thin partitions, with perhaps archways instead of doors. In such cases noise is likely to be an important objection, apart from other obviously undesirable features.

If the house decided upon has the minimum possible number of rooms -- kitchen, living room and bedrooms --

and none of them large, it will probably be necessary to make some of them serve two purposes. The children's room should be adaptable for study purposes, hobby room, or other occasions where quiet and privacy are desirable. A child's greatest feeling of importance comes from the pride and joy of having a room of his own. In a room that is used for something besides a place to sleep, with a single bed and dresser, should not be less than 8 x 10 feet. A bedroom that must contain a double bed should be larger, a minimum of 9 x 12 or 10 x 10 feet.

Efficiency of the House

The next thing to be considered is the efficiency of the home, which is governed by the location of the rooms with relation to one another and to the passageways and entrances between them. In most cases the kitchen is the heart of the house. The average housewife spends most of her time in the kitchen.

The fatigue produced by housework may be reduced greatly by selecting a house that has been well planned. An efficient kitchen is one that is convenient in size and location, large enough for informal dining and child play, and small enough to reduce unnecessary steps. Surrounding the kitchen should be the dining

room, laundry, and storage space.

Efficient arrangement of equipment in the kitchen and laundry will help reduce the drudgery of the home; proper location of electrical outlets in relation to the work areas; and the bathroom and laundry fixtures easily reached for use and cleaning will all assist in the efficiency of the home.

Circulation

Before talking about relationships of rooms, it will be necessary to consider the circulation about the house. It is probably one of the most important requirements in designing a house. A short, quick route may easily save thousands of steps in the course of a month. Much depends upon the desigh of the individual rooms, the location of the doors, and the grouping of furniture.

The kitchen should be arranged so that the sink, stove, refrigerator, and working spaces are conveniently grouped. If washtubs are installed, it is best to install them in the kitchen and not in the basement, particularly if there is no door opening directly from the basement to the yard.

When the dining room is located in the living room, it should be located as near the kitchen as possible.

Adequate floor space should be available for extension table and six to eight chairs, plus a sideboard or serving table. A sideboard is considered better because it allows for storage of the linen, cutlery, and china which makes it readily available to the table. Some people prefer a separate dining room, but they do not always care to go to the expense of an adequately large dining room.

If at all possible, the dining room should open off the living room as well as off the kitchen. An archway between the two rooms or the two combined to make an L-shaped room, so much the better. In this way the dining room may be used as an overflow space while entertaining large groups and, if necessary, tables may be set in both rooms without breaking the party into sections. This would not work as well with a hallway between the two rooms.

Entrance halls are helpful, especially in wet weather or during the winter months. Halls are helpful in retaining the heat and help to keep out the cold during the winter months. A hall provides a place for removing muddy shoes and wet clothes. It is well also to have the entrance hall equipped with a clothes closet.

Bedrooms should be planned so that the early

morning sun will not shine in the sleeper's eyes. Think also of cross ventilation, so that a good circulation of air can be obtained. A room with one window usually creates a difficulty in this respect. Cross ventilation is desirable not only in each room but also from one side of the house to the other. No bedroom should have a special door to the bathroom if the bathroom is to be used by occupants of another bedroom. This means that one or the other of the doors is locked all the time, and usually it is the wrong one.

The bathroom should be accessible to all bedrooms as well as to the other rooms of the house. It should have one door leading from a central hallway and it should never be necessary to go through any other room to enter the bathroom. One bathroom may serve a house that consists of up to six rooms, whether it is a one-story or a two-story house. Graff (8:83) says:

> . . . an extra toilet on the ground floor can be of inestimable benefit. It should, preferably, be in the back porch or hall, for the benefit both of the children, who will not have to track up the whole house, and for adults in the garden or indulging in other outdoor activities. Where the main bathroom is on the second floor, such a provision is almost a necessity, and if the prefab does not provide it, the plumbing layout should be checked to see if it can be installed at little extra expense. All bathrooms and toilets should, of course, have a window both for ventilation and sunlight. And curtains are preferable to non-transparent glass.

Safety in the House

Stairways are one of the greatest sources of accidents in and around the house. Stairs from one floor to another should be straight or in two easy flights wherever possible and not too steep. These stairways constitute a means of vertical circulation and as such should be easy of ascent and well lighted so there will be no physical hazards. Steps are bad when they come in unexpected places. All stairways should be provided with a switch that permits the light to be turned off or on from either the top or the bottom of the stair. Cellar steps are particularly dangerous and should be provided with good lighting and a substantial handrail. If the stair is of the open type, it should be provided with a handrail that is not low enough for a tall person to topple over and balusters that are not spaced too widely apart that a child may fall through.

Window sills are the cause of a great number of minor accidents, especially to children. The window sills in the play room or the children's room should be a flush type which will eliminate the sharp corners of the window stool.

The kitchen, the scene of much activity, is also the scene of many accidents. A narrow kitchen results

in pans and equipment being knocked off of the table tops or breakfast table, heads bumping into open cupboard doors which often leave a cut or bad bruises and person to person contacts. Crowded cupboards in the small kitchen are often built in over the stove and cause the busy housewife to reach over the stove and scorch or badly burn either the person or her clothing.

Lack of storage space in the house often results in toys, equipment and supplies being left out in the open where someone may fall over or walk into them. Children may get into poisons, irritants, and flammable materials used for cleaning and disinfecting that should be stored out of the reach of the children.

All these things are concerned with the design and equipment of the house. If they are not obtainable in the prefabricated house selected, the prospective builder should look into the possibilities of having these changes or additions made while the house is under construction.

CHAPTER VI

SELECTING THE SITE

Selecting a site on which to erect a prefab is no different than selecting a site for a conventional-built home, and the procedure is about the same. There are, however, the problems of building restrictions and codes which regulate the use of new materials and equipment. It is desirable to here present the guiding principles of site selection in some detail however, because it has a large bearing on the final cost of the prefabricated house, the livability of the house, and the security of the investment. According to Graff (8:86):

> The site, as a matter of fact, is one of the most important factors in determining the kind of prefab you should buy. In most places there are definite restrictions on the type and size of house you can put up and the materials of which it may be constructed. So before you even begin to comb a neighborhood for a site for your house you should make sure that the local ordinances will permit you to put up the type of prefab you have chosen. After you have found the site you also need to make certain that there are no restrictions in your deed, and no other agreements or covenants exist that will limit your use of the land.

Aside from the physical aspects of the land that composes the building site, some thought should be given to the surrounding area.

Character of the Neighborhood

The general character of the neighborhood can best be determined by the type of people who live in the community, the kind of houses they live in, and the care they take of their houses. A shabby community is more likely to grow shabbier than to improve, and is likely to be used as an industrial or commercial area. This may result in an increase in the value of the property, but it will necessitate vacating the property and rebuilding. Whether the future increased value of the property would override the inconveniences and delays is doubtful. Many factors should be studied, according to Graff (8:89):

> The community, like the house, should meet the needs of the family and your pocketbook. Not only are the tax rate and the general level of assessments important, but you want to know what you are getting for your money in the way of schools, garbage collection, police and fire protection, good roads, and so on. You may want to be near a church, shops, and transportation, and, for the sake of your youngsters, close to parks, playgrounds, or other recreational facilities. Some, of course, prefer more isolation, regardless of resale potentialities, and land probably will cost less in scattered districts.
>
> Having decided on the general area, you next need to know something of the history of the properties around your prospective building site, and plans for its future. From the local government offices, the neighboring property owners, bankers, and realestate dealers, you may

learn the trend of realestate values. From the surveyor's office you can get a copy of zoning regulations, and information on sewers, water supply, street lighting, and prospective road improvements which might involve assessments against your property.

Another important thing to look out for is the existence of nuisances. Those may consist of anything from periodical bad smells from a dump or glue factory, to traffic hazards.

Size of Lot

Almost everyone feels it would be best to obtain a spacious house and large lot. Some of the advantages and disadvantages of a large lot according to Erickson and Soules (7:36) are:

Advantages of a large building site:

a) More space around the house, lawns, flower gardens, etc.

b) More distance between the house and road.

c) More distance between the house and the neighboring house.

d) More chance for formal gardens, pergolas, and outdoor living.

e) More playground for children.

f) Place for raising fruits and vegetables.

g) More opportunity generally for creating artistic unity between home and surroundings.

Disadvantages of a large building site:

a) Added investment as a rule.

b) More unsightliness, if not kept up.

c) Greater cost in maintenance, if help must be hired.

d) May take more time than is available and thus become a burden rather than a pleasure.

e) Raising vegetables and fruits on a city lot is not always profitable and should not be considered as a source of definite income.

Factors that greatly influence the locating of the house upon the site are the shape of the lot, shape of the house, the need for and possibility of a basement, direction of prevailing winds, adjoining property, the conditions on each side of the property, and accessibility to the street.

On a small lot, or a plot not much wider than the house, there is very little choice as to where the house will be placed. Building regulations, trees, and the houses next door will help to determine the location of the house.

Topography

The topography of the lot will govern, to a large extent, the type of architecture that should be erected upon the land. It has always been the custom in the prairie states to build the houses low and horizontal

in mass and treatment, to harmonize with the sweep of the plains; and that the house built in the hills assume outlines similar to the more rugged terrain. A gentle slope, if it is in the right direction, is usually good. A steep slope is not too desirable. Designers have attempted, at times, to introduce different floor levels between the principal rooms, a practice which, at its best, does not improve the economy of circulation through the house. A perfectly flat site is rather flexible and will readily receive the majority of prefabricated houses now being designed. If a basement is desired, the excavated material may have to be hauled away, and this adds to the expense. In some instances this material may be used to raise the grade (ground level), so that the basement need not be dug out to so great a depth and the house will stand higher.

The added height of the house above the street level may allow better sewer connections and drainage of the site. The added height may result in a long flight of stairs from the street level to the house. This is usually dangerous in northern climates which encounter icing conditions. It is also dangerous and a nuisance where there are children and elderly people.

In the conventionally built house, the architect can bring the walls down lower or juggle the floor

levels to fit the site. This is not so readily done with the prefabricated house. In a prefabricated house, what goes between the sill and the ground is up to the buyer and the contractor who is engaged to put in the foundation. The way the house is adapted to the site is therefore more important in connection with a prefab than with any other type of house.

Nature of the Ground

The nature of the ground is of the utmost importance when selecting a site for a prefabricated house. If the site selected is one of rock, excavation will be very expensive, and will possibly prevent excavating for a basement. Soil full of large rocks is still quite expensive to excavate and necessitates the removal of boulders because they cannot ordinarily be used for grading. Sand or gravel are good, unless they are full of water. This type of soil will require that a good grade of top-soil be hauled in and spread before the lot can be landscaped. A hard clay, covered with a good type of loam is about the best soil that can be found for a building site. Beware of filled ground, unless it is old enough and sufficiently settled to make a firm foundation.

Of equal importance is the level of the ground

water (the water table). The water table changes with the seasons. It is also important to know the flood level of the area before buying. If it is not possible to have a dry basement, provisions should be made for a utility room. A basement set into a side hill should be provided with drain-off tile to drain the water from the high side of the house.

Exposure

Exposure, or orientation concerns itself with the placing of the house with reference to the sun, winds, trees, views and streets. Sunshine is most desirable in those parts of the house which are most lived in. Sunshine helps to make the rooms more cheerful and healthful and saves on the electric light bill. Sunshine can also bring with it intense heat in the summer months. It is often desirable to have the kitchen facing east or northeast, and the living room on the south or southwest side. It may be necessary to provide adequate shade trees or wide eaves to limit the summer sun.

The direction of prevailing winds will have a decided influence upon the orientation of the house on the site. It will dictate the location of the outside porch, and whether it should be an open or a

closed porch. Outdoor living areas will call for protection to ward off cold winds, and hot summer winds, but this will depend on other conditions. Care must be exercised so as not to shut off cooling breezes in the summertime, nor to restrict the window views.

In thickly developed areas the biggest problem may be that of maintaining privacy from neighbors and passing pedestrians. As a general rule, the outdoor living and play areas are placed to the back of the house for this reason. Children's play areas are usually kept as far from the road as possible to reduce traffic hazards. If it becomes necessary to provide a play area in front of the house, a sturdy fence or wall and gate that is not too easy for a child to open may be a wise provision.

In locating the house, thought must be given to the location of the garage and the driveway. Consider the clearing of the driveway of snow in the winter and keeping it free from weeds in the summer, the accessibility of the delivery entrance for groceries, services and fuel. If oil is used, the fuel-oil tank should not be more than 150 feet from the nearest point to which the tank truck can be driven. Nor should the filler pipe be in the middle of a grass plot where it

will be buried in snow in the winter and cause an ugly brown patch in the summer. The coal chute, if used, should be located near the driveway. This will permit the delivery truck to back into the driveway and unload directly into the basement coal bin, saving the laborious task of carrying or wheeling coal to a back entrance.

The proper location of the service entrance will greatly simplify the work of the housewife in her household duties. If the entrance is not too far back from the street and on one side it will serve the deliverymen better and conserve the garden area to the rear of the house.

The location of the garage is also important. If possible, the garage should be located to the side of the rear entrance and connected by a covered walk. A door in the back or side of the garage will allow it to be used for a variety of purposes, including garden tools.

Having considered all these items and others that may arise in the course of planning, Graff (8:97) would use this method:

> . . . a final decision as to orientation of the house can be helped by a little pencil and scissor work at home. All that you need is a scale drawing of the plan of the house, which you can get from the prefabricator, and

a plan of the lot drawn to the same scale. If the lot plan shows the adjoining properties, so much the better.

You can cut out the house plan and one of the garage, if that is separate, and lay them on the lot plan in various positions, being sure that you know which is north. By juggling them around you can see which arrangement is best, and where your various doors and porches will come, and which rooms will catch the sun.

If you are skillful with the scissors, a three-dimensional model of the house, . . . made of cardboard cutouts pasted to the lot plan. In either case you may save yourself a great deal of trouble later on when the house is built and the opportunity of changing your mind is gone.

CHAPTER VII

MAINTENANCES AND EXTRAS

The original intent of this paper was to show a comparable cost of maintaining a prefabricated house with that of a house built by other methods. "The data on maintenance costs, however, are even more nebulous than on production costs. No recorded experience reveals what it costs to maintain houses of different qualities and types." (4:47) "Good materials and careful workmanship, of course, simplify the problem of maintenance as well as operation. Attempts are often made to show that lower operating and maintenance costs more than offset a substantially higher original cost." (8:179) The cost of maintenance and operation depends partly upon the amount of wear to which the dwelling is subjected by its occupants, the weather, and the kind of upkeep it receives.

This chapter is concerned with the maintenance of the prefabricated house and what will be necessary to maintain it.

A. Exterior Maintenance

Before making the final decision as to the house of your choice, you should consider the maintenance

that your house will require. The amount of maintenance that a house may require will depend upon the type of house, methods of construction and the materials used in its construction. Extra money spent on external surfaces may well offset upkeep, such as painting or refinishing over a period of years.

Siding

One of the materials most characteristic of the exteriors of American houses is wood siding. Wood siding was used quite extensively by the Colonial builders of New England, and the excellent condition of the houses of that period attest the permanency of wood as a building material. Wood siding is of several types, and a number of woods are used, some of which are practically impervious to moisture, others that are not so good. Cedar and redwood are often left unpainted, due to their natural resistance to decay. Some of the other woods used do not weather so well, and crack and decay as a result of alternate wetting and drying. Such woods as these must be painted and will need repainting every three or four years. The cost of repainting or refinishing, and perhaps occasional patching should be weighed carefully against the cost of maintaining other types of surfaces.

Plywood is being used by a great number of prefabricated home builders in ever increasing quantities, mostly in the form of stressed-skin panels. According to Monahan (14:70), the stressed-skin panel is structurally sound.

> There is no longer any doubt of the structural soundness of prefabs. Carefully erected, they stand in all kinds of wind and weather as well as conventional construction does. The industry has acquired ample experience to show that stressed-skin panels, in which the sheathing becomes a structural unit with the frame, are efficient and safe at thickness as slight as two inches. The crucial link in the chain is the connector, which joins the panel together. Many firms have solved this problem by devising joints that virtually weld one panel to another. Some prefabs have been favorably tested in 200 miles-an-hour winds.

Other properties that will help to curtail maintenance costs as explained by the Douglas Fir Plywood Association (6:7) are:

> Condensation is no problem with plywood walls. Two coats of asphalt paint on the back of a plywood panel, or a layer of glossy surfaced asphalt building paper makes an effective and economical Vapor Barrier, according to the U. S. Forest Products Laboratories.

The Douglas Fir Plywood Association's Architectural Catalog, (6:9) offer the following information on finishing plywood:

> Field studies, exposure fence studies and weatherometer studies indicate that the best paint job for regular wood siding is also best for Exterior type Douglas fir

> plywood. Three coats of high quality exterior paint are suggested. These paints contain high percentages of white lead and oil and give good service on plywood. They permit minute expansion and contraction without breaking the paint film. (Paints which set to a hard, brittle film are to be avoided.) Good performance on plywood has been given by high grade exterior paints which were primed with a high percentage of linseed oil. The value of oil in reducing checking has been borne out in extensive research studies and commercial applications. Aluminum primer, compounded with the best grade of long oil phenolic varnish vehicle, is an excellent primer for plywood. Two coat paints are available which perform satisfactorily when properly applied although experience data on such procedure is meager. Textured finishes, using high grade resin base paints with asbestos and silica, also have proved popular.

The maintenance of a variety of panel-type walls involve the occasional recalking of the joints. If your house has such joints it would be helpful to know how often this will have to be done and what is used to caulk them. The Douglas Fir Architectural Catalog (6:9) gives the following suggestion for caulking:

> Suggested treatments for both horizontal and vertical joints as well as water table details . . . All edges of plywood siding -- no matter whether butted, veed, covered or exposed -- should be bedded in a thick lead and oil paste or other suitable compound. This is knifed on as panels are installed. F.H.A. specifications for the "bedding" or "filler" is: 100 lbs. of paste white lead, 1 3/4 gals. raw linseed oil and 1 pint of dryer. Dryer may be reduced to 1/2 pint if boiled linseed oil is used. If plywood is installed as lapped siding, it is recommended the lap be at least 2" and bedded in paste; also, horizontal edges should be beveled slightly so water drips from outside edge.

Another popular material used for siding, is asbestos siding. Asbestos siding will last indefinitely and need no maintenance except for an occasional hosing down to remove the dirt. Asbestos siding is easily broken if rammed, but that is considered as an accident.

Roofing

Prefabricators are using a variety of roofing materials. The type that will be used on the house will be the type that is selected when the purchase is made. This is true in most cases.

The most common types of roofing materials today are: wood shingles, slate roofs, tile roofs, metal roofs, asbestos and asphalt.

Many people like the wood shingles for aesthetic reasons although they are not fireproof and are subject to decay, cracking and curling. "Unless edge-grain shingles of first quality have been used and applied properly with rustproof nails, you will not get a lifetime roof." (17:64) Western red cedar, cypress, and redwood are the woods used for most of the shingles in this country. Staining or dipping them in creosote gives them greater weather resistance.

Practically all the prefabricators are using the mineral-surfaced asphalt shingles. Roll-type roofing

is generally used on the cheaper houses while the separate shingles are reserved for the more expensive models. Asphalt shingles are cheap, easy to apply, and light in weight. The surface of asphalt shingles consists of a coating of fine stone-like granules embedded in asphalt. Asphalt shingles are not fireproof but are highly resistant to flying embers. Properly applied, a roof covering of this type requires very little maintenance.

Asbestos shingles, made of asbestos fiber and a high percentage of Portland cement, are often used, particularly in congested areas where building codes prohibit combustible roofing.

Drains and Gutters

Draining the roof is a very important matter, and most prefabricators include sufficient gutters. Where gutters are not provided, the eaves usually project farther from the house. The drain-off then drips on the ground, spoiling the landscaping and mud splashes the foundation or the lower section of the house. This type of drainage may run down the side of the foundation wall or around the piers causing extra maintenance in some form or another.

If there is a choice of gutters, Graff (8:63) would select copper gutters because:

> . . . These require the least amount of maintenance and last longest. The only drawback is that the copper streaks and stains white paint, or any other light color, where water splashes from it on the painted surface. This, of course, adds to the over-all cost of maintenance, but it can be overcome by painting the gutter too.

Nearly all of the manufacturers' brochures list galvanized-iron gutters as standard equipment on their houses. Galvanized-iron will rust through within a few years unless the surface is protected by paint or red-lead. Galvanized gutters will also stain the house, and the only remedy is to keep them painted. Wood gutters are used quite extensively throughout the Northwest in conventional built homes and could be requested, in some instances, in place of the galvanized gutters. Wooden gutters, of course, need several coats of paint, particularly the inside of the gutter. It is also customary to use metal downspouts with the wooden gutter, which will also require occasional painting. Wooden gutters may be painted the same color as the trim and add to the attractiveness of the house.

Another point of importance in connection with the roof is the flashing between the roof and the chimney or the dormers. These joints are usually coated with a sealing compound then covered with flashing. Graff, (8:64) says:

> . . . The prefabricator may or may not provide the flashing for the dormer. He probably will not provide it for the chimney, and you may have to leave the whole thing to the erecting contractor. In that case it is well to know that the flashing may be of copper, which is the best, or zinc, or even galvanized iron. Any flashing should last a year or more, after which it may be necessary to inspect it occasionally to see that it is not corroded, and that, in the case of the chimney, it is properly cemented into the brickwork and has not broken loose.

Window Sash

The window sash used in prefabricated houses may be made of wood, steel, or aluminum. They may be fixed, double-hung, casement, or of a projection type, a new design that is hinged at the top and open horizontally. Whichever type of sash is used, repainting will be necessary except for the aluminum casement. Aluminum will need careful watching if exposed to salt or sea air, which affects the metal.

All types of sash will require new putty from time to time as the old putty dries and flakes. Suspension mechanisms are likely to need attention, depending upon the type of suspension used. The old-fashioned cord and weight is the type that will require frequent attention. The cord is being rapidly replaced by chains which will not wear and break as readily as the cord. One type of balance uses a flat steel strip

which has long life and is practically unnoticeable in use. Another type that has proven quite successful is the mechanical spring balance.

Metal sash must be checked when changing a broken glass, or even when painting to see that rust has not developed between the putty and the metal. If rust has developed, care must be exercised to see that all the rust is removed before the glass is replaced in the sash.

" . . . The exposed portions of the wood frame and the sash should preferably be heartwood from such durable species as red cypress, genuine white pine, redwood, edge grained Douglas fir, or southern pine. Other woods, although often less durable, may be used." (15:52)

Window Screens

Window screens are an important item that requires a certain amount of maintenance. Copper screen will last for several years without replacement and perhaps is the most satisfactory. Screens may be painted where there is excessive chemicals in the air or as protection against salt air. The paint needs to be thin, and applied with a piece of felt rather than with a brush, which would allow an excessive amount of paint to flow onto the screen and to stop up the holes. "The newest

thing in screening, which some prefabricators offer, is made of a plastic material. This is reported to be strong and durable, and to need no painting or maintenance whatsoever." (8:71)

Termite Shields

In many localities of the United States, termites are a threat to the building industry. The usual practice is to lay a shield of metal along the top of the foundation, extending outward on both sides of the wall, and the wood sill of the house is laid on top of the shield. Copper is the best metal to use and care should be taken to see that it extends outward far enough to prevent termites from building a tunnel around the flange.

Termite proofing is not generally supplied by the prefabricator, so arrangements can be made with the erecting contractor to supply the material and install the shields. If the house is already erected without termite shields, it will be necessary to watch the cellar or foundation walls or piers for signs of the clay tunnels that the insects build toward the nearest wood member. Such tunnels should be destroyed and extermination started at once. A house with a basement

makes it very simple to examine the walls for termites, but a house without a basement should be provided with an opening that will make easy access to the piers so that they may be examined.

B. Interior Maintenance

The maintenance of the interior of a prefabricated house is as important as the exterior maintenance.

Plaster walls, as a rule, are easy to repaid, but some of the materials used in prefabricated houses for inside walls and partitions are both delicate and difficult to restore to their original condition.

The plaster wall is the most common and one of the most satisfactory of the interior finishes. Plaster may have a smooth finish, sand finish or various troweled effects. Sanded or troweled surfaces have a tendency to act as dust catchers and it is possible that the desired effect will not outweigh the maintenance of the wall. If the plastered wall is not to be painted, a smooth putty plaster wall is an ideal surface to receive wallpaper. Wallpaper permits a wide range of effects. Plaster also makes an excellent surface for paint, and may be cleaned quite easily; however, painted walls will show dents and scars, especially if the color is light.

Wallboards present a different problem. Wallboards have no resistance other than their own stiffness, while the plaster wall has a firm backing of lath which is very rarely damaged when the plaster crumbles. Door-stops may prevent a doorknob from punching a hole or making an unsightly dent in any material.

Fiberboard wall or partitions are another problem, as stated by Graff (8:67):

> Fiberboard wall or partition units are likely to need maintenance attention for other reasons than surface damage. They expand and contract considerably with changes in temperature and humidity of the air, and the joints cannot satisfactorily be concealed. Papering them over is useless because they merely split the paper at the joints. Recognizing this, the manufacturers try to make a decorative feature of the joints either by covering them with narrow wood strips or beveling off the edges of the board to make v-joints.
>
> In either case, if the panels are butted too tightly against one another, leaving no room for expansion, the edges of the joint will press together and bulge outward. Whether they are covered with strips or not, the result is an unpleasant appearance and a complicated repair job. Conversely, if the joints are not tight enough they will widen still more when the panel shrinks. V-joints will show ugly gaps, and covered ones will either have the strip loosened or need to be replaced with wider ones. The extent of these defects depends upon both the quality of the material and the care with which it is installed, and there is usually no protection beyond the reputation of the makers.

Gypsum board consists of a 3/8-inch or half-inch

layer of compressed gypsum between two sheets of very durable paper. Expansion and contraction is practically unnoticeable in this material, and a fairly satisfactory joint may be made by covering the joint with tape which may either be painted or plastered. A hole through the panel will require the replacement of the entire panel, while small surface damage may be repaired by filling with plaster of Paris.

The kitchen and bathroom walls require a surface that is washable, usually a glossy or semi-glossy paint or washable wallpaper, with perhaps an enamel surface where the wall is subjected to fingerprints. Using tile or linoleum for surfaces that may be splashed will reduce maintenance costs provided it is securely attached and the edges protected by metal binding strips.

Plywood panels are being used on nearly all of the stressed-skin type of prefabricated houses. Plywood paneling allows moderate income families to have hardwood interiors in the form of veneers, which are easily finished and long lasting. Whether the interior is of hardwood or fir,it can be finished with paint or enamel, or can be given a mellow natural stain, or papered. Plywood walls are dry, air-tight construction. Panel edges may be butted flush, vee-grooved, covered with decorative moldings or have inset molding.

Floors

Floors have texture, color, and durability, depending upon the material from which they are constructed. They may be built of wood, linoleum, tile, mosaic, or asphalt tile. In some cases cork flooring is used.

Linoleums are used, in the main, in the kitchen and bathrooms, but the modern trend has found its place in the living room and dining room as borders for backgrounds for rugs.

Since floor coverings of any kind are not usually supplied by the prefabricator, it will be necessary to have the erection contractor supply the floor covering. The maintenance cost on linoleum will depend upon the grade of material with which the floor is laid. Some prefabricators use linoleum on the counter tops of kitchen sinks and cabinets. This provides a clean, vermin-proof work top, provided that all the edges are tightly cemented down. The only maintenance likely is in case the joints open owing to the expansion of the wood, or the linoleum lifts when the wood shrinks. In the event that this should happen, water may get under the linoleum and cause the wood to rot. The remedy is to relay the material as soon as possible.

An equally good floor covering for the kitchen is asphalt tile, provided it is of the grease-proof

variety. This is important because grease attacks the common type of asphalt tile and it cannot be waxed with common floor wax. It is easily laid and is usually somewhat cheaper than the high-grade linoleum.

Mosaic tile may be had in the bathroom since most of the floor covering is headed as "extras". This is waterproof and needs very little maintenance, allows some very interesting patterns, and the small size of the tile minimizes breakage due to falling objects.

For the rest of the house, hardwood floors are desirable. Some prefabricators provide the floor with the purchase price of the house, while others provide it as an extra. Oak flooring is the most commonly used of the hardwoods and the most to be desired. It takes a natural finish and will not dent under the weight of ordinary furniture while the only maintenance necessary is the removing of scratches from the finish.

Soft woods require considerable maintenance to reduce wear. Soft wood floors dent, scratch and scar easily, and wear shows up quickly.

Whatever type of flooring is used, the boards should never exceed four inches in width. This minimizes the size of the individual cracks due to the shrinkage of the wood.

Stairs

The stairway in a two-story house receives the major part of the traffic, and some maintenance is expected here even if it is only eliminating the squeaks. The treads of the stairway should be of hardwood and solidly supported on at least three continuous members.

Chimneys

A well constructed chimney with flue liner should not require excessive maintenance for a number of years. Annual cleaning should be all that will be required to eliminate interference with the efficiency of the heating unit. All solid and liquid fuels will leave ashes, soot, or a coating of resin in the flues, and fuel gas will leave a deposit of condensed moisture, which may attack the mortar in the joints.

EXTRAS

The prefabricators have not standardized on the completeness of their houses. Nearly all manufacturers have a different conception of extras. Some classify a towel rack in the bathroom as an extra, while others use extras as a merchandising scheme with everything from the lighting fixtures to the floor furnishing and

painting listed as extras.

Very few prefabricated houses have ever been designed from the start to incorporate everything that the owner would want. Even in conventional construction it is likely that after the house is well under way the owner will find several things overlooked in the contract. All these are extras which add to the original cost of the house a great deal more than expected when the contractor is asked to make the changes.

To avoid this extra cost, in buying a prefabricated house an itemized list of what is included as standard equipment should be made. Check this list with the most desired items wanted in the house. The fact that a number of items are listed as standard equipment does not mean that all of the necessities are there. Prefabs not only differ widely in design but also differ greatly in the degree of completeness.

Very good reasons for an itemized list, according to Graff (8:54) are:

> . . . in self-protection always insist on an itemized list of equipment and features included with the house at the price you have agreed to pay. If there are other things you want included, then is the time to specify them and agree upon a price. Those things that the prefabricator cannot supply may be secured through the erection contractor, who will install them at a definite figure.

Some manufacturers give their customers a choice of items without extra cost. In order that the manufacturer may offer a change of design within houses of basic design, such items as trim for doors and windows, porch entrances, and others are optional. On the other hand, front, back, or side entrance porches, door hoods, or step railings, which also may come in various standard designs, are most often sold as extras.

Open-porch terraces are often shown in prefabricator's brochures as part of the house though actually they are not always included. Some prefabricators also include what they call a car port. This is not a garage. The car port may be just an extension of the roof to form an open-sided shelter, or a separate roof spanning the driveway. It is possible to enclose the car port later to make it into a garage, but such a procedure may prove costly, especially if the work is done after the house is finished. If a garage is desired, it would be advisable to either order a garage with the house, or have a garage built by the erecting contractor while he has all of his equipment on the site.

Prefabs usually do not come equipped with window shades, venetian blinds, or valance boxes. The thought is that many of the owners would not be satis-

fied with the builders' selection. The purchaser may select the shades and patterns desired and the manufacturer will supply them at extra cost.

Electrical wiring and outlets should be checked, especially in the kitchen. Very few, if any, of the prefabricators supply their houses with an electric range and it is possible that they do not provide the three-wire supply circuit. This can be expensive if it is not installed at the time of erection. Graff (8:56) says:

> The number and location of electric outlets, if supplied by the prefabricator, is, ordinarily, based on F.H.A. minimum requirements. On the other hand, anything approaching what might be called "gracious living" will almost certainly necessitate extra outlets in more convenient places. This important extra is best taken care of during construction of the house in the factory, and if that is not possible it should be done during erection. Additional electrical work after the house is finished is both expensive and inconveniently messy.
>
> . . . . . .
>
> . . . Very few manufacturers install any electric wiring in the plant. They may provide outlets, together with chaseways for pulling the wires through, but that is all. The panel system of construction, in particular, makes it quite impractical to install any wiring in the plant.

The refrigerator, range, washing machine, and dish washing machines are regarded more as pieces of furniture than items of equipment and usually come

under the heading of extras. Installation costs are often charged against the cost of the home, if supplied by the erector.

The exterior of the house is not complete until it is landscaped. Quite often no allowance is made in the family budget to take care of the landscaping, with the result that a house is left with an unfinished appearance. It will cost several hundred dollars to buy shrubs, trees, and flowers and to grade and construct a good lawn for a small property.

These are a few of the things that need to be taken into account in selecting the house and in figuring the possible maintenance costs. It is impossible to anticipate all of the requirements or to foresee every possible expense, but the two items of maintenance and extras should be seriously considered before buying.

CHAPTER VIII

SUMMARY

The purpose of this study is to provide needed information about prefabricated houses. The prospective home owner may feel the need of some concise method of evaluating an assembled prefabricated house or a set of plans and specifications presented by the local distributor of prefabricated houses. The preceding information has been presented to show that prefabrication is not an end in itself, but another means of acquiring a satisfactory dwelling. It is not whether the house is a prefab or not, but whether the particular prefab under consideration will represent the greatest dollar value, and involve the least amount of time, trouble, and risk in obtaining the house.

It is not important how the parts of the house were made and put together as long as the final results desired are obtained. In some instances the buyer will find that the prefab solves his problems. In some cases the buyer would be better off to buy a speculatively built house which would give many benefits of prefabrication because it would be a complete package consisting of the finished house

and the plot. Buying a speculative house relieves the buyer of the necessity of acquiring a lot, and receives considerable help from the builder with the legal formalities. Just how far the prefabricator can go in relieving the buyer of worrisome details depends upon the degree to which the sales outlets have been developed. If the plans of the majority of prefabricators mature, many of the legal and financial formalities, and the problem of dealing with contractors will be taken care of; thus the acquiring of a house will be simplified greatly.

When this becomes a reality it will be a simple matter to order the type and size of house that is desired and have it erected and finished, ready to move into, all within a matter of days; and with no more loss of time and effort than it takes to sign the necessary papers. There are almost as many types and varieties of prefabs as there are manufacturers. Some are good, and some are not so good from the dollar-value standpoint. In either case a comparison of the prefabricated house in question, with houses of conventional construction, is often the only practical yardstick available. By such a comparison it is possible to judge how well these houses fulfill their function of supplying shelter and affording

comfortable yet economical living.

In spite of the best efforts of manufacturers it is unlikely that, under present building codes, only a few of the many people that need a home will ever obtain a prefabricated home. Building codes have not kept pace with modern building materials. Until such time that urban administrators investigate and study the construction methods and materials employed in prefabrication and revise the codes to correspond to the new way of construction, prefabrication cannot benefit the urban population and the entire prefabrication industry will suffer.

The prefabrication industry has also been hampered in its effort by the Building and Construction Department of the A.F. of L. The building trades unions are fighting the factory-built home on the ground that the work involved in the house should have been done locally. Plumbers' locals insist on removal and local replacing of the plumbing. Union-friendly building inspectors will refuse to approve wiring they cannot see.

To achieve the goal of better planned dwellings for American families involves not only problems of design; it involves technical problems of engineering and research, development of new materials,

construction methods and equipment that will make possible the production of better houses at prices which the average family can finance.

Buying a prefabricated house is somewhat different than buying a conventional-built home. To assure the prospective buyer a satisfactory transaction, the following procedure is recommended:

1. Buy preferably from a local dealer or other authorized agent who will erect the house. It would be impracticable to buy a prefabricated house and erect it if experienced local facilities for erection are not available.

2. Be sure that the quoted price covers a complete house. If the price is for less than a complete house, check the items (such as foundation, painting, kitchen equipment) that are not included and determine the additional cost for their installation.

3. Determine whether the house in question conforms with recognized industry construction standards, local codes, and the requirements of the Federal Housing Administration for insured mortgage financing.

The industry standards, issued by the National Bureau of Standards, are known as Commercial Standard CS 125-47 for prefabricated houses. (Copies are

available from Prefabricated Homes Manufacturers' Institute, 908 20th Street, N.W., Washington 6, D.C.

Leading manufacturers construct their houses in conformance with these requirements, which gives assurance the dwelling will be structurally strong, have sufficient space to comply with health standards, be properly insulated, adequately ventilated and be equipped with approved plumbing and heating facilities. Some of the manufacturers issue a "Certificate of Conformity," which serves as a written guarantee that the house conforms to minimum standards.

To facilitate obtaining firsthand information on houses manufactured west of the Rocky Mountains, a list of manufacturers is appended.

FINDINGS

An analysis of the prefab industry has shown that:

1. An ample variety of designs and structures are possible with the assembly-line production methods.

2. Prefabricated houses have been proven practical, economical, structurally sound, and susceptible to good architectural treatment.

3. The Federal Housing Administration has given blanket acceptance to a number of the large prefabricators. If a builder can demonstrate a sound design and proper workmanship in the shop and on the job, he will have little difficulty getting Federal Housing Administration insured loans.

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A P P E N D I X

MANUFACTURERS OF PREFABRICATED HOUSES

ARIZONA

Cabana Co.,
75 W. Portland,
Phoenix, Arizona.

Prefabricated Homes, Inc.,
P. O. Box 1112,
Phoenix, Arizona

Southwestern Sash & Door Co.,
Phoenix, Arizona

Williams Construction & Engr. Co.,
P. O. Box 344,
Phoenix, Arizona

CALIFORNIA

Barr Lumber Co.,
Santa Ana, Calif.

California Homes,
1132 M St.,
Sanger, Calif.

California Pre-Fab. Corp.,
5301 Valley Blvd.,
Los Angeles, Calif.

Custom Built Homes,
601 E. Broadway,
Long Beach, Calif.

Hamill & Jones,
3029 Exposition Blvd.,
Los Angeles, Calif.

Kaiser Community Homes,
875 Subway Terminal Bldg.,
Los Angeles, Calif.

Lincoln Lumber Co.,
Oakland, Calif.

Ply-Wel Industries,
4905 Tidewater Ave.,
Oakland, Calif.

Plywood Structures, Inc.,
6307 Wilshire Blvd.,
Los Angeles, Calif.

Pre-Bilt Homes Co.,
2901 S. San Pedro St.,
Los Angeles, Calif.

Precision Homes Co.,
Stockton, Calif.

Prefab Mfg. Co.,
4805 E. Sheila St.,
Los Angeles, Calif.

Quality Homes,
1022 S. Robertson Blvd.,
Los Angeles, Calif.

Rand Construction Co.,
6239 Wilshire Blvd.,
Los Angeles, Calif.

Standard Demountable Homes,
Los Angeles, Calif.

Stewart & Bennet,
National City, Calif.

OREGON

Horsley Structures, Inc.,
Eugene, Oregon.

Prefabrication Engineering Co.,
American Bank Building,
Portland, Oregon.

Timber Structures, Inc.,
Box 3782,
Portland, Oregon.

UTAH

Anderson Lumber Co.,
Ogden, Utah.

WASHINGTON

Brady Construction Co.,
707 Spokane St.,
Seattle, Wash.

Farwest Sales & Engineering,
6420 S. Tacoma Way,
Tacoma, Wash.

Modelow Company,
3400-16th W.,
Seattle, Wash.

Precision Builders,
3116 S. Oakes St.,
Tacoma, Wash.

Prefabricated Products Co.,
4000 Iowa,
Seattle 6, Wash.

Rowe & Thompson,
9004 So. 19th St.,
Tacoma, Wash.

South Bend Fabricating,
South Bend, Wash.

Standard Prefab. Corp.,
5400 Marginal Way,
Seattle, Wash.

Tacoma Lumber Fabricating Co.
P. O. Box 1133,
Tacoma, Wash.

Western Home Builders,
615 Alaska Ave.,
Seattle, Wash.

ANALYSES OF PREFAB SPECIFICATIONS

PREFABRICATION ENGINEERING CORPORATION
PORTLAND, OREGON*

Any type Prenco Home you select comes to you complete. You do not take a chance on "hidden" building costs, "extras", budget errors, materials and mechanics' liens or contractor's interpretation of performance.

Designed for permanency in construction, Prenco Homes are conventional in appearance and function. They are "different" principally in the method used in building them -- by controlled construction methods -- in a factory.

Your Prenco Home will be delivered by the factory or distributor to your prepared foundation in three-dimensional sections, each an eight foot portion of the house. Four sections form a two-bedroom home, five sections form a three-bedroom home, etc.

Sections are completely finished on the factory assembly line -- even to plumbing, electrical wiring and fixtures, heating installation, trim moulds, doors, hardware, millwork, linoleum, special fittings and

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*Condensed from Prenco Brochure, 1947.

interior painting. Field assembly consists of these first steps: Grouping sections on the foundation, covering section joints and connecting wiring and plumbing at the joints. Next, workmen will install plant-manufactured porches, entrance features, sunshades, etc.; install gutters and leaders; make connections with service utilities; text heating equipment, and apply final cost of paint to exterior.

Approval For Loans

Prenco Homes are approved for long-term mortgage insurance by Federal Housing Administration, based on appraisals comparable to traditionally-built house valuations. They also have the approval of the Technical Division of the National Housing Administration, the Bureau of Buildings, City of Portland, Oregon, and the City and County of Los Angeles, California.

Stress-Skin Construction...This means all structural units -- floors, walls, partitions -- are heat and pressure treated. This bonds plywood to framing members with thermosetting glue....a method of fastening that is stronger than the wood itself.

Waterproof Plywood...of Douglas fir is used on surfaces exposed to the weather. Thickness varies

according to use as follows: Floor construction -- bottom surface 3/8-inch asphalt coated, and top surface, 1/2-inch; exterior wall surface, 1/2-inch; interior wall partition and ceiling surfaces, 1/4-inch; roof surface, 5/16-inch.

Framing Lumber...used for joists, studs, plates and rafters is Douglas fir or Western hemlock, kiln-dried.

Insulation...and vapor barriers consists of sheets of genuine aluminum foil placed in all floors, walls and roof.

Floor Finish...in bathroom and kitchen-laundry is pattern linoleum or asphalt tile, with these optional floorings in remaining rooms: Linoleum, broadfelt carpeting laid wall-to-wall or vertical grain fir plywood sealed, waxed and buffed.

Windows...are modern scientific type. Windows in the living room and bedrooms are a fixed light type, with top and bottom ventilators. Screening is placed behind louvres in the ventilators, thus making the window a "picture window" type. Windows in kitchen-laundry and bathroom are double-hung type, screened and weather-stripped.

Cabinets...in kitchen-laundry and bathroom. Kitchen work-counter tops are linoleum-covered. Lots of closet space -- closet shelves and hanging poles are built-in, constructed of B and better selected dry Douglas Fir.

Finish Roofing...is three-ply, built-up roofing, with 85 lb. mineral surfaced capping sheet. Roof edges are finished with metal trim. Wood gutters and metal leaders are used. Flashings are of noncorrosive metal.

Special Fittings...include louvred sunshades over most windows, front door bell, bathroom accessories and mirror.

Finish Hardware...is of standard manufacture, non-corrosive type. Exterior doors have cylinder key locks; interior, safety latch sets.

Paint Used...on exterior wall surfaces is a heavy float coat of prenite -- a special lead, oil and asbestos fibre paint. Other exterior woodwork is finished with an outdoor type white paint; all interior woodwork and cabinets in the kitchen-laundry and bathroom, in white enamel lacquer; ceilings painted white and walls will be painted in choice of four colors or white.

Plumbing...work is installed according to established practices. Included are a standard grade

bathtub and shower, water closet, wash basin, kitchen sink, laundry tray, automatic water heater, fittings for clothes washer, with required piping and fittings.

Heating...is a forced warm air heating system, complete with furnace, distribution ducts and thermostat control. Equipment for use of gas, electricity or oil may be installed.

Electric Work...and materials used are designed to comply with recommendations of the National Electric Code. Included are service equipment for metering, service switch, ground, fuse panel, branch circuit wiring to all outlets and switches. All lighting fixtures are installed. An abundance of plug-in outlets are located for practical use.*

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*Condensed from Prenco Brochure, 1947.

HORSLEY STRUCTURES, INC.
EUGENE, OREGON*

The Horsley Structures, Inc., was initiated by S. Clements Horsley, a well known architect and pioneer in prefabrication methods.

The Horsley system contemplates the construction of an alphabet of structural panels designed so as to be suitable for many types of structures. Thus, as our 26 letter alphabet can be formed into a million words, so these basic structural entities, factory produced in quantity, can be used to construct a thousand different buildings, from one story to many stories. Such a system provides flexibility and variety in both plans and product. In order not to spread its immediate operations too thinly, Horsley Structures is concentrating its current production on seven different models of homes ranging from a small two bedroom unit to a spacious three bedroom house. Three of these homes are styled in a distinctly modern manner, while four follow more traditional design.

CONSTRUCTION AND ERECTION

Horsley homes are built by the panel method com-

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*Condensed from Horsley Structures, Inc., Brochure, 1947.

bined with a system of aligning members at the juncture of all planes. Each panel has a skeleton structure or frame, covered on both sides by plywood. The plywood is pressure glued to the framework so that the surfaces of the panel work with the frame to form a box girder type of panel. Panels are assembled and glued in jigs as a belt-line product. Each panel has an interlocking edge on all four sides, and all are interchangeable.

Panels come from the factory completely insulated and finished. Filled with fireproof mineral wool insulation, they will not sustain combustion and will pass more than a one hour fire test under ASTM standards.

At the juncture of all planes -- floors with walls, ceiling with walls and roof with walls -- there is an aligning beam which performs a twofold purpose: (a) aligns all panels into a true plane, and (b) insures an accurate and tight joint between wall panel and the floor or roof. The aligning foundation beams are set in place first, and to these beams are interlocked the floor panels, which come to the building site completely finished with insulation, hardwood flooring and surface treatment. The walls also interlock with the foundation beam, and all panels are glued into place with the latest resorcinal resin glue, pressured by the use of properly spaced screws. When the walls are up they are

aligned by an eave beam which interlocks with the walls and with the ceiling panels.

Interior and exterior wall surfaces may be of any color or of natural wood finish. Paneling of the hardwoods, such as walnut, cost little more than painted surfaces so that even the lower-priced homes may afford beautiful wood-paneled walls. Special plastic treatment is pressed and baked into the wall surfaces after the panel has been fabricated. Upkeep and maintenance of surfaces are kept to a minimum for as much as ten or fifteen years by this special treatment.*

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*Condensed from Horsley Structures, Inc., Brochure, 1947.

PRECISION HOMES COMPANY
STOCKTON, CALIFORNIA*

The PRECISION HOMES COMPANY, and its affiliate, Central Lumber Company, have been in the prefabrication business for about eight years. They had produced and sold several hundred homes prior to our entry into the war.

Current production of Precision Homes is limited to three basic one-floor models providing either two or three bedrooms. Each model can be obtained in a right or left hand plan and in different elevations and styles, so that a good deal of variety in appearance can be achieved. Breezeways, arcades, porches, attached or detached garages, shutters, window boxes, and other architectural treatment are supplied as optional equipment.

MATERIALS AND CONSTRUCTION

The Precision Homes method of wall construction consists of 4 x 8 foot panels, studded 16 inches on center, with double studs occurring every four feet when assembled, to form a structure of post and girder design.

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*Condensed from Precision Homes Company Brochure, 1948.

Exterior-grade plywood is both glued and nailed to outside walls for stressed skin construction, by which the plywood carries a portion of the building load. Interiors of the Precision panels are covered with gypsum board, which may be either painted or papered as desired by the ultimate purchaser.

Floors may be either of two types furnished by the company. The first type consists of a heavy concrete slab foundation with asphalt tile flooring laid over the concrete. The second is an all-wood floor structure of regular floor panels with hardwood flooring in all principal rooms. Linoleum or tile is supplied for bathroom and kitchen. Ceiling and roofs are also constructed by the panel method. Asphalt shingles, wood shingles, or built-up composition roofing are furnished and applied after the house has been erected at the site. Wood interior and exterior doors and wood-framed casement windows are installed in the wall panels at the factory and are complete with glass and hardware. Window and door screens and window blinds are all furnished by the company.

In addition to the basic superstructure of the house, Precision Homes supplies most all of the equipment used in the home. Either a BX or Romex wiring system is installed at the site together with lighting

fixtures in the hall, bedrooms, dining room, kitchen, bath and utility room and numerous plug-in receptacles at convenient locations in the living room. All plumbing, bathroom fixtures, including such minor items as a medicine cabinet, towel rods, soap dishes, paper holders, etc., the kitchen sink, laundry trays and a gas fired water heater are furnished and installed. Wood kitchen cabinets cover one entire wall of the long kitchen in each of these homes. A gas-fired floor furnace or electric wall panels are included as standard heating units for these homes.*

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*Condensed from Precision Homes Company Brochure, 1948.

LINCOLN LUMBER COMPANY
OAKLAND, CALIFORNIA*

The Lincoln Lumber Company produce, at the present time, an 848 square foot Ford Factory Built Home which sells for $3320.00 F.O.B. the factory. The Lincoln "Superior" cabin and Lincoln Monterey Cabin sell for $1795.00 each, F.O.B. the plant. Eight-foot extensions are available for these two cabins at $400.00 each. Lincoln also offers a 12 x 24 Thrifty Cabin for $1095.00 and a Thrifty Deluxe cabin for $1350.00.

The Lincoln-Ford Factory-Built Home comes packaged as follows:

Seven Floor Sections

Half-inch five-ply veneer sub floor nailed and glued on 2 x 6 joists with 3 x 6 girders.

Twelve Exterior Wall Sections

Three-eighths inch waterproof three-ply exterior; one-quarter inch waterproof three-ply panel inside, glued and nailed on 2 x 3 studding 16" on centers.

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*Condensed from Lincoln Lumber Company Brochure, 1948.

Seventeen Inside Wall Sections

One-quarter inch three-ply waterproof panel glued and nailed on both sides of 2 x 3 studding 16" o.c.

Nine Ceiling Sections

One-quarter inch three-ply waterproof panel glued and nailed (room side) on 2 x 4 joists 16" on center.

Thirty-one Roof, Jack Rafter and Gable Sections

One-half inch five-ply waterproof plywood, glued and nailed on 2 x 4 rafters 16" on centers.

Roofing felt (15#) and thick butt composition shingles (210#) furnished for site application.

Thirteen Doors, Twelve Windows and Trim

Factory fitted with special metal slides. Interior and exterior trim, gutter and down spouts.

Insulation

Exterior walls, ceiling and bathroom walls are insulated with one inch thick Kimsul insulation or equal.

Electrical

BX cable rough wiring installed in wall and ceiling

sections for easy site completion. Entrance service, plugs, switches and light fixtures furnished for site assembly.

Cabinets

One hundred and thirty-two cubic feet of kitchen and linen cabinets, plus metal medicine cabinet.

Hardware

Nails, bolts, finish hardware and flashing.

Heating

Minimum 35,000 B.T.U. Duo-Wall floor furnace.

LABOR AND MATERIALS FOR THE FOLLOWING, BY OTHERS

1. Foundation, mud sill and under pinning.
2. Plumbing.
3. Finish floor covering.
4. Painting.
5. Flues.
6. Garage.
7. Rustic or other exterior finish.
8. Concrete porches, walks and driveways.*

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*Condensed from Lincoln Lumber Company Brochure, 1948.

SOUTH BEND FABRICATING COMPANY
SOUTH BEND, WASHINGTON*

Girders

Lumber for girders will be of 900 lbs. per square inch or equivalent material.

Studding

Outside wall and partition studs shall be No. 2 common and Better Douglas Fir and/or Spruce and/or Hemlock. Studs shall be 2 x 4" except where otherwise noted, spaced 16" on center. Studding shall be doubled at the sides of window and door openings and doubled above the door and window openings.

Plates

Plates shall be No. 2 Common and Better of the same size as the studs, single at the bottom and double at the top.

Roof Trusses

(Refer to roof framing section for details)

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*Condensed from South Bend Fabricating Company Brochure, 1948.

Sub-Flooring

Cover the floor girders throughout the house with prefabricated panels 8 feet and 4 feet long and approximately 4 feet wide of 2 x 8" T & G No. 2 Common or Better.

Roof Sheathing

Cover the upper chord of trusses with No. 3 Common and Better roof sheathing laid at right angles and nailed to the trusses, or cover the trusses with 1/2" Ext. DFPA S01S Plywood, or equal.

Insulation

Apply 2" Lo-k or equally efficient insulation between studding of all exterior wall panels.

Exterior Wall Covering

Cover all exterior wall panels with 1/2" S01S DFPA Plywood, or equal, glued with waterproof glue to framing members.

Interior Wall and Ceiling Lining

Cover the interior side of all wall panels with 3/8" S01S Exterior DFPA Plywood glued to framing members. Plywood should have edges recessed to receive "Perfatape".

Frames and Sash

All sash shall be 1 3/8" thick. Fixed shutters. Windows and sash glazed with S.S.B. glass. All windows and sash and frames shall be installed in wall panels at the plant, complete with all the finish hardware.

Doors

The front door will be 1 3/4 inches thick. All interior and rear door shall be 1 3/8 inches thick. Closet doors shall be 1 1/8 inches thick or shall be made of plywood.

Painting

All material shall be given a primer coat of Sherwin-Williams Primer CH-3285 at the plant. All other painting will be done on the job by the contractor at his expense.*

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*Condensed from South Bend Fabricating Company Brochure, 1948.

PRECISION BUILDERS, INC.
TACOMA, WASHINGTON*

Construction is structurally approved by the Federal Housing Administration, and the Underwriters Division, F.H.A., Washington, D. C.

Lumber used is #1 common, Douglas Fir, for floor beams, floor joists, ceiling joists, purlins and roof trusses; #2 common, or better, for the sub-floor, wall and roof sheathing.

Plywood used on the exterior, such as siding, gable covering, eave boxing, etc., will be of exterior grade, in accordance with DFPA specifications.

Floor beams are laminated of 3-2 x 8's.

Floor joists are 2 x 8's spaced 16" centers; headers are 2 x 8's; solid bridging of 2 x 8 is spaced 8' - 0" centers; sub-floor is 1 x 8 shiplap.

Exterior walls are 8' - 0 1/2" in height and are of varying length, up to a maximum of 29 feet. Studs are 2 x 4's spaced 16" centers; top plate is doubled 2 x 4's; bottom plate is single 2 x 4; corner posts are 4 x 4's; sheathing is 1 x 8 shiplap. Studs are doubled at all openings and headers over openings are doubled with header members placed on edge. The doors and

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* Condensed from Precision Builders, Inc., Brochure, 1948.

window frames are factory-installed, including flashing and caulking; sheathing and paper is in place; siding, of the type selected by the buyer, is in place. Diagonal corner braces are full-length 1 x 4's let into the studs and plates; all interior wall panels are diagonally braced. The inside face of the walls is not covered, but left open to receive utilities; dry-wall or plaster interior finish is site applied.

Studs, trimmers, headers and cripples for the interior partitions are cut to length, bundled and marked. Studs are spaced 16" on centers and doubled at openings; top plates are doubled to permit interlocking at all wall sections. Door frames are shipped knocked down.

Roof trusses are cut, prefitted, unit-bundled and marked. Depending on size, truss joints will be fastened with nails, nails and gusset plates, bolts, split rings, or combination of these. The top chord is a single 2 x 6, the bottom chord two 2 x 4's; 1 x 2 ledger strips carry pre-cut 2 x 4 purlins and ceiling joists at 24" and 16" centers, respectively. Trusses are normally spaced 4' - 0" centers. Roof sheathing is laid solid, with the starter strip laid parallel to the roof edge, its lower edge supported by the starter purlin; the balance of the sheathing is laid vertically,

parallel to the roof.

Gables are normally made and shipped in one piece, up to a minimum of 24 feet in length. Studs are 2 x 4's flat, bottom and top plates are 2 x 4's on edge. The bottom chord is stiffened by a 2 x 4 flat; when the gable is placed on the wall, this latter 2 x 4 extends inward to carry the ceiling joists and serve as lath strip. Longer gables will be divided at the center. Siding and louvers are in place.

The finish roofing may be either cedar shingles (16" - No. 1 grade) or 215# composition roofing, site applied.

Field Assembly

The foundation is built by the builder, in accordance with local requirements and conditions.

The outside wall panels are placed, plumbed, fastened at the plate and corner, and braced to the floor.

Gable ends are placed next, being certain to have them square and plumb before starting erection of the roof trusses. The gables control the location of the trusses.

Roof trusses are placed from each end toward the center, using the pre-cut purlins and ceiling joists as spacers.

The interior partitions are erected after the roof is in place.*

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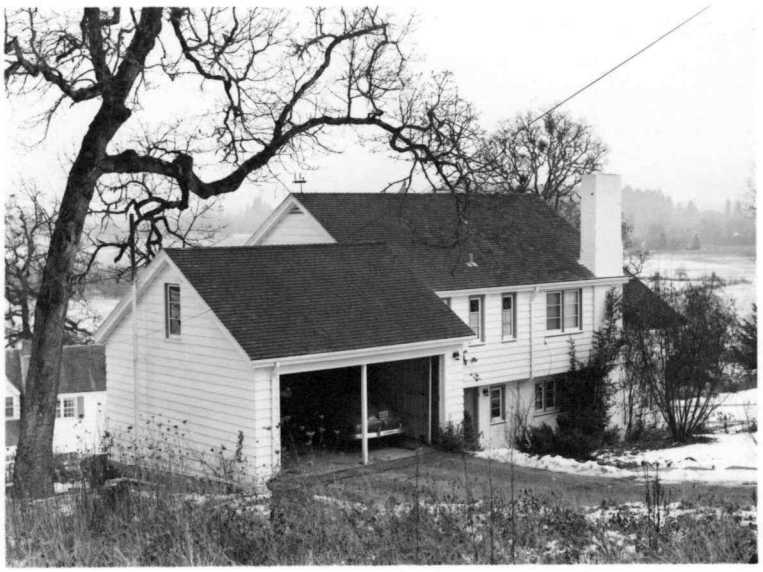
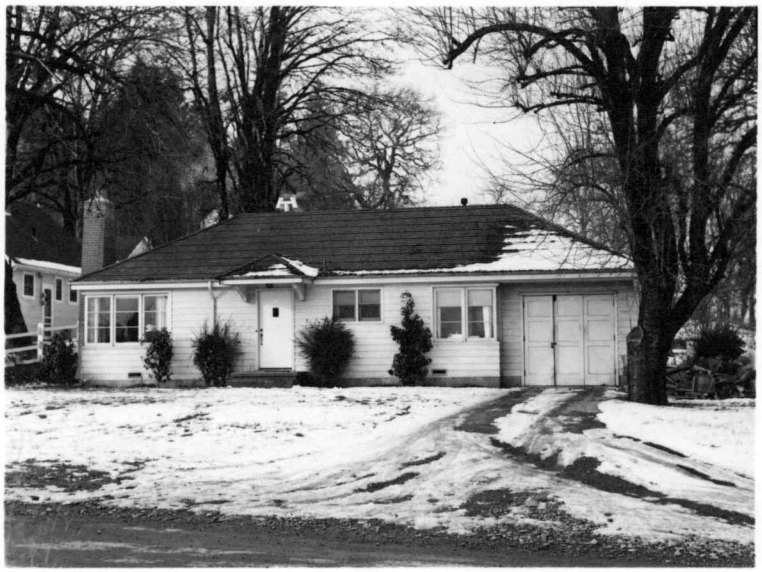
*Condensed from Precision Builders, Inc., Brochure, 1948.

The following photographs of prefabricated houses are submitted to offset the belief that all prefabricated houses look alike. The home, like a man's hat, must express the owner's individuality and taste, if not style and distinction. Prefabricators are providing the public with a number of basic designs. Each of these can be varied by changes in trim, shutters, entrances, type of doors and windows, and in numerous other ways.



FRONT AND REAR VIEWS OF A
TWO-STORY HOUSE OF NEW ENGLAND COLONIAL DESIGN

A LARGE PREFABRICATED HOUSE OF MODERN DESIGN



A TWO-BEDROOM HOUSE OF WALL-SECTION CONSTRUCTION

CHECK LIST*

WHAT TO LOOK FOR IN BUYING A HOME

Item	FURNISHED Satis-factory	FURNISHED Unsatis-factory	Estimated Cost of Additional Items
Excavating & Grading			
Foundation or Basement			
Waterproofing Basement			
Drainage Tile Around Basement Wall			
Foundation Vents			
Basement Windows & Frames			
Sill and Anchor Bolts			
Exterior Walls			
Studs, Plates & Sheathing			
Insulation			
Vapor Seal			
Building Paper Between Sheathing and exterior surface material			
Siding, Shingles, Stucco or Masonry Veneer			

* Adapted from Carr, A Practical Guide To Prefabricated Houses. (3-109-10)

Item	FURNISHED Satis-factory	FURNISHED Unsatis-factory	Estimated Cost of Addition-al Items
Painting			
Interior Walls			
Lath & Plaster or Wallboard			
Woodwork Trim			
Varnish & Stain			
Wallpaper or Paint			
Floors			
Joists and Bridging			
Subflooring			
Hardwood Finish Floor			
Linoleum for Kitchen and Bath			
Building Paper Between Subflooring & Finished Flooring			
Roof and Ceiling			
Rafters, Ridges, Collar Beams, etc.			
Sheathing			
Slater's Felt			
Roofing Shingles, Built-up Metal, Slate			
Ceiling Joists, Bridging Headers, Plates & Stripping			

Item	FURNISHED Satis-factory	FURNISHED Unsatis-factory	Estimated Cost of Additional Items
Lath and Plaster or Wallboard			
Doors and Windows			
Exterior & Interior Doors			
Door Frames & Trim			
Window Sash with Glass			
Frames and Balances			
Window and Door Screens			
Shutters			
Weatherstripping			
Hardware: hinges, Lock sets, window fixtures, screen hangers, etc.			
Sheet Metal			
Gutters			
Downspouts			
Door & Window Flashing			
Valley & Ridges			
Termite Shield			
Chimneys			
Fireplace			

Item	FURNISHED Satis-factory	FURNISHED Unsatis-factory	Estimated Cost of Additional Items
Stairs and Hand Rail			
Basement			
Second Floor or Attic			
Cabinets and Interior Detail			
Kitchen Cabinets			
Cupboards			
Broom Closets			
Bookcases			
Shelves in Closets			
Clothes Hooks and Hangers			
Built-in Chests			
Towel Rods, Paper Holders, Door Stops, etc.			
Plumbing			
Kitchen Sink			
Dishwasher			
Garbage Disposal			
Bathtub			
Lavatory			
Toilet			
Laundry Trays			

Item	FURNISHED Satis-factory	FURNISHED Unsatis-factory	Estimated Cost of Addition-al Items
Laundry Machines			
Water Heater			
Water Softener & Conditioner			
Exterior Hose Bibs			
Heating			
Warm Air			
Steam			
Hot Water			
Oil Storage Tank (where oil burner is employed)			
Electric Wiring			
Overhead Fixtures -- Kitchen, Utility Room			
Basement, Dining Room, Bath			
Wall Lights			
Duplex Receptacles			
Switches			
Door Bell			
Radio Outlet			
Telephone Outlet			
Porches and Terrace Steps			

Item	FURNISHED		Estimated Cost of Additional Items
	Satisfactory	Unsatisfactory	
Garage			
Landscaping			
Grading			
Seeding or Sodding			
Planting			
Walks and Drives			

* Adapted from Carr, A Practical Guide To Prefabricated Houses. (3-109-10)