A HISTORY, DEVELOPMENT AND EXPLORATION OF
PANELIZED CONSTRUCTION

by

Francis Freile Fleetwood
Bachelor of Arts, Bard College
(1970)

Submitted in Partial Fulfillment
of the Requirements for the
Degree of Master of
Architecture

at the

Massachusetts Institute of Technology

June, 1973

Signature of Author...

Department of Architecture May 11, 1973

Certified by

Thesis Supervisor

Accepted

Chairman, Departmental Committee on Graduate Students
DISCLAIMER OF QUALITY

Due to the condition of the original material, there are unavoidable flaws in this reproduction. We have made every effort possible to provide you with the best copy available. If you are dissatisfied with this product and find it unusable, please contact Document Services as soon as possible.

Thank you.

Pages 42 & 94 have been ommitted due to pagination errors.
A HISTORY, DEVELOPMENT AND EXPLORATION
OF PANELIZED CONSTRUCTION

by

FRANCIS F. FLEETWOOD

ABSTRACT

The objective of this thesis is an exploration of the possibilities of establishing an adaptive process between the panelized manufacturing industry and man. Initial control or the ability of clients to choose from differing alternatives and/or to become involved in the process of design, and the secondary control, or the ability of the user to adapt his environment, are examined in the early history, the panel and its systems, manufacturing and material handling, the use of a computer and through design studies.

It was found in the historical analysis that most of the structural concepts and details used in the modern industry were refined or invented in the nineteenth century and that initial and secondary control was limited. Secondary controls are directly related to design and a typology of panels, structural concepts, and connections is examined in order to specify the limitations imposed by different systems of panelization. Manufacturing and material handling was found to exert size controls on the initial product, but have little influence on secondary or adaptive ability of the structure. Computer programs, such as the one developed by the author, illustrate how greater initial flexibility could be approached in manufacturing and material handling. A design exploration is presented in the last chapter to examine and explore the limitations and possibilities available in panelized construction.

Submitted to the Department of Architecture on May 11, 1973
in partial fulfillment of the requirements for the degree of Master of Architecture

Thesis Supervisor: M. K. Smith
Title: Professor of Architecture
<table>
<thead>
<tr>
<th>SECTION</th>
<th>INTRODUCTION, SCOPE AND METHODOLOGY</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>SECTION II</td>
<td>THE EARLY HISTORY OF PANELIZED CONSTRUCTION: A PERIOD OF RICH VARIETY OF IDEAS</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Introduction</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Early Patents</td>
<td></td>
</tr>
<tr>
<td></td>
<td>F.S. Barnard 1839</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>D. Fitzgerald 1856</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>A. Derrom 1861</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>D.N. Skillings 1861</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>J. Montgomery 1869</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>J.M. Peck 1881</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>V.W. Blanchard 1883</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>W.M. Ducker 1905</td>
<td>25</td>
</tr>
<tr>
<td>SECTION III</td>
<td>PANEL, PANEL SYSTEM AND CONNECTION TYPOLOGY</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Introduction</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>Typology of Panels</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>Load Bearing Panels</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>Post and Beam Systems</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>Panel Systems</td>
<td>45</td>
</tr>
<tr>
<td>SECTION IV</td>
<td>THE PANELIZED HOUSING INDUSTRY: MANUFACTURING AND MATERIAL HANDLING LIMITATION ON DESIGN</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>Introduction</td>
<td>54</td>
</tr>
<tr>
<td></td>
<td>The Panelized Package</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>Sales</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>Production and Material Handling</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td>Limitation on Design</td>
<td>64</td>
</tr>
<tr>
<td>SECTION V</td>
<td>COMPUTER APPLICATION IN PANELIZED MANUFACTURING HOUSING COMPANIES</td>
<td>68</td>
</tr>
<tr>
<td></td>
<td>Acorns Designation Code (Old)</td>
<td>72</td>
</tr>
<tr>
<td></td>
<td>Acorns Designation Code (New)</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td>Hypothetical Computer Assisted Design Process</td>
<td>88</td>
</tr>
<tr>
<td>Section/Appendix</td>
<td>Description</td>
<td>Page</td>
</tr>
<tr>
<td>------------------</td>
<td>--------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>SECTION VI</td>
<td>DESIGN</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A Panelized House</td>
<td>91</td>
</tr>
<tr>
<td>APPENDIX I</td>
<td>LIST OF PATENTED PANEL HOUSES</td>
<td>97</td>
</tr>
<tr>
<td>APPENDIX II</td>
<td>CLEMEN'S CATALOGUE</td>
<td>100</td>
</tr>
<tr>
<td>APPENDIX III</td>
<td>LIST OF TAPED INTERVIEWS</td>
<td>110</td>
</tr>
<tr>
<td></td>
<td>Acorn</td>
<td>111</td>
</tr>
<tr>
<td></td>
<td>Grossmans</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>Space Makers</td>
<td>130</td>
</tr>
<tr>
<td></td>
<td>Stanmar</td>
<td>140</td>
</tr>
<tr>
<td></td>
<td>Yankee Barn</td>
<td>151</td>
</tr>
</tbody>
</table>
SECTION I

INTRODUCTION, SCOPE
AND METHODOLOGY
This work arises from the author's feelings of disquiet about the situation of the middle class with respect to their ability to control their dwelling environment within economical constraints. It is assumed from the rapidly spiraling number of industrialized-factory manufactured housing starts that much, if not all, of the new housing in the next decade will be factory manufactured. This thesis focuses on a few critical aspects of one type of industrialized construction - panelized manufactured housing - in order to ascertain what steps should be taken by the industry to create more responsive structures.

In attempting to explore panels and their manufacturing, the author approaches the current design and practices with the pre-disposition of a designer searching for limitations that place constraints on the designing of creative, responsive structures. Moreover, an attempt is made to ascertain how the process may be changed to meet the specified objectives. This approach - starting with the objectives - has been characterized in the sociological literature as the Normative Relevance tree technique. In other words: to identify some socially desired goal, such as flexibility, and work to discover the extent to which existing knowledge and techniques must be developed before that goal can be attained.

The clothes we wear, the cars we drive, the furniture we sit on are all mass-produced. Over 40% of the housing starts in 1972 were also industrialized. The individuality of goods is fast disappearing.
As men, we are in the position of choosing one predetermined size or another, even if our own size falls somewhere inbetween. As we look in the mirror at our image we are forced to realize that the modern situation is of our own creation.

"On the one hand, men have come to see themselves more and more as part of a mass market, consumers of essentially identical produce, recipients of persuasive messages beamed at the millions. On the other hand, men as producers, as parts of a system of mass production with its many models and variations in the world of the white collar worker, and professionals have come to see themselves progressively as performers of simple, uniform, repetitive mechanical tasks. They are on the one hand consumers and on the other hand manpower; on the one hand filler-out of consumer preference forms, one among statistical myriads, and on the other hand temporary fillers of jobs characterized by job descriptions which are designed precisely to avoid hint of individuality."

The progressive dissolution of man is not hard to understand, especially when the impersonality of the goods and of his environment are considered. We have worked ourselves into a situation in which we have to make increasing accommodations and compromises.

This thesis addresses just this problem of adapting the technology of the panelized manufacturing industry to man. It is concerned with the individual's control over his dwelling environment. Initial control includes the opportunity to choose different alternative designs and to become directly involved in the design process. Secondary control involves the ability to adapt the panelized environment over time. The objective of this thesis is to explore the possibility of establishing a responsive process between the panelized manufacturing
industry and its clients. The work focuses on two aspects of the total industry that can be isolated only theoretically. These are production and design. Marketing, management, unions, transportation, and politics are assumed to have secondary importance to the overall objectives.

Initial and secondary control are an individual matter related to the same human need of establishing a natural, responsive relation with the objects around one. A relation is based on action, and dwelling is the sum total of a multitude of actions that establish a relation with one's space. It concerns person consideration, decisions and man needs continually to adjust his environment to fit his desires and whims. These needs have been dealt with by the Dutch architect Habraken in his theory of natural relation, in which he explores the necessity and ramifications of designing adaptable structures.4

If the designer is to effectively challenge and probe the potentials of the manufactured housing industry in order to create more responsive environments, so that relating will be facilitated, then it seems an investigation must be first centered on the unique capabilities and limitations of structural concepts inherent in the system and materials with which he is working. This exploration attempts, in Sections III, IV, V, and VI, to do that with the panelized manufactured housing industry, a subject about which little has been published. The material and concepts presented here are based on information obtained from manufacturers of panel houses and on personal experience of working within the industry.
Section II probes the first patented panel house touching on the earliest application of technology centered around panelization in order to see what was used when and to determine, in a very limited way, the effect these details had on the resultant structure. It further illustrates the variety and richness of the early systems. Section III attempts to form a typology of panels, panel systems, and connections in order to specify their relation to the objective of a more responsive dwelling environment. This section is not intended to be an exhaustive review of all systems and details being used in the industry but conceived of as establishing a broad framework of types and families. Section IV introduces the reader to the panelized housing industry. This section also examines two critical aspects affecting dwelling design – fabrication and material handling. Section V examines the productive interface of computer assisted production developed by the author in conjunction with Acorn Structures and hypothesises about possible further developments in relation to designing unique structures in conjunction with clients. Section VI is a design exploration illustrating the potentials of improving the current design by adding non orthographic spaces to the panelized housing vocabulary. It takes the same basic plan and by applying it to three different structural systems illustrates how different structures systems can create somewhat different spaces.
FOOTNOTES TO SECTION I


4. Ibid., page 14
SECTION II
THE EARLY HISTORY OF PANELIZED CONSTRUCTION:
A PERIOD OF RICH VARIETY OF IDEAS
Panelized structures have been produced in America for over a hundred and thirty years. However, throughout the decades the terminology has constantly kept changing. In fact, vague and imprecise terminology still plagues the manufactured housing industry. In the nineteenth century the most common term used to describe all manufactured homes was "portable." "Portable" not only described houses, but was used in reference to barns, chicken coops, and any shelter that was produced in a lumberyard or factory and then transported to the site. Other terms commonly used in the latter part of the century were "precut," "sectional," and "demountable." These terms have different and somewhat more specific connotations today. In the 1920s the term "prefabricated" became tainted because of all the shabby wartime construction. "Manufactured homes" then became the common term.

This chapter is concerned chiefly with the structural detail and initial and secondary flexibility of the early panelized houses. Clearly many of these details were adapted from standard construction of the times to fit a factory-finished form of panelized construction. Other details and structural concepts were invented specifically for panelized construction. What is important about the early panelized houses from 1839 until 1920 is that they established a majority of the details and structural concepts evident in the panelized manufactured housing industry today. As a by-product they also set a style that often clearly showed the panelization. The
so-called modern movement in panelized housing began in 1920 and ended in the 1950s. It has been studied and documented by such authors as Burnham Kelly and Alfred Bruce.\textsuperscript{1} The period prior to 1920 has never been studied previously. Certain limitations are evident when dealing with historical materials, primarily obtaining a complete enough record of the period to be able to make accurate statements. Patents can provide us with an accurate survey of the ideas of the period relating to panelized construction. However, what was patented was not always produced and what was produced was not always patented. When additional material was found indicating production, it will be referred to.

In 1839, the first panelized house was patented by Fredk S. Barnard of Philadelphia, Pennsylvania (Figure 1). This was 22 years before what is generally recognized as the first panelized house. Certainly there were others that predated this house, but documentation of this is difficult. Barnard's house is remarkable because it establishes an important family of details that are still being used today, even though the house was built without plywood. What was established was the four-way lap condition on a load-bearing panel. The patent specification read as follows:

"The lower floor A is composed of a rectangular from B the size of the building proposed to be erected say about 12x18 feet of stuff 3x4 inches mortised and tenoned together at the angles. Under the sides of this frame are secured boards C of greater width than the sides of the frame projecting inward so as to form ledges for the floor joists D to rest on which are also notched into the frame at the ends. This frame is to rest on piles, piers, or other supports in the position in which the building is to be placed or on a suitable
foundation. One or more boards are secured to the under sides of the joists between and parallel to those just described. A floor A is laid and secured on these joists of a length and breadth equal to the frame less the thickness of the outside horizontal boards E which are to rest against the edge of the floor and upon the top of the frame. The side F of the house is composed of vertical parallel boards F planed on both sides and tongued and grooved and when put together form a side equal in length to the length of the floor A and secured on the inside by parallel strips G' G'' G''' G'''' of less length than the side equal to twice their thickness and on the outside by two similar strips H E one above and the other below, the latter E being the strip that rests on the frame and the upper strips being placed below the upper edge of the side of the building equal to their thickness or the depth of the groove in the plate attached to the roof hereafter described. The lower inside strip G forms a washboard and is on a line with the ends of the vertical boards. The strip G above that which forms the washboard serves for the chair board. The third strip G from the bottom forms the inside casing of the doors and windows and serves as a pin strip. The fourth strip G forms the cornice of the lower room and supports the floor of the upper room and ceiling of the lower room. The fifth strip G assists in supporting the roof. These parallel horizontal strips also serve another valuable purpose — namely to connect and secure together the vertical boards. The outside strips are as much longer as the inside strips are shorter than the side of the building for the purpose of lapping and forming the joints at the angles. The opposite side of the house as well as the two ends are made in a similar manner to that just described, excepting that the length of the ends is less than the width of the floor equal to twice the thickness of the vertical boards of the sides. Openings for doors and windows are left in the sides and ends wherever required framed to suit the doors and windows made use of; the windows being of the usual construction.

The panels were 12 to 18 feet long. The specifications do not indicate the height of the panel, but from the scale drawing it may be assumed that the first floor panels were eight feet tall and the second floor panels were five or six feet tall. The lower panel conforms closely with some of its modern counterparts. Insulation came from the space left between the skins of the vertical boards.
There is no information on the construction of the roof. It may be assumed that it was precut, since a house package was supplied.

The total product was similar to the standard house of the times for the working class. It was a simple sheathed structure inside and out. Perhaps just coincidentally, the vertical striation of the exterior panel closely resembles the striation of the reverse board and batten plywood so commonly used in panelized houses today. The house offered neither initial nor secondary flexibility.

In 1849 an active industry developed for the production of houses for the California Gold Rush. Many thousands of men landed on the shores of California needing shelter. For the next two years, England, the United States, France, Germany, and even China and New Zealand produced many thousands of precut panelized and metal houses. Ships sailed across the Pacific and around Cape Horn laden with houses. Unfortunately the available information is sketchy, including only descriptions of size, price, and style but no structural information. None of these houses was patented. They were for the most part of a utilitarian nature for temporary shelter at tremendous cost, as illustrated in this newspaper clipping.

"Robin and Treadwell of New York built some six hundred in two years and S. P. Lincoln of Brooklyn, two hundreds models which cost less than four hundred (dollars) in New York and sold for five thousand (dollars) in California."²
FIGURE 1

THE GRAPHIC CO. PHOTO-LITH. 30 & 40 PARK PLACE, N.Y.

-12-
D. Fitzgerald.
Iron Structure.
No. 14,952. Patented May 27, 1856.
J. Montgomery

Portable House.

No. 66,572. Patented Feb 2, 1869

FIGURE 5.
J. Montgomery
Portable House.

Patented Feb 2, 1869.

FIGURE 5
J. M. PECK.
Construction of Buildings.
No. 239,669. Patented April 5, 1881.

FIGURE 6

(No Model.)

Inventor:

Attorney:

2 Sheets—Sheet 1.
J. M. PECK.
Construction of Buildings.

No. 239,669.
Patented April 5, 1881.

FIGURE 6
V. W. BLANCHARD.
PORTABLE BUILDING.
No. 271,776.
Patented Feb. 6, 1893.

FIGURE 7

Witnesses:

[Signatures]

Inventor

V. W. Blanchard.

Attorney

[Signature]
V. W. BLANCHARD.
PORTABLE BUILDING.

No. 271,776.
Patented Feb. 6, 1883.

FIGURE 7
The description of these wooden houses indicates that some of the technologies afforded by balloon frame (developed in 1833)\(^3\) were being used but in combination with traditional post and beam construction and mechanical joints. In particular the industry began using smaller and lighter members than conventional builders. Transportation must have been one of the critical factors.

In 1856 D. Fitzgerald of New York City patented a new mode of constructing a circular house (Figure 2). The original house was not panelized, but in addendum patent he patented the first sectional roof the next year, No. 1720. Patent drawings of this first panelized roof have been lost. No indication is given as to whether the panel was load bearing or was simply a skin over precut rafters. However, this circular precut house was the first patented house using roof panels.

In 1861 A. Derrom of Passaic, New Jersey, patented a portable hut (Figure 3). The hut has the first patented dove-tailed studs and plates (Figure 8, Derrom patent) and is the first attempt at tongue-and-grooving evident in a panelized house. The panels are three boards wide, connected by smaller cross-boards that are inserted into grooves made in the studs. Every third panel is inserted into a grooved post. The hut uses metal fasteners at the floor and ceiling (see Figure 4, Derrom patent).
The effect of this hut is severely utilitarian. All the structure is visible accepting the tongue-and-groove family of connections. The grooved post represents the first visible effect of manufacturing on the panelized house. Machining notched post, as simple as it sounds, is something that represents a significant step toward rethinking traditional structures and adapting the product to fit the factory processes. The hut is the first patented post-and-beam structure with infill panels, a commonly used structural method of modern panel manufacturers.

D.N. Skilling of Boston, Massachusetts, also patented a panelized house in 1861 (Figure 4). The house was constructed of interchangeable roof panels. This was the first patented house to use interchangeable infill panels in a post-and-beam system. "Sills, post, plates, doors, windows, etc. are cut, fitted by machinery to one size, so that any piece marked No. 1 will fit and may be used in any other number." As reasonable as this may sound, it was the first time interchangeable parts were patented for a panelized house. The concept of interchangeable panels is unfortunately one that is not very evident in the panelized manufacturing industry today. The concept has far-reaching implications, especially when applied to design. It makes it possible to order a standard house and decide at the location where the windows and doors should be placed.
In order to design interchangeable panels, it was necessary to do away with all lap conditions. The panels consist of a frame and horizontal boards on the inside and outside. The panels were not load bearing. The sides abutted a T-shaped post that also served as a batten. Construction details were provided with each house.

"Select the sills marked A. Lay them in pairs on the foundations or blocking, bring the corners together, take the corner irons with the screws and fasten them; level the sills....then take the wall sections, stand it on its edge on the sill....lay in the floor timber marked B, take the thick one which will be found in the bundle, put it in the center of the building...."

J. Montgomery of New York patented a panelized house in 1869 consisting of hallow-core detachable metal-faced panels (Figure 5). The end pieces of the frame have a tongue to hold the panel and consequently the panels have a lip projecting past the frame of the panel and tacked into the next panel. The specifications stress the assets of the metal skin. "A house thus constructed is proof against any external fire to which houses are ordinarily liable."

This shiny "house" brought panelized construction two steps forward. It established a horizontal tongue-and-groove connection at the floor and ceiling that would be copied frequently in later years. And for the first time it used one continuous sheet, of metal, for the exterior surface. Panelized manufacturers would have to wait many
years before plywood was mass produced in the 1930s to simplify construction and form a single surface to sheath their panels.

Chicago was alive with activity in the early 1870s. Prefabricators were turning out houses, schools, town. "No one who has not visited these huge manufactories of portable houses can have any correct idea of the magnitude of operation." The panelized structures were not patented but some information is available about the structure of this period.

The building of the Union Pacific opened up vast regions in the treeless great plains. Settlers needed shelter. Instead of shipping only wood, prefabricated houses were also hauled. Firms such as Clemens' Ready Made Sectional Houses were doing very well offering settlers a modest but substantial first house.

"We have undertaken to meet widely noticable want of good, strong, tight, durable and comfortable ready-made houses, of smaller cheap class, so contrived as to be made in parts by machinery and economized labor in a factory, and which can be compactly transported wherever lumber for building now goes; be easily and securely put up without the aid of...and when put up, will afford all of the essentials of a good of a good, permanent dwelling."

Clemen's sectional home is a post-and-beam structure with infill
panels. The posts have a double-tongue connector and extend past the panels to serve as battens on both the interior and exterior. The panels were interchangeable with windows and door inserted. Roof panels were also supplied with the package.

Clemens' Ready Made Sectional House did not advance the state of the art of panel construction but were vastly popular throughout the Midwest. Their illustrated catalog (see Appendix II) is the second oldest document of its kind. It differs markedly from its modern counterparts in that it concerns itself with the structure and structural details. Its simple technical approach is refreshingly different.

J.M. Peck of New York patented an attractive improved panelized house in 1881 (Figure 6). His house shows rabbeted and grooved framing timbers and siding panels composed of tongue-and-grooved boards connected by battens rabbeted upon edge to form projecting tongues. The roof is composed of grooved battens connected by rabbeted boards. In other words, a complete rabbeted, tongue-and-groove panelized house.

Elegantly designed and fitted together, the house uses interchangeable rectangular panels that are visible from both the exterior and interior. Like many modern panelized houses, the interior finish is left off and is meant to be finished on site. The house is definitely the child of a factory operation with so many rabbeted, tongue-and-groove pieces. This is clearly shown with a little gingerbread-residual
brackets added on. The house once erected could not be modified without taking the entire structure apart.

W. Blanchard of New York City patented the first sandwich panel house in 1883 (Figure 7). The glued sandwich consisted of horizontal boards, metal, gypsum, plaster of paris, and a second layer of horizontal boards. The walls were load bearing with holes in the panels for long, floor-to-ceiling tie rods. The roof panels were similar with built-in gutters and T-shaped battens at the joints. Cross ties on the second floor were tightened by bolts. The window frame's vertical interior sash extended from floor to ceiling.

This early attempt at panelization seems remarkably sophisticated, especially when compared with its modern-day counterparts. The panels were a manufactured product built up with pieces until it formed a large weather-tight structural component. The glued sandwich structure, however, looked no different from any other house of the time except for the interior window detailing and was more difficult to adapt than a stick-build house.

The first use of trusses in a patented panelized house occurred in 1905 (Figure 8). W.M. Dicker of New York patented a house that used both gable end and intermediate trusses supporting roof panels. The trusses were a straightforward application of conventional construction with notches inserted to support the ridge pole. Other refinements evident in the patent relate to panels that are connected
together on the vertical axis with a spline and horizontally connected with a transverse wall plate running the length of the building. The panels consisted of horizontal exterior siding, nonconducting sheet material, plaster and wire gauze for site-applied finishing.

By 1905 the main structural adaptations and inventions had occurred. Variations and refinements of the basic principle were to occur slowly after 1905. The basic principles, forming a typology of panel systems and connections that is elaborated on in Section III, were mostly evident in these early attempts at panelization. Thus the early systems showed the load-bearing hollow-core panel both large and small, exterior and infill panels in conjunction with post and beam supports and innumerable combination systems (that have not been included). The basic connections that were established were the four-way lap conditions and the large family of rabbited and tongue-and-groove joints. Other elements that are presently used, such as roof, floor, and sandwich panels and trusses, were also first tried in this period.

Prefabricators continually stress three advantages of their product: QUALITY (although this is questionable), LOW COST, and SPEED OF ERECTION. In spite of these advantages and improving architectural styles, none of the early prefabricators succeeded in maintaining themselves in business. Part of the problem then, as it is today, was the easy entry, easier exit nature of the industry. Markets
and prefabricators seemed to come and go responding to the push-and-pull situation of the times. The early prefabricators never actively sought to penetrate the traditional stick builders territory and consequently no solid middle-class houses were ever produced. For the most part, these "houses" were no more than thermally inadequate sheds. Nonetheless, their contributions were significant to the establishment of a new concept of construction. The variety of and richness of panels, panel systems and connections has never been surpassed, even if many ideas never were manufactured.
FOOTNOTES TO SECTION II


SECTION III

PANEL, PANEL SYSTEM AND
CONNECTION TYPOLOGY
Section III of this thesis attempts to classify panels, panel systems, and details through text and drawings. The following typology is not intended to be an exhaustive review of all systems and details being used in the industry. Nor is it intended as an exploration of possible system combinations or assemblages (see Figure 1). The typology is conceived of as establishing a broad framework of types and families that could be added to. It does, however, classify all ten case studies and give a satisfactory picture of the state of the art, while pointing out a few new directions.

TYPOLOGY OF PANELS

Stressed skin panels are the most efficient structural wood system for walls, floors, and roofs. They are constructed from framing members to which plywood is bonded by either glue-nailing or simply glueing. The plywood sheathing causes the panels, under loading, to act as an integral unit, therefore stressing the skin. Consequently, the panels require fewer ribs and a reduction of pieces and sizes in all framing materials.

In spite of proven efficiencies and lightness, stressed skin panels are not in widespread use. One often-cited reason has to do with local codes that have not generally recognized this type of construction. Stressed skin panels have been used and tested for over thirty-five years by the Forest Products Laboratory. Their findings indicate that the components used and tested showed no visual evidence of deterioration after twenty-five years. It may be
DISCLAIMER

Page has been omitted due to a pagination error by the author.

Page 42
assumed that all panels referred to in this section are not stressed skin unless otherwise indicated.

LOAD-BEARING PANEL

Small Load-Bearing Panels can easily be distinguished from large panels because of a reliance on a four-foot planning module corresponding to the standard width of exterior plywood and an economical breakdown of stud spacing. They are so constructed that they can easily be handled by two men without a crane. Frequently, however, smaller two-foot panels are used in special circumstances. The planning module refers to the exterior dimension of the studs and not the plywood, because of the various up-and-down and side lap combinations. The two interior studs are spaced sixteen inches on center and the exterior studs are spaced closer. Vertically small panel systems have established a standard called "full-height panels", which are based on the floor-to-ceiling or floor-to-floor heights for the rectangular sides of the structure. Full-height panels use one piece of plywood. On the gable ends the vertical standard established with the full-height panels breaks down. Gable end panels range up to eighteen feet in height, or the height of two pieces of plywood. The four foot panel system was used by only two of the ten case studies examined.

Large Load-Bearing Panels refer to panels ranging in length from eight to forty feet. This is the current, somewhat unspecific, terminology being used in the industry. Large-panel manufacturers
seldom apply any specific standard to panel lengths, but work within a range of sizes determined by erection procedures. If a crane is to be used on the site, the panels range from sixteen to forty feet when design permits. These panels are most frequently used to construct a large number of houses at the same site or for the construction of multiples. If panels are to be lifted by hand, the panels range from eight to sixteen feet, design permitting. Large panels are constructed from 2 x 4-inch studs spaced sixteen inches on center and generally sheathed with plywood or particle board.

POST AND BEAN SYSTEMS

Non-Load Bearing Panels are characterized by their use in relation with post and beams. At the moment, the most common and the most economical external wall construction is not post and beam panels. For "aesthetic" not structural reasons, post and beam structures are being built. However, if the wall panels used in post and beam structures could be mass-produced in sandwich construction, at lower cost than standard wood load bearing panels, then it seems that lower cost potential could be realized. Seven of the ten panelized firms studied used some or all post and beam panels. However, this high percentage is not representative of the United States as a whole where a majority of panel systems use large load bearing panels.

Infill Panels are positioned in the same plane as the post and beam. They range in length from eight to fourteen feet, which is determined
by the ratio of the post and beam sizes. For spans of over fourteen feet, the depth of the beam becomes a critical factor. For spans of less than eight feet, it becomes uneconomical to use posts and beams. Infill panels are in general constructed of the same size members and in an identical way to load-bearing panels. They have limited design flexibility plan, because of their size and their direct dependence on the posts and beams, but the panels themselves are economical to manufacture. Headers for the doors and windows are unnecessary because the panel is just a skin.

Exterior and Interior non-load-bearing panels offer two different but related use conditions. They are not constricted in length unless they are fastened to the post and beams. Attachment can theoretically be made to any number of elements, including the floor or ceiling. This family of panels offers extreme flexibility in plan because the support conditions of the building are not dependent on panel placement. Headers are unnecessary and consequently manufacturing is simplified. One system out of seven using post and beam panels, used exterior rather than infill panels.

**PANEL SYSTEMS**

The following text and drawings explain and illustrate the secondary adaptive capabilities that are created as a direct result of the structural systems. Both load-bearing and non-load-bearing panel systems provide lateral stability to the structures. There are
basically three different types of panel assemblage systems used today: (1) Load Bearing System, which relies on the panels for support (Figure 2), (2) Post-and-Beam and Non-Load-Bearing Panels System (Figure 3) which relies on the post and beams for support, and (3) Post-and-Beam and Load-Bearing Panels Combination Systems (Figure 4) which mix support conditions.

Roof and floor panels are not considered in the typology because they may be used in any of the above systems without affecting the typology. Roof and floor panels are capable of sustaining greater loads than wall panels and consequently are heavier. Thus they require cranes at the site and are not generally used for single-family house construction.

Both small and large load-bearing panel systems restrict the secondary structural capabilities of addition or substantial modification. Many interior partitions are load bearing and large spaces are generally unadvisable in this type of construction. Small load-bearing panels offer substantial flexibility in plan but are more expensive both to manufacture and erect. Large load-bearing panels offer less flexibility in plan but are most economical to manufacture and erect. Both small and large load-bearing panels require headers and cripples at doors and windows.
Post, beam, and panel systems are less restrictive of secondary adaptive capabilities of addition and modification than are load-bearing panel systems. Post and beams, not panels once erected, are difficult to alter but do not seriously impede spatial definition. Post and beam panel systems use more wood, but panel manufacturing is simpler than in the case of load-bearing panels. Headers are unnecessary because beams carry the loads. Post and beam panel systems are the most costly to manufacture and erect because of the greater amount of wood and number of pieces.
SMALL LOAD-BEARING PANEL SYSTEM
COMBINATION PANEL SYSTEM
Panel connections are either edge or right-angle connections. They could be considered part of the traditional family of joints except that panel joints involve two and sometimes three elements: the exterior skin, the frame, and occasionally an interior skin. Panel connections frequently fall into traditional joint categories, but they also mix jointing conditions with one element, say the frame, butting, while another element, say the skin, rabbeting. In order to clarify the terminology and present an index of possible alternatives, Figures 5 and 6 illustrate the standard end and right-angle connections. Figures 7, 8, 9, 10, 11, 12, 13, 14, 15, and 16 illustrate standard jointing detailing used in the case study. Figures 17 and 18 illustrate connections used in Section VI.
END CONNECTIONS
RIGHT ANGLE CONNECTIONS
VERTICAL CONNECTIONS (COMBINATIONS)

butt rabbet facia

butt dado facia
VERTICAL CONNECTIONS
roof or cantilever

floor

overhang

on slab on floor on floor on slab

HORIZONTAL LAPS
HORIZONTAL CONNECTIONS

rabbet

lap
HORIZONTAL LAPS-GABLE END

fixed glass

no down lap
overhang

clipped

HORIZONTAL UP-LAPS
WINDOW CONNECTIONS
TRUSS ON PANEL
FOOTNOTES TO SECTION III


2. Ibid, page 2

3. Ibid, page 11
SECTION IV

THE PANELIZED HOUSING INDUSTRY:
MANUFACTURING AND MATERIAL
HANDLING LIMITATION ON DESIGN
One of the ramifications of imprecise terminology and the lack of commonly agreed-on meanings in the manufactured housing industry is the plethora of contradicting statistics. Panelized homes are, for statistical reasons, frequently lumped into what is called "package homes," which includes precut, log, and the geodestic family of houses. The statistics presented here include only panel houses but exclude panelized houses produced for builder-developers, because accurate information is difficult to obtain for in-house developments.

Panelized housing represents a significant and growing segment of total shelter construction. In 1972 an estimated 375,000 units were built, comprising 14.5% of the total housing starts. The volume of output is expected to increase this year by 13% bringing the total percentage of panelized housing starts up 1% to 15.5%.

There are over 600 firms producing panelized structures. They range from such housing giants as Boise Cascade Housing Group, Evens Products Homes Group, and National Homes, which produce 1,815, 1,600, and 21,879 units annually, respectively, through such medium-size producers as Acorn Structures, Grossman Homes, Hodgson Houses, Reliable Homes, Spacemakers, Stanmar and Teckbuilt, which produce 200 to 600 units annually, to small manufacturers, such as Yankee Barn, which produce less than 100 units a year.

The ten panelized housing manufacturers selected as case studies for Section III as well as this section are representative of the
diversity found in New England. Unfortunately, it is difficult to
determine how representational these companies are of the rest of
the nation, since there is almost no current literature available
on panelized housing. Plant inspections, interviews, follow-up
interviews. (see Appendix IV), and work experience at Acorn Structures
supplied the sources for the following investigation and analysis.
The ten panelized housing manufacturers selected are Acorn Structures,
Grossman Home, Hodgson Homes, Kingbury Homes, Leasure Homes, Reliable
Homes, Spacemakers, Stanmar, Teckbuilt, and Yankee Barn.

THE PANELIZED PACKAGE

The panelized package varies from company to company. Some panelized
manufacturers supply everything but the foundation, but most supply
considerably less. The general rule that seems to hold true for
the panelized manufacturing industry is the larger the panels, the
more inclusive the package.

The package may be broken down and classified by components. Shell
components vary considerably from company to company. Typically,
what is supplied is wall panels with windows and doors inserted,
precut posts, plywood for the roof and floor, tarpaper shingles,
exterior trim, and nails. A few companies supply stairs, floor and
roof panels, insulation in the panel, precut exterior siding, and
interior sheathing. Finishing components such as doors, kitchen
cabinets, and precut studs for partitions are almost always supplied
with the package. Occasionally some items such as sinks and appliances are available as an "optional extra." Code variation and union resistance effect the package by limiting what can be factory produced.

Thus panels are only one of the many items being supplied to the builder. Part of the services being provided to the builder besides fabrication is simplified purchasing. Each panelized housing manufacturer has its own package. Customers are required to take the entire package. Deletions of anything included in the package are not permitted. Extra-cost options, such as delux kitchen cabinets and more or less windows, are usually available.

SALES

The panelized housing industry in New England, unlike the automobile and mobile home industries, has no formal, readily definable distribution network. The typical panelized manufacturer relies on advertisements and referrals followed up by sales visits for either developers or single-home consumers.

Advertisements are generally placed in local publications with the exception of the so-called giants who use both local and national publications. Advertisements aimed at developers are placed in trade publications such as Professional Builders. Single-home advertisements are placed, depending on market, in local newspapers for primary housing and in secondary home publications and sports-oriented magazines, such as Leisure Home Living and Vermont Woodsman.
for the vacation market.

Selling points to the developer can be summarized as follows (although points 7-9 only refer to the so-called giants):

1. Faster completion of units and consequently greater turnover on capital and more units a year
2. Better cost control in a price squeeze
3. Simplified purchasing
   a. No material expenditures or checkers
   b. No need to speculate on changing prices
   c. Less theft on site
4. More flexible operation
   a. Smaller staff
   b. Quick adjustment to change in demand
5. Referral of single-family house construction
6. Elimination of architect and use of company "architect"
   and planners for large panelized firms
7. Alliance of builder with large corporation for improved image
8. An advertising program and budget to sell houses to developers
9. Market analysis help

Large manufacturing firms have developed advertising programs to help entice developers away from other panelized manufacturers. Advertising programs are planned and budgeted with the help of Madison Avenue strategists. Selections in the construction manual are specifically planned to assist developers with forecasting housing demand and estimating total cost, along with instructions on
how to put the house up. Large manufacturing firms are assisting developers financially by absorbing percentages of all advertising expenditures incurred in selling units. Ready-made radio spots are provided free to developers. Professionally planned layouts are also supplied to builders to be placed in local newspapers. Boise Cascade, one of the larger manufacturers, even offers Hawaiian vacations to its high-volume developers.

Selling to single-family customers is complex and defies any typical patterns. It generally revolves around salesmanship. Once contact is made with a potential customer by salesmen or builder-dealers, large elaborate sales books are brought out with glossy photographs of house models. The number of house models from which the customer is able to choose varies from 3 to over 100. Also available from some manufacturers is the option of designing one's own layout within the design vocabulary. The client soon realizes that this is an expensive option. The typical "customization" referred to in the advertisement is the opportunity to choose window types and locations. The four typical and historic selling points used by almost all panelized home manufacturers are Fixed Price, Speed of Erection, Quality Produce, and Time-Tested Designs.

**PRODUCTION AND MATERIAL HANDLING**

In the 1920s and 1930s it was traditional for prefabricators to own tracts of woodland and to have ovens of their own to dry the wood. Today wood is generally purchased by the carload and is kiln-dried
Douglas Fir. Most often panelized manufacturers use only the highest grades available. Sometimes the plywood is remilled square. As much as feasible (in terms of cost and specific sizes) precut is purchased, corresponding to the commonly used sizes.

The term "manufactured housing" connotes to people outside the housing industry visions of assembly lines, heavy and complicated equipment, and a general level of sophistication far beyond the reality of the situation. The panelized manufacturing plant has more in common with a lumber yard than an automobile manufacturing plant. Part of the similarity exists because of the material - wood - and part of it exists because of the multitude of assembly and material storage points.

The panelized manufacturing processes are basically different from other industrial manufacturing processes. The manufacturing processes involve, in general, a series of assembly areas instead of one large assembly line. Some materials supplied by the material manufacturers go to one or more assembly areas; some materials do not go through any fabrication at all. Typical fabrication areas could include sawing areas, millwork areas, exterior wall assembly line or jigs, interior wall assembly line, gable department, and truss department. Kingsbury Homes, for example, has nine assemblage stations in their new plant in Muncy, Pennsylvania. They are:

1. SAW DEPARTMENT where lumber is cut to size. Some of this goes to the loading dock and some goes on to other
assemblage stations.

2. MILL WORK DEPARTMENT where stairs, rake assemblies, closet shelves, soffit assemblies, and other items are constructed. From here these items are transferred to the loading dock.

3. PAINTING DEPARTMENT where all exterior trim is primed, painted, and dried. From here the exterior trim is transferred to the loading dock.

4. EXTERIOR WALL ASSEMBLY LINE where exterior walls are constructed. Windows, doors, and exterior sheathing are applied here. From here panels go directly to loading dock.

5. INTERIOR WALL ASSEMBLY LINE where interior partitions are assembled. They go directly to the loading dock.

6. GABLE DEPARTMENT where gable end panels are assembled and sheathed. They go directly to the loading dock.

7. TRUSS DEPARTMENT where trusses are gang-nailed together. From here they go directly to the loading dock.

8. DOOR DEPARTMENT where doors are drilled for hardware and prehung door assemblies are constructed. Each unit is then boxed and delivered to the loading dock.

9. LOADING DOCK where all subassemblies are checked off for loading and sequentially loaded on the truck for convenience during erection.
The usual plant machinery consists of circular saws, planers, double end tenoners, truss assembly jigs, fork lifts, and cranes and hoists. Each plant usually has a particular machine designed in-house to satisfy some specific need. Molders most frequently used in the 1920s and 1930s are now used only by large panelized housing manufacturers specialising in low-cost housing.

The assembly jig is the heart of the panelized factory. A jig and its feeder racks are simply tables where the fabricating is done. They should have guides of one type or another eliminating holding the pieces by hand. Tape measures are frequently attached to the sides. However, this was found not to be the case in a few factories. In contrast to too little equipment, some panel manufacturers used quite sophisticated hydrolic "pop out" devices in conjunction with a series of automatic nailers on railes above the table. The benefits of this type of equipment is still being debated. The evidence seems to fall somewhere in the middle. But it should be noted that gable end panels are incapable of being assembled in many sophisticated jigs. Jigs are for the most part tables which facilitate hand fabrication of panels.

The movement of materials is an important part of the panelized manufacturing industry. It is carefully planned to coordinate with all other activities. The objective of material handling is not to handle the material at all. This seeming contradiction sums up how most experts feel about this task.
There are "a series of material handling functions which must be considered. Shipping of raw materials, unloading, storage, distribution of materials to work stations, handling of materials at the work station, and handling the storage of the finished product until it is loaded on the outgoing truck." This is a complicated task and must be well coordinated if slowdowns in production are to be avoided, especially when there are many subassembly stations.

The equipment involved in these tasks was surveyed by Automation in Housing. It was found that the most commonly used machinery was fork lifts, cranes and hoists, pallets, carts, and dollies. Excluded from the survey was an indication of how much muscle power is used compared to machinery. In the plants visited by the author, a surprising amount of material was still being moved by hand.

Panelized manufacturing plants are designed so that materials can be unloaded directly to storage and then, on demand, moved to points of secondary storage or shipping. Each assembly station has its own secondary storage areas. After the material is fabricated or when it is needed it is moved directly to buffer storage points and then onto the waiting trucks.

Systems involving the coordination of material handling are still primitive, although some efforts are being made to computerize scheduling. Most systems are based on experiences of what is being produced and what is used when in the production cycle. Therefore
new structures often impede the material handling process. The theories in this field have, in general, come from outside the panelized manufacturing industry and are not conceived to handle a wide range of alternative products. The introduction of the computer into the fabrication may prove to be an asset to the material handlers by providing material handling schedules for changing products.

Although plant machinery and material handling functions are basically similar from plant to plant, differences exist. These differences are related to the specific product produced. They are also related to the size of the panel. Panel manufacturers that produce large panels rely on more and heavier equipment than those panel manufacturers that produce small panels. However, it should be noted that incrementally changing panel sizes or minor changes in details does not affect plant machinery substantially. Actual fabrication is generally performed by hand in association with jigs from diagrams. Material handling is affected by any and all changes. Material handling skills increase in inverse proportion to the size of the panel and in direct proportion to the number of variations produced because of the greater number of elements being moved and manufactured.
LIMITATIONS ON DESIGN

There are only two major obvious limitations affecting initial design control coming from the manufacturing and material handling process. First, a designer must use the apparatus and know-how established in a housing manufacturing firm. He must work with that system, that manufacturing plant, and that machinery. The second limitation is that it is too expensive to inventory a large number of specialty items. There must be some standardization of parts used and design must use the basic sizes already available.

Other often-cited limitations are those having to do with the use of trapezoidal and triangular panels for opposing shed shapes, gable extensions, and dormers. This family of panels is incapable of being integrated smoothly into any standard production system. They require special assembling tables and cutting lists, consequently eradicating any savings inherent in the manufacturing process. However, the use of these specialty panels can be justified by design benefits. As a rule-of-thumb these panels cost two times as much as standard rectangular panels. Frequently use of these panels can be avoided by the use of gable end panels. (see Section VI)

Another often cited limitation has to do with changing floor-to-floor heights. This affects all jigs and cutting lists. Also affected are the material utilization efficiencies gained through mass purchasing of precut lumber. If floor-to-ceiling heights
are increased beyond eight feet, special higher-priced plywood must be purchased and shipping problems will be encountered. Stairs and exterior trim detailing must be recalculated with each floor-to-ceiling change. However, establishing a new floor-to-ceiling height or expanding a system to have two can sometimes be justified by design criteria. Frequently this problem can be avoided through the use of two standard panels (see Section VI).

Other than these specified limitations, manufacturing offers few constraints to designers. The constraints stem from material handling, cutting operations and from the jigs that facilitate hand fabrication. It is initial flexibility in design that is affected, not secondary flexibility which was shown in Section III to be limited by panels, panel systems, and joints. Manufacturing processes currently being used indicate that potentially removable panels are not more expensive or more complicated and are, in fact, commonly used. Panelized housing producers are using removable panels for "architectural considerations" (i.e., because the system was designed that way) and, curiously enough, question the value and possibility of future use. In other words, they feel that it is just a spin off from the panel system and is not especially significant.

The industry representatives questioned about the value of seeking to develop processes whereby the customers could economically be in a position to design their own house, with or without an architect,
were in almost complete accord. Their responses were negative. They felt that their "systems" were too this to happen, with the exception of Acorn, which is working in this direction by establishing a rule book. Current manufacturing organizations are not at this point well enough organized to produce too many different products, and certainly not well enough organized to produce continually changing products. In other words, the industry is manufacturing specific designs. As Leonard Stolba, an architect at Spacemakers, puts it: "We are a craft hall selling design. Techbuilt has one, Stanmar has a lot. We have a lot. Acorn has a few. Leisure Homes has a few." The way in which industry sees itself can be restated simply as manufacturing a PRODUCT - house models. There are no exceptions in the ten case studies. Although some firms claim to be custom fabricators, it is simply not true.
FOOTNOTES TO SECTION IV


2. Ibid., page 198


5. Ibid., page 312


7. Ibid., page 28

8. Ibid., pp. 34-35

9. Ibid., pp. 34-35
SECTION V

COMPUTER APPLICATIONS IN PANELIZED MANUFACTURING HOUSING COMPANIES
Computers which have found application in virtually all areas of human activities are beginning to make inroads in panelized manufacturing industry. The mythology around the computer has to a certain extent scared off manufacturers who have shunned all sophisticated production machinery. The introduction of computers has occurred in the management areas, accounting and financial analysis, and is only now being introduced into production.

Because of high cost of owning a computer panelized manufacturers have generally relied on time sharing for managerial uses. However recent developments in hardware, the computer and software, programming techniques have changed the situation radically. The cost of a small computer has spiraled downward to well in the range of a small housing producer. Business oriented languages such as BASIC (Beginners All-purpose Symbolic Instruction Code) and FORTRAN (acronym for formula translation) have been refined and tested and therefore suitable for the cautious nature of the industry.

One of the more sophisticated uses of a computer in fabrication has been developed and applied by the Morgan Machine Corporation which codes data for a large panelized housing manufacturer for the flat fee of $85. "The program converts an architect's drawing into coded information which is sent through the computer. The program provides the read-back of the constants being used, a tally of material, cutting lists, sub assembly work sheets, panel assembly work sheets and a computer drawn erection plan needed to panelize a structure." The program provides "primary analysis" of the wall panels but does not
calculate other interrelated variables necessary to construct the structure. It does not, for example, determine the size and number of rafters for the programmed panels. The capability required for such applications can be simply labeled "Secondary Analysis".

A more complex application initiated by the author illustrates the substantially same "primary analysis" functions being handled by the computer. This application differs from the preceding one in that it involves small four foot panels and lap joints. The program was developed at Acorn Structures in Acton Massachusetts in January and February, 1973, over a period of six weeks in conjunction with the employees of the firm. A new code designation was devised as the first step in order to serve as an interface between the computer and the designer. The code works by systematizing the needed panel information into seven digits. Each numerical place describes a different set of structural and consequently production conditions. The designer must code the panels in his drawings. The panel designations are fed into the computer. The program developed prints out cutting list, packing list, could keep tract of inventory and with a set of overlays creates manufacturing drawings. The program also could schedule material handling operations. The number of possible design options within the system has been expanded to include well over 100,000 panels by storing each unique part instead of the whole panel. The number of employee hours involved in production has been reduced while reducing the possibility of error.
Acorn's Designation Code

In theory the standard panels were, at Acorn: 1) those which were programmed into the computer and 2) those panels which were not programmed into the computer but fell into the descriptive designation code. In practice, the standard panels were those stored in the computer. They were the 600 standard and special panels, not in the old descriptive code but used in the construction of the 30 basic houses and clusters. There was no correlation between the basic houses and the standard panels. In fact, the basic houses were by no means any solid standard because of strong commitment and strong marketing pressure to individual customization of the units. Each panel was stored in the computer as an entity in itself. With the new code each letter represents a standard detail. The combination of letters represents a panel. Thus new panels can be handled in manufacturing without any additional labor. The new panel designation code: 1) included most of the old standard and special panels, 2) allowed for more flexibility in customization of houses by providing more alternatives, and 3) allowed for orderly and controlled growth of details while simplifying the operation of the production department.

The code designation works by systematizing the needed panel information into dependent component parts. The component parts form the seven categories on the top of the following pages and are arranged in order to minimize the needed number of digits for the maximum number of panels. This approach employs a conceptually consistent system which allows for growth and change of details and panels.
COLUMN 1  THE FIRST COLUMN OF THE PANEL DESIGNATION CODE INDICATES THE HEIGHT OF THE PANEL.

D  DOOR PANEL

F  FULL HEIGHT PANEL

H  HALF PANEL

R  HEADER

X,Y,Z  SPECIAL PANELS

---76---
NUMBERS INDICATE THE PANEL POSITION ON GABLE END PANELS

1. THE NEW PANEL DESIGNATION CODE ESTABLISHES 5 AS THE BASIC FULL HEIGHT PANEL. THE ADVANTAGE OF THE CHANGE IN NOMENCLATURE IS THAT IT ELIMINATES SPECIAL E, F, PANELS USED IN THE SALT BOX BY NUMBERING THE PANELS CONSECUTIVELY IN EITHER DIRECTION OF THE NUMBER 5 PANEL. THE TALLER PANELS ARE DESIGNATED BY THE LARGER NUMBERS
<table>
<thead>
<tr>
<th>COLUMN 2</th>
<th>THE SECOND COLUMN IN THE PANEL DESIGNATION CODE INDICATES THE FRAME WIDTH AND THE SIDE THE CHANGE OCCURS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>IS A FULL WIDTH FOUR FT. FRAME</td>
</tr>
<tr>
<td>B</td>
<td>IS A FRAME WHICH IS HELD BACK FOUR IN. ON THE LEFT SIDE</td>
</tr>
<tr>
<td>C</td>
<td>IS A FRAME WHICH IS HELD BACK FOUR IN. ON THE RIGHT SIDE</td>
</tr>
<tr>
<td>D</td>
<td>IS A FRAME WHICH IS HELD IN 0-1-13 ON LEFT SIDE</td>
</tr>
<tr>
<td>E</td>
<td>IS A FRAME WHICH IS HELD IN 0-1-13 ON RIGHT SIDE</td>
</tr>
</tbody>
</table>
IS A HALF WIDTH TWO FT. FRAME

IS A HALF WIDTH FRAME HELD BACK FOUR IN. ON LEFT SIDE

IS A HALF WIDTH FRAME HELD BACK FOUR IN. ON THE RIGHT SIDE

IS A FULL WIDTH FRAME HELD BACK FOUR IN. ON EACH SIDE
<table>
<thead>
<tr>
<th>FRAME - PLY HEIGHT</th>
<th>FRAMEWIDTH &amp; HAND</th>
<th>PLY HEIGHT</th>
<th>FRAME &amp; PLY MODIFIER</th>
<th>FRAME - PLY WIDTH &amp; HAND</th>
<th>ROUGH OPENING</th>
<th>TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>D</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>E</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>G</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>H</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>T</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

COLUMN 3  THE THIRD COLUMN IN THE PANEL DESIGNATION CODE INDICATES THE PLYWOOD LAP CONDITIONS CAUSED BY A ROOF, CONTILEVER OR PANEL ABOVE, OR A SLAB OR WOOD FLOOR BELOW.

A B C D E G N T

TOP CONDITION  ROOF OR CANTILEVER  FLOOR  FLOOR

BOTTOM CONDITION
<table>
<thead>
<tr>
<th>FRAME-PLY</th>
<th>FRAMEWIDTH &amp; HAND</th>
<th>PLY HEIGHT</th>
<th>FRAME&amp;PLY MODIFIER</th>
<th>FRAME-PLY WIDTH-HAND</th>
<th>ROUGH OPENING</th>
<th>WINDOW TYPE</th>
</tr>
</thead>
</table>

**COLUMN 4**

The fourth column in the panel designation code indicates the pitch on the roof.

2

Indicates a 12/12 pitch (only one digit can be accepted by the machine so 2 is used) or 45 degrees

4

Indicates a 4/12 pitch or 18 1/2 degrees

6

Indicates a 6/12 pitch or 26 1/2 degrees

8

Indicates a 8/12 pitch or 33 1/2 degrees

/ / 

Indicates panel with a window (specified in columns 5, 6, 7)

S

Indicates to remove the header.
**COLUMN 5** COLUMN 5 DESIGNATES A PLYWOOD CONDITIONS

**THE CONDITIONS ARE:**

- **M** IF A WINDOW OR DOOR IS CENTRALLY LOCATED BETWEEN THE MODULAR LINES, AND THE PLYWOOD LAID IS STANDARD FULL WIDTH, THE PLYWOOD CONDITION IS DESIGNATED M

- **R & L** IF A WINDOW OR DOOR OPENING IS RIGHT OR LEFT OF CENTER AND THE PLYWOOD IS STANDARD, THE PLYWOOD CONDITION DESIGNATION IS R FOR RIGHT OR L FOR LEFT

- **N** IF A WINDOW OR DOOR OPENING IS CENTRALLY LOCATED BETWEEN THE MODULAR LINES AND THE PLYWOOD IS FOR AN INSIDE CORNER, THE PLYWOOD DESIGNATION IS N

- **S & P** IF A WINDOW OR DOOR OPENING IS RIGHT OR LEFT OF CENTER AND THE PLYWOOD IS STANDARD, THE DESIGNATION IS S FOR RIGHT (STARBORD), P FOR LEFT (PORT)
Columns 6, 7

Columns 6 and 7 are related and specify windows or doors.

Column 6 refers to the rough opening in the plywood.

Column 7 refers to: the window, fixed glass or window and fixed glass. In the case of a narrow casement window where the vents can be reversed, column 7 refers to the side on which the vent is located.
The proceeding application of a computer illustrates how a machine in conjunction with a designation code and a set of standard set of details can expand initial design potentials through "primary analysis". However the computer has "secondary analysis" capabilities of determining the set of interrelations between panels and other building elements and cost. The computer also has the capabilities of making all drawings if it receives, in one form or another, the needed information.

Presently producing a new house model causes significant added expense under standard practices. There are four sets of drawings and list required after a new design is established. These drawings and list could be handled by a computer with "secondary analysis" capabilities. There are what the industry calls the "standard set of ARCHITECTURALs". There are the TAKE OFF List which included all items being shipped. There are a set of PANEL DRAWINGS from which the panels are hand fabricated. And there are CUTTING LISTS. As one panelized executive puts it, "We get so much paper with a new house that it's got to cost you at least $2,000". If that cost is added on to the $5,000 in material and another $1,000 in labor and $3,000 in overhead, it becomes evident why panelized housing manufacturers are reluctant to design a new house. It simply costs too much and puts panelized houses out of the market.

The computer has the capabilities of digesting a new design and calculating simple functions and completing the "secondary analysis". 
Thus eliminating a significant part of the expenses of designing a new house. If such programs were established, the client could become involved as follows.
HYPOTHETICAL COMPUTER ASSISTED DESIGN PROCESS
The proceeding flow chart represents a hypothetical design process sequence. A salesman would act as an architect with full understanding of the design potentials of the given system. He would, with sketches or plastic models, assist the client in designing his own home. The resultant would be coded by the salesmen and mailed to the factory where the structure would be drawn and priced by the computer. The results would be returned to the customer for approval and then be sent back to the factory where the computer could perform "secondary analysis" for manufacturing.

As was pointed out in Section IV, the industry is not concerned with design flexibility and the hypothetical design process suggested is just that. The key issues being determined throughout the industry with regards to the computer are which operations should be computerized for greater cost efficiencies (and sometimes greater design potential), which operations are better left alone. It seems that the critical issues are being determined by the amount of customization and/or the size of the panels and/or the units produced.
FOOTNOTES TO SECTION V

SECTION VI
DESIGN:
A PANELIZED HOUSE
DISCLAIMER OF QUALITY

Due to the condition of the original material, there are unavoidable flaws in this reproduction. We have made every effort possible to provide you with the best copy available. If you are dissatisfied with this product and find it unusable, please contact Document Services as soon as possible.

Thank you.

Missing page 94
## APPENDIX I

The following is a list of wooden patented portable houses and structures from 1839 until 1920.

<table>
<thead>
<tr>
<th>Year</th>
<th>No.</th>
<th>Year</th>
<th>No.</th>
<th>Year</th>
<th>No.</th>
<th>Year</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1839</td>
<td>1,439</td>
<td>1882</td>
<td>256,661</td>
<td>1856</td>
<td>14,355</td>
<td>1882</td>
<td>256,860</td>
</tr>
<tr>
<td>1846</td>
<td>1,742</td>
<td>1882</td>
<td>256,661</td>
<td>1856</td>
<td>14,952</td>
<td>1882</td>
<td>269,680</td>
</tr>
<tr>
<td>1857</td>
<td>17,256</td>
<td>1883</td>
<td>271,308</td>
<td>1857</td>
<td>17,270</td>
<td>1883</td>
<td>271,776</td>
</tr>
<tr>
<td>1861</td>
<td>32,757</td>
<td>1883</td>
<td>274,265</td>
<td>1861</td>
<td>33,758</td>
<td>1883</td>
<td>290,991</td>
</tr>
<tr>
<td>1862</td>
<td>36,701</td>
<td>1884</td>
<td>291,625</td>
<td>1867</td>
<td>62,831</td>
<td>1884</td>
<td>293,574</td>
</tr>
<tr>
<td>1867</td>
<td>68,937</td>
<td>1884</td>
<td>297,863</td>
<td>1867</td>
<td>69,580</td>
<td>1884</td>
<td>298,790</td>
</tr>
<tr>
<td>1869</td>
<td>86,572</td>
<td>1884</td>
<td>302,000</td>
<td>1869</td>
<td>88,657</td>
<td>1884</td>
<td>304,531</td>
</tr>
<tr>
<td>1871</td>
<td>117,721</td>
<td>1884</td>
<td>305,584</td>
<td>1872</td>
<td>129,805</td>
<td>1884</td>
<td>306,942</td>
</tr>
<tr>
<td>1872</td>
<td>132,533</td>
<td>1885</td>
<td>308,833</td>
<td>1874</td>
<td>152,085</td>
<td>1885</td>
<td>316,859</td>
</tr>
<tr>
<td>1875</td>
<td>163,559</td>
<td>1885</td>
<td>319,436</td>
<td>1875</td>
<td>163,888</td>
<td>1885</td>
<td>323,938</td>
</tr>
<tr>
<td>1876</td>
<td>180,975</td>
<td>1885</td>
<td>324,456</td>
<td>1876</td>
<td>198,926</td>
<td>1886</td>
<td>333,903</td>
</tr>
<tr>
<td>1878</td>
<td>202,911</td>
<td>1886</td>
<td>335,835</td>
<td>1878</td>
<td>204,545</td>
<td>1886</td>
<td>341,735</td>
</tr>
<tr>
<td>1878</td>
<td>231,593</td>
<td>1886</td>
<td>345,944</td>
<td>1880</td>
<td>231,593</td>
<td>1886</td>
<td>352,011</td>
</tr>
<tr>
<td>1881</td>
<td>250,867</td>
<td>1887</td>
<td>355,441</td>
<td>1881</td>
<td>239,669</td>
<td>1887</td>
<td>359,749</td>
</tr>
<tr>
<td>Year</td>
<td>No.</td>
<td>Year</td>
<td>No.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>---------</td>
<td>------</td>
<td>---------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1888</td>
<td>388,424</td>
<td>1890</td>
<td>419,859</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1888</td>
<td>309,589</td>
<td>1890</td>
<td>425,250</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1888</td>
<td>391,442</td>
<td>1890</td>
<td>435,112</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1889</td>
<td>414,976</td>
<td>1890</td>
<td>436,668</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1889</td>
<td>419,859</td>
<td>1891</td>
<td>444,604</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1890</td>
<td>425,250</td>
<td>1891</td>
<td>450,025</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1890</td>
<td>436,668</td>
<td>1891</td>
<td>451,733</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1890</td>
<td>444,604</td>
<td>1892</td>
<td>468,785</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1891</td>
<td>450,025</td>
<td>1892</td>
<td>469,638</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1891</td>
<td>451,733</td>
<td>1892</td>
<td>477,757</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1891</td>
<td>456,307</td>
<td>1892</td>
<td>484,413</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1892</td>
<td>468,785</td>
<td>1892</td>
<td>490,205</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1892</td>
<td>469,638</td>
<td>1892</td>
<td>500,458</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1892</td>
<td>477,757</td>
<td>1892</td>
<td>507,680</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1893</td>
<td>500,458</td>
<td>1893</td>
<td>536,435</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1893</td>
<td>507,680</td>
<td>1893</td>
<td>539,226</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1893</td>
<td>536,435</td>
<td>1893</td>
<td>540,084</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1895</td>
<td>539,226</td>
<td>1895</td>
<td>552,533</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1895</td>
<td>540,084</td>
<td>1896</td>
<td>552,533</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1895</td>
<td>552,533</td>
<td>1898</td>
<td>602,194</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1898</td>
<td>602,194</td>
<td>1898</td>
<td>604,277</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1898</td>
<td>604,277</td>
<td>1898</td>
<td>611,309</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1898</td>
<td>611,309</td>
<td>1899</td>
<td>618,851</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1899</td>
<td>618,851</td>
<td>1899</td>
<td>630,908</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1899</td>
<td>630,908</td>
<td>1899</td>
<td>631,541</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1899</td>
<td>631,541</td>
<td>1899</td>
<td>638,494</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1899</td>
<td>638,494</td>
<td>1899</td>
<td>649,352</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1899</td>
<td>649,352</td>
<td>1899</td>
<td>651,251</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1899</td>
<td>651,251</td>
<td>1900</td>
<td>659,117</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1901</td>
<td>673,327</td>
<td>1903</td>
<td>720,344</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1903</td>
<td>724,408</td>
<td>1904</td>
<td>760,135</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1904</td>
<td>765,017</td>
<td>1904</td>
<td>765,930</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1904</td>
<td>777,531</td>
<td>1905</td>
<td>788,445</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1905</td>
<td>794,595</td>
<td>1906</td>
<td>809,163</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1906</td>
<td>819,129</td>
<td>1906</td>
<td>831,810</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1906</td>
<td>837,937</td>
<td>1907</td>
<td>844,861</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1907</td>
<td>849,709</td>
<td>1907</td>
<td>856,198</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1907</td>
<td>859,727</td>
<td>1907</td>
<td>865,590</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1908</td>
<td>892,571</td>
<td>1909</td>
<td>935,744</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1909</td>
<td>960,207</td>
<td>1910</td>
<td>974,230</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1910</td>
<td>980,837</td>
<td>1911</td>
<td>981,992</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1911</td>
<td>1,007,871</td>
<td>1912</td>
<td>1,045,219</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1912</td>
<td>1,045,223</td>
<td>1913</td>
<td>1,052,960</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1913</td>
<td>1,070,474</td>
<td>1913</td>
<td>1,075,368</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1914</td>
<td>1,083,409</td>
<td>1914</td>
<td>1,086,650</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Year 1915  No. 1,124,063
Year 1915  No. 1,124,216
Year 1915  No. 1,124,563
Year 1915  No. 1,152,655
Year 1915  No. 1,160,882
Year 1916  No. 1,178,338
Year 1916  No. 1,179,785
Year 1916  No. 1,193,833
Year 1917  No. 1,221,672
Year 1917  No. 1,228,317
Year 1917  No. 1,232,168
Year 1917  No. 1,236,635
Year 1917  No. 1,238,228
Year 1917  No. 1,249,011
Year 1917  No. 1,250,415
Year 1918  No. 1,256,393
Year 1918  No. 1,262,156
Year 1918  No. 1,262,564
Year 1918  No. 1,263,068
APPENDIX II

CLEMEN'S SECTIONAL HOME
ILLUSTRATED CATALOGUE OF
See Price List at the end of the Book.

No. 8. 14 x 35 1/2 feet.

No. 8, Ground Plan, 14 x 35 1/2.

D I R Y  G O O D S  A N D  G R O C E R I E S.

ILLUSTRATED CATALOGUE, DESCRIPTION
AND
PRICE LIST

Clemens' Ready Made Sectional Houses

RICHARDS, NORRIS & CLEMENS,
MANUFACTURERS,

Cor. West 22nd and Laflin Streets.

CHICAGO:
MILLARD & DIXON, STATIONERS AND PRINTERS.
1872.
A House Cut in Two Crosswise.

Figure 1.
Fig. 1. Is a transverse sectional elevation of a small, one story house, showing the mode of construction and of bolting together.

A House Cut in Two Lengthwise.

Figure 2.
Fig. 2. Is a longitudinal elevation of the same house as Fig. 1.

A Peaked Roof House Cut in Two Crosswise.

Figure 3.
Fig. 3. Is a transverse sectional elevation of a small, one and a half story house, showing additionally the construction of a steep roof in sections, and other parts on the new plan.
Part of a Wall Section.

Fig. 4. Represents, in the upper diagram, an end view, and in the lower a plan of one end of a wall section of a house, showing an anchor cleat E, near the end, nailed to the matched boards composing the section, and by which they are held together in transportation and in putting up the house. This section shown is of common matched stuff.

Corner of Walls.

Fig. 5. Is a plan of one corner of a building with the roof removed, showing the relation of parts and the angle irons staying the corner. The wall boards, A, clamped between the inside and outside plates D D, are represented, of common tongued and grooved stuff on one side from the corner, and on the other side, the boards are grooved on both edges of each and have between them the web of our new matched joint batten, the ridge of which is cut away to afford a seat for the outside plate.

Clemens' New Wall Battens and Compound Siding, Partitioning or Ceiling.

Fig. 6. Represents, first above, an end view of part of a wall section, with our new single battens S' S' interlocking with double matched joints between the matched boards, which are shown grooved on both edges. Next below is an end view, representing, in similar connection our double solid batten T' T', making treble matched joints with groove edged boards. And lowest in the figure is a plan of one end of a wall section, A, showing some battens with their external portion cut away near the ends of the sections of boards for attaching the anchor cleat E, and, upon this, the inner grooved sill or plate D. This improvement is unequalled for strength, tight joints and beauty of appearance.

Clemens' Improved Roof Boards and Roof Battens.

Fig. 7. Represents above a plan of one end of a section of matched roof boards with double grooves running near to and parallel with their edges, on which are roof battens L L, while below in the figure is an end view of the same, also showing the edges of the battens.
ILLUSTRATED CATALOGUE OF

extending partly over the grooves of the roof boards, remote from the matched joints, to prevent rain from being driven under the batten. And further, the batten is grooved through its length on the underside, which serves the double purpose of arresting any water which may work from outside along the under surface of the batten, and causing it to drop into the inside groove of the roof boards, and also serves, in case the battens are warped by the sun, to prevent the loosening of the nails by which the battens are fastened down near their edges. This device obviously secures close fitting joints, where the edges of the battens rest and are nailed between the double grooves of the roof boards, for the reason that the batten has no bearing upon the roof boards save near its edges, and therefore there is no fulcrum midway by which the nails can be drawn in any possible shrinkage or warping of the batten. These improvements make a new thing of battened roofs, rendering them more durable, it is claimed, than when made of shingles, and available for general use at much less inclination of the roof.

Floor Section and Frame.

Figure 8. Is a plan, representing a floor section turned upside down, showing the two joists $G G$, with the bridges $B B$, spiked between the joists, and together forming the frame of a floor section. Upon the bridges the matched floor boards $F F$ are nailed, lying the same way with the joists. When these floor sections are put together, the edges of adjacent floor boards on each unite with a matched joint, and the adjacent sections are fastened to each other by carriage bolts which pass through the ends and middle of adjacent joints, as shown in figures 4, 2 and 3. This mode makes the floor very strong and rigid in every direction, and it forms an unyielding base for the attachment of the side walls of the building.

End and Side Views of the Floors.

Figure 9. Represents a side elevation of a floor composed of five sections bolted together, showing an inside sill, $D$, with its groove to receive the anchor cleat of the wall sections, the shouldered ends of the floor joints resting on the sill. Below this in the figure is an end elevation of the same floor, shown with an inside sill lying against the outside joist.

The Walls Ready to go up on the Floor.

Figure 10.
DIRECTIONS FOR ERECTING A
CLEMENS SECTIONAL HOUSE.

The floor and wall sections of each building sent out are numbered 1, 2, 3, 4, in the order they go together, commencing at the front end, right hand side, as shown in Fig. 10, where F represents a floor of five sections. First, upon any temporary foundation sufficiently level for the joints to rest upon, bolt the floor sections together. Then commencing with the right hand side, and so around to the front, place the inside sills with their grooved sides outward, upon any suitable level foundation of blocks, stone, brick or timber, and cause the ends of the floor joists to rest upon the side sills, with care to have the bolt holes in these sills exactly correspond with those holes through the end bridges of the floor sections, and also to have the holes in the end sills true with holes in the sides of the joists against which they lie. The sills are each numbered and stenciled marked where they are to go, each piece being numbered 1, 2, &c., at the end which goes towards the front right hand corner, and they may be nailed to keep their places around the floor. Next, upon the floor as a platform, put together the wall sections which make the right hand side of the house, as one faces the floor from the front end, arranging the sections in the order they are numbered at the bottom of each, as shown in the diagram Figure 10. In putting side together, the outside sills and plates marked No. 1 at the front end of each are first placed parallel and sufficiently apart on the floor, the sill to the left and the plate to the right, and the outside of both downwards towards the floor. Upon this place the wall sections in order as numbered, with their marked inside surfaces upward, and their lower ends, bearing the number, placed on the sill, with care in entering the matched joints with which the sections unite, that the bolt holes through the anchor cleats at the end may correspond with the holes in the sill and plate. This may be regulated by removing the nuts from some of the longest carriage bolts, and thrusting the bolts down through the holes in the wall sections into those of the sill and plate.

When the sections of a side are so put together, with the sections containing windows or doors in their places ready for use, the inside plate, as it is numbered and marked, is to be put on over the anchor cleat of the upper ends of the sections, its bolt holes being made to correspond with those below, and bolts are passed through both plates and the intervening wall sections, and the nuts of the bolts tightened upon temporary wooden washers. Next, to temporarily fasten the outside sill to its place for raising, drive two or three light nails through the lower end of each section into the sill, and then take out the bolts which were put into the siding and sill holes to regulate the putting together of the sections. The bolt holes should be found to correspond for every bolt, because the parts were all in place at the factory when the holes were bored through them.

Short cleats temporarily nailed across the top of the inside and outside plates, to keep them in their places while raising the side, answer instead of the bolts tightening on the wooden washers.

The side is now ready to be raised, for which purpose it is slid off from the floor horizontally upon the ground, with the outside sill resting upon any supports which are level with the bottom of the inside sill. The side is then raised upright, and thus supported by bracing props. The anchor cleats at the bottom then are made to enter the groove in the inside sill, and the bolt holes being brought to range, the longer carriage bolts are inserted from the inside, passing through the end bridges of floor sections, the inside sills, the lower edge of the side wall, and out through the outward sill, and when screwed up, clamping and staying all these parts firmly together. The anchor cleats being beveled on one edge, and fitting into corresponding beveled grooves in the sills and plates, as is shown in Figures 1, 2 and 3, are drawn to their places with a wedging fit.

In like manner, the other sides of the house are put together, raised and bolted to the floor, and angle irons or straps may be put on the
At this stage of its erection the building is represented by the end elevation, Figure 11, and the plan, Figure 12.

The house is now ready for the roof, which is built in sections much like the floor, and it also comes together with matched joints at the union of the sections. These are numbered from the front end at the right in the order they are to be put on. In Figure 13, the upper diagram is a side elevation of a roof section; the middle is a roof section turned upside down, showing rafter and bridges, while the lower one is an end roof section, showing the gable board \( F \), which comes on the outside of the outward end plate \( D \), and is supported by short bridges \( J \) and the cant cornice boards \( M.M \), to which the gable roof boards are also fastened.

To always have access to the screw nuts of the bolts under the eaves, their heads may be set outward. The iron corner strips should be put on, attached by the long bolts next the corners of the \( A.A \), and angle iron inside the corners of the plates.

The roof being on and bolted to the plates, then with the extra roof battens sent with each house, cover the matched joints at the junction of the roof sections, nailing or screwing them on through their edges. Before putting on the battens, however, it is best to screw the ridgeboard to its seat on the apex of the roof boards. In some cases the roof is made without the ridgeboard.

The cant boards, or cornices, are to be nailed to their places under the eaves. Assemble moldings are to be fastened under the edges of
each two adjacent rafters; partitions set up on base strips fastened on the floor; cross partitions are fastened to the sides of the rafters overhead and other partitions to cleats for the purpose on the under side of the roof; base boards, or base mouldings, to be fastened around the sides of the wall and partitions, and quarter round mouldings for all the inside corners, are to be put in their places. All these light, long pieces, sent tied up in bundles, go along with the loose sills and plates, which, for smaller houses, are in single full length pieces. All these are shipped ready fitted and marked as they are to go in the house. The marks on each piece, which is to lie horizontally, are on the end towards the front right hand corner of the building, and so around, and the same with partition sections. When the house is to stand permanently, the cornices, battens, mouldings, and base boards may be nailed to their places; otherwise, most of these pieces should be put on with wood screws.

The sections of each house are shipped dry, and the bolt holes will all come in place for the bolts. It is important that they be kept dry until the house is set up, by carefully piling the floor and side sections and covering them with the roof sections, if out door.

If the sections become swollen by exposure to saturating rains, it is necessary to dry them and by strong wedging clamps and hammering, set the expanded sections back to their original width.

The foregoing describes the details of erecting a one story, low roofed house. For the erection of houses of more than one story, and of steep-pitched roofs, we send additional directions on a printed circular.

When our improved ventilating chimney is fastened on the hole made for it on the roof, the house is supposed to be ready for use.

---

The upper part of Figure 14, on the right, represents an elevation of the chimney detached, and on the left a longitudinal sectional elevation, while below is a plan of the same showing a part of the conical cap Y' removed. To the left is a plan with both the cap Y' and the semi-conical hood Y' removed, and between the two last is a section taken horizontally through the lower part of the chimney. In the figure, K is the outside tube or case, which is closed at the top and bottom. H' is the smoke flue open at both ends, for connection with a stove pipe below. At the upper end it is surrounded by the hood Y', which connects it with the top end of K, to which, at the lower end, it is also connected by passing through the bottom of K. V is a conical base fastened to K, by which the chimney is attached on the roof. S S are openings in the annular sliding register cover Y', the adjustable movement of which, horizontally, either closes or opens corresponding openings in the tube K, for the purpose of ventilation. The noxious air from below passing through the open register into the space between K and H', escapes through holes in K, under the hood Y'. Z is a projection on Y', by which the latter is adjusted. These chimneys are of galvanized iron in the external parts, and can be made of any size, and proportioned in length to
any kind of house. They are safely transported, easily attached, strong and tight on the roof—look well and draw powerfully.

For houses of more than one story we can furnish terra cotta tubular chimneys, which fit together in short sections.

CONCLUDING REMARKS.

In calling public attention to the foregoing illustrations and description of our Ready Made Sectional Houses, we invite the most critical investigation to the consideration of their merits.

We have undertaken to meet a widely noticeable want of good, strong, tight, durable and comfortable ready made houses, of the smaller, cheap class, so contrived as to be made in part by machinery and economized labor in a factory, and which can be compactly transported wherever lumber for building now goes; be easily and securely put up without the aid of labor, and when put up, will afford all the essentials of a good, permanent dwelling.

The concurrent opinion of candid examiners, and the interest which the invention has excited wherever known, testify that our claim of unequalled success is not ill grounded.

To convey the clearest information to inquirers who live at remote points, as well as to give the distant purchaser suitable directions for putting his house together, this descriptive pamphlet is hastily published. In subsequent editions, from time to time, we purpose to increase and vary the number and styles of the engraved plans, giving designs and estimates for one and a half story cottages, two story houses, country school houses, small churches, and other buildings for which our mode of construction is adaptable.

PRICE LIST

CLEMENS' READY-MADE SECTIONAL HOUSES.

ACCOMPLAINTING ILLUSTRATED CATALOGUE OF 1872.

The prices here given are subject to change with prices of materials and labor, as we may announce, and are for houses complete from the sills up, delivered on the cars in Chicago. The term PLAIN in the list implies styles of external finish, like the perspective cuts Nos. 1, 4, and 6, and ORNAMENTAL designates various kinds of architectural finish, like the perspectives Nos. 8, 5, and 7.

| House No. 1, Walls 9 ft., plain | $200 |
| House No. 2, Walls 9 ft., plain | $275 |
| House No. 3, Walls 9 ft., plain | $330 |
| Verandah, 5 x 15 ft, extra | $25 |
| House No. 4, Walls 9 ft., plain | $310 |
| House No. 5, Walls 9 ft., plain | $330 |
| House No. 6, Walls 10 ft., plain | $395 |
| House No. 7, Walls 10 ft., plain | $425 |
| Chicago Basement, Balcony and Stairs, extra | $375 |
| Store No. 9, Walls 10 ft., with Store Front | $435 |
| House No. 10, Walls 9 ft., plain | $290 |
| House No. 11, Walls 9 ft., plain | $245 |
| Verandah, 5 x 15 ft, extra | $25 |
| Railroad Station No. 12, Walls 12 ft., Platform, special terms | $675 |
APPENDIX III

INTERVIEWS
Mr. Fleetwood: How do you use an architect here at Acorn?

Br. Bemis: We use architects in three different ways. We use architects in conjunction with our design and engineering departments, three who are graduate architects, none of whom are registered. They are involved in the day to day work of the design department. They work on some of our new designs, some of our special adaptations of our standard designs. We have in the past and are currently working with a registered architect on a retainer basis. There are two of them at the moment, who are partners, who consult with us on our day to day problems. They help us working out new designs and plan variations of our standard concepts. We also work with outside architects who come to us with a specific project of more than one house. They must be willing to work within the constraints of our panels system when developing special designs. The best current example of that is multi-family townhouse type dormitories for Vassar College which we did last year. We have very definite long-range hopes that we would be able to get to a building system, which is at the moment a four-foot wall panels and pre-cut floor and roof system, well enough delineated,
organized for an architect to work with and with the aid of an instruction book. The book would describe the limitations of the system so that an architect will be able to develop a design which would involve little customization of our panels, hopefully none, thus minimizing the contact between the architect and ourselves. At the moment we have found that as simple as our system seems to be, we have allowed enough variations on how we put panels together so that it's not easy to turn an architect loose through the system. We only work with outside architects who have projects big enough to warrent working closely with a consultant in design. In other words, it needs to be three or more living units in order for it to be worth our time and the architect's time.

Mr. Fleetwood: What are the manufacturing problems in using triangular or trapezoidal panels in your houses?

Mr. Bemis: We basically have developed our system around rectilinear geometry, three-dimensional geometry. A couple of reasons for this is that basically we feel that the customer has grown up in these kinds of spaces and feels most at home with them. More important than that, we are working with a basic material which doesn't really lend itself too easily to non-rectilinear spaces and therefore odd shapes of panels. Our panels are sheathed in plywood which is becoming an increasingly

-112-
significant dollar portion of our package and it comes in rectangular sizes and it's very difficult to cut without very careful layout.

Mr. Fleetwood: Here at Acorn you use a four foot panel. Four foot wide and eight or nine feet tall. Could you give me the reason for this, and do you feel that this is the optimum size and do you feel that a larger panel could be justified?

Mr. Bemis: Our panels, as I indicated before, are basically wall panels and the primary reason for selecting a four foot dimension is that plywood, our major material, comes in that size. Also there is the traditional sixteen inch studed spacing. It obviously doesn't relate well to five foot bathtubs and three foot front doors.

Mr. Fleetwood: What is the price range of your houses? The package price and the finished price?

Mr. Bemis: Our houses now cost about $17 - $22 per square foot range depending on the complexity and size of the house. As a rough rule-of-thumb our package is something like half that finished cost, that cost being the house itself not including the land and the site development, landscaping and so on.

Mr. Fleetwood: How many houses do you manufacture a year?

Mr. Bemis: We did 400 houses last year. 400 units some of which were multiples.
Mr. Fleetwood: Does your price fluctuate with the season?

Mr. Bemis: Yes, we have developed a selling program which gives inducement to customers to order houses in the fall, winter or early spring delivery and construction. This is important for an organization such as ours to level off the building fluctuations, to keep busy during the winter time.

Mr. Fleetwood: What is the average size of an erection crew and how long does it take to finish the completed shell?

Mr. Bemis: A typical builder's crew is four to six men and it takes them from delivery of the package to the site, where the foundation is completed and ready, ten days to two weeks to have it closed, weather-tight.

Mr. Fleetwood: How do you purchase your wood and is it pre-cut?

Mr. Bemis: We purchase our lumber and plywood almost entirely from the west coast. It is only pre-cut so far as the pieces that we use in large numbers and standard sizes high.

Mr. Fleetwood: How much premium do you pay for pre-cut and is it accurate dimensionally?

Mr. Bemis: It is accurate dimensionally. The part that we buy is the standard 2 x 4 stud which is used in all of our one-story height wall panels (exterior wall panels) and in our one-story height interior petitions. It's just under eight feet and I think we pay a significant premium for that.

-114-
Mr. Fleetwood: What components such as kitchen cabinets, metal chimneys, windows, bathroom fixtures, kitchen appliances do you use?

Mr. Bemis: We sell a standard brand kitchen cabinet in our package in two styles. We sell no plumbing fixtures. We sell, if the customer wants it, ranges and refrigerators and we have dishwashers, chimneys and metal fireplaces, both the built-in type as well as the free standing chimney units.

Mr. Fleetwood: Are you experiencing any difficulty in obtaining mill work such as pre-hung doors, etc?

Mr. Bemis: Yes we are. The door business is becoming extremely critical in supply. We expected a particular brand of unfinished wood veneer door for one of our two alternative doors for interior use this year and we've been told that the only available interior door we could get was going to be factory finished masonite doors. Not what we would like.

Mr. Fleetwood: How much inventory do you keep, say, on windows in terms of number of houses?

Mr. Bemis: I can't really answer that but probably 25 to 40 houses. Somewhere in that range.

Mr. Fleetwood: What components would you like to see on the market in terms of different size doors or windows?

Mr. Bemis: If I began to think about it for any length of time, I would come up with a well thought out list, but
the one item that concerns me most, and is not
generally available, is windows and sliding glass
doors which do not come in sizes that have really
been thought out. For example, most metal windows
come in sizes which have given no consideration at
all to their relationship to the building structure.
A four foot window requires a full four foot opening
and this makes orderly planning of the structure of
the building very difficult. You end up with an
unsystematic dimension for the structure of the house
which doesn't really match the finished material very
well. Sliding glass doors have the same problem and
in height sliding glass doors do not relate to other
door heights. A six foot eight sliding glass door
doesn't fit the same opening height that a six foot
eight interior door takes.

Mr. Fleetwood: What equipment do you use in manufacturing such as
fork lifts, power saws, cranes, dollies?

Mr. Bemis: Our material handling equipment is primarily fork
lifts. In our new plant we plan to continue this.
We do use overhead cranes in a light capacity for
moving material, for accumulation into large bundles
which are then handled by a fork lift. Our machines
and equipment are relatively simple.

Mr. Fleetwood: What volume of business do you consider necessary to
justify this capital outlet in equipment, in plant,
Mr. Bemis: One thing we have been successful in doing to date is keeping our plant equipment extremely simple and on a low level compared to other manufacturing businesses to be financially successful. Otherwise we would have been moving into a much more expensive plant. Where this level establishes itself really depends upon what each home manufacturer establishes as the scope of his operation and how he plans to work. We will need to produce around 500 units a year.

Mr. Fleetwood: The next two questions are speculative. How much growth do you see in the panelized housing industry?

Mr. Bemis: I think it will be substantial. I think that as the industry shakes out the people who haven't really been successful in the modular or sectional housing units, the public will recognize the value of an organization with a product that doesn't go as far as that, and leaves more to be done on site. I think this industry has been working in the background, to sort of speak, because the modular businesses received so much publicity in the last two or three years. I think there will be very substantial growth in this particular kind of fabricated product.

Mr. Fleetwood: It's now 13.5% of total housing that are panelized. Do you expect that by 1980 it might rise to 20 or 25%?
Mr. Fleetwood: There's certainly much speculation about the real cost savings on panelized housing. Do you feel that there is any substantial cost savings?

Mr. Bemis: It all depends on what you're comparing it to. The real cost savings on housing can only come from two sources. First is obviously construction systems and materials which generate real economies in savings. These are very difficult to achieve in the present market because of codes, consumer preferences. The material costs are escalating just about the same as labor cost. So the only real way at the moment that you can actually produce an economy is by making the job run much more efficiently and quickly. Having competent builders using an efficient, thought-out system. I think panelization, even to the relative limited degree that we carry it, can provide a framework within which a builder can work quickly. The Acorn system facilitates the organization of the work and makes it more systematic, more orderly and more predictable with fewer variables from job to job, repetative details and sequencing, what he does and when he does it. For the builders who work regularly with our houses, each house gets a little easier for him instead of being a whole new project. Consequently the costs come down.
Mr. Fleetwood: Although the builders you deal with are all sold on panelized housing, do you find it difficult to persuade new builders into using panelized systems?

Mr. Bemis: For a long time in the past and for a long time to come it's a seller's market and the most popular builders have, without much sweat, all the work that they want. They don't really care that much whether they build a panelized house or a stick-built house because they can usually find a customer for either one. The builders that are most interested in our houses are those who are anxious to build more houses with less struggle, to be more productive, who do have a good design sense and can appreciate a well designed contemporary house. We don't have too much trouble in persuading those people. They're all confronted every year with more and more orders and finding well qualified carpenters to work for a builder is difficult. There's no question, our building system reduces the skills required so it increases the productivity of the worker whether he's skilled or not.
GROSSMAN'S

Donald Man, April 10, 1973

Mr. Fleetwood: What is the price range of Grossman's Homes?

Mr. Man: Any range. The Grossman's homes sell for $15,000 to $18,000 on up to $30,000 or $40,000.

Mr. Fleetwood: How do you use an architect here at Grossman's?

Mr. Man: We do our own home designing. These fellows do it here or they have outside designers do it but we don't have architects as such. The only time we work really with architects is if we're doing an apartment project, condominium, or something that an architect is working on and we'll come up and work with him and convert it to panelization.

Mr. Fleetwood: Do you foresee any possibility of using architects to design single homes?

Mr. Man: Yes, I would say we would.

Mr. Fleetwood: On a one house basis?

Mr. Man: Well, for our particular needs, not too much on a one to one basis because we work through contractors. Our volume, I don't think, is big enough right this minute plus the fact that we go into so many different areas. We ship all over New England and into Eastern New York State.

Mr. Fleetwood: What are your manufacturing problems in designing triangular and trapezoidal panels? I'm not talking
Mr. Man: Not too much, because whatever problems we've come up with have been rather minor. They've been in a particular project. We had some up north and some down south that required odd panels, fly-off roofs, things like that. We haven't run into any problems in designing. Manufacturing takes a little bit longer.

Mr. Fleetwood: Would you say the cost is significantly more?

Mr. Man: I'd say if you have "x" number of dollars per lineal foot for the straight wall, this would be almost twice.

Mr. Fleetwood: How many houses, living units, do you manufacture a year?

Mr. Man: Last year we did almost 500.

Mr. Fleetwood: By what arrangement are your houses built? Do you use builder-dealers or can anyone build your house?

Mr. Man: We have some builder-dealers, we have salesmen who will sell to a contractor who's building for a customer, or on a large apartment project we work either directly with the building owner or the subcontractor. We work with a variety of people.

Mr. Fleetwood: Do you offer your clients a fixed price or does it vary seasonally?

Mr. Man: No, it only varies according to the cost of material and labor.
Mr. Fleetwood: In your small homes, what is the average size of an erection crew and how long does it take them to put up the shell of the house?

Mr. Man: Once the deck is on?

Mr. Fleetwood: From the foundation.

Mr. Man: From the foundation, a good four man crew could put up a house in a day and have it all enclosed.

Mr. Fleetwood: Do you manufacture wall panels, floor panels?

Mr. Man: We have.

Mr. Fleetwood: In other words, you just supply pre-cut stud and plywood wall panels?

Mr. Man: Right.

Mr. Fleetwood: Is the plywood all cut or is any if it field-cut?

Mr. Man: The only time we let them field-cut is when we need it for strength in handling. When they have to cut off a stairwell or something like that, otherwise, we completely cut everything.

Mr. Fleetwood: Your panels are 2 x 4 inch studs with plywood sheathing?

Mr. Man: Yes. We have made honey comed panels and we have made roof panels years ago but not any more.

Mr. Fleetwood: How and where do you purchase your wood?

Mr. Man: We have a lumber purchasing department and I just give them my requirements and they go out and buy it at the best price.
Mr. Fleetwood: Does all your wood come from Grossman's?

Mr. Man: None of it. We buy it from outside vendors.

Mr. Fleetwood: Do you in turn buy it from Grossman's?

Mr. Man: No, they buy it for me. My buyers buy it from lumber mills out in the West.

Mr. Fleetwood: So your lumber purchasing is separate from Grossman's?

Mr. Man: Well, it's part of Grossman's but I don't buy it from them. It's a play on words, really.

Mr. Fleetwood: Do you use pre-cut?

Mr. Man: Pre-cut studs I buy.

Mr. Fleetwood: Do you find these dimensionally accurate?

Mr. Man: Yes. We've been able to weed out the ones that are not over the years so that we know some people that are going to be a little sloppy and we won't buy from them.

Mr. Fleetwood: Do you pay a premium for this?

Mr. Man: Yes, but it's worth it.

Mr. Fleetwood: What components do you use, such as kitchen cabinets, appliances, bathroom fixtures, windows, doors, pre-hung doors?

Mr. Man: We have our own door and window shop here in the warehouse.

Mr. Fleetwood: You hang all your doors?

Mr. Man: No, we don't any more. We just changed our system so we don't install the windows or doors in the
Mr. Fleetwood: Really!

Mr. Man: We use to.

Mr. Fleetwood: Why did you change? This is very unusual.

Mr. Man: We changed because we wanted to build a larger panel. We want to have a large panel you can put up with a small crew. A panel where you don't need a crane because a lot of these house are put out in the woods, way out where you can't get any equipment in. To make a larger panel you have to leave out the windows and doors then you have less damage.

Mr. Fleetwood: How long are your panels?

Mr. Man: We can make up to 24 feet.

Mr. Fleetwood: You feel that without windows this can be handled by three men?

Mr. Man: Three or four men.

Mr. Fleetwood: And with windows what do you feel the optimum might be?

Mr. Man: I've made them 24 feet with windows but they have to have a crane to handle it.

Mr. Fleetwood: And what is the optimum size without a crane, with windows?

Mr. Man: I'd say twelve feet at the very outside.

Mr. Fleetwood: Why are you going with longer panels when it seems the direction of the industry is with shorter panels?
Mr. Man: I don't say the direction of the industry is to shorter panels. It all depends on what your building. If your building post and beam then you would have shorter panels.

Mr. Fleetwood: Boise Cascade is staying under twelve feet. Reliable also likes to keep it down although they're using 20 and 30 foot panels.

Mr. Man: I'd like to but you can't always do it on the framework and the layout of your house, you can't always keep it down. If you have a series of windows or doors you're bound to have a break somewhere. We've been working on what they call a modifice "Rico System". Years age they had a four foot module with a window in it and everything on it. This was good but it's outlived its usefulness. You have too many joints, you have too much lumber, so we've cut down on the lumber by making longer panels. Also, unless you have a perfectly flat deck, with a short panel you'll get discrepancies. A long panel will bridge many discrepancies in the deck.

Mr. Fleetwood: Do you supply bathroom fixtures?

Mr. Man: We supply the whole thing but I don't have anything to do with that. I make my portion and somebody else supplies theirs and it's all put on a truck out back here.
Mr. Fleetwood: So the package is a turnkey operation.

Mr. Man: Yes.

Mr. Fleetwood: How much inventory do you keep in stock say on windows?

Mr. Man: I don't keep any inventory because my shop is down here and I order them for each individual house.

Mr. Fleetwood: In other words, you use all the windows Grossman's carries, as a building supplier?

Mr. Man: Down in this building, there's thousands of windows.

Mr. Fleetwood: Are your panels interchangeable from house to house?

Mr. Man: Not the system we're starting now.

Mr. Fleetwood: Do you have a given set down lap?

Mr. Man: Yes 1/2 an inch. We use to have 9 inches. Now we have 1/2 inch lap on the bottom and 1/2 inch lap on the top?

Mr. Fleetwood: And you use a cover board on the downlap?

Mr. Man: Yes, we just provide skirt or coverboard.

Mr. Fleetwood: Do you have any side laps?

Mr. Man: Only on the corners.

Mr. Fleetwood: What equipment do you use in manufacturing, such as fork-lifts, power saws, cranes and dollies?

Mr. Man: We have fork-lifts, we have hoists, we have lumber carts, we have automatic saws and of course we
Mr. Fleetwood: Do all your houses use trusses?

Mr. Man: All except the cape.

Mr. Fleetwood: How much growth do you foresee here at Grossman's and within the panelized housing industry within the next few years?

Mr. Man: I'd say within the next five years we anticipate about a 30 to 35%.

Mr. Fleetwood: There's certainly a lot of disagreement about the cost savings involved in panelized housing. Do you feel that there are any cost savings?

Mr. Man: Well, I think that if you take everything into account, first there's a high rate of vandalism right now and any job you go on to. Nobody is going to pick up a panel and walk away with it, where they'd pick up a 2 x 4 and walk away. And the fact that you get the house up quicker and get the door in and shut and locked up in one day I think is a savings. You don't have any clean-up costs. You can do it with inexperienced help. All you need is one good man on the job and the rest of them can do their work. So when you compare cost of material to cost of material there isn't a savings but when you compare the cost of material and start taking in all these other things I think there is a savings. In fact, there must
Mr. Fleetwood: be or people wouldn't use it. When you get into an apartment project there certainly is a savings or they wouldn't use it, on a large project.

Traditionally people are saying that the savings is in erection time. That a builder can build more units per year. This certainly would account for some savings. Do you agree with that?

Mr. Man: Yes. We have dealers all over New England and New York State. Everyone of our branches has salesmen and we have a contractor sales division that has about 50 salesmen. Although they're not all selling houses, they're selling components. A kitchen cabinet is a component. We feel we are a component business and especially in apartment construction. We did an apartment last year that had 180 units. In our little shop here we got out 65 trailer loads in 50 days and kept him right on schedule. So from the time he started in August, on February 1 he opened the doors to the first tenants. 180 apartments, trusses and panels. We sent down a load of panels in the morning, they'd have them up by noon and in the afternoon the crew would put the deck up and the next morning the next panels would arrive.

Mr. Fleetwood: Do you put your insulation in your panels?
Mr. Man: We do whatever they want. We do a lot of different things. Sometimes they do want it and sometimes they don't. Sometimes they want texture 1-11 right on the studs, a single coverage, and we do that, then we put the windows in.
INTERVIEW WITH SPACE MAKERS INC.
Roger McPhee & Mr. Berry, April 17, 1973

Mr. Fleetwood: How do you use an architect here at Space Makers?

Mr. McPhee: We have an architect that works for us in the drafting department. He is in charge of the drafting department. We have basic design houses that were designed by architects in the beginning when we first formed the company. They're what we call our standard houses. We never build a standard house. Every house we have there's modifications on it, there's changes on it and our architect checks these changes. He's in charge of making sure that the houses meet the standards of the building codes in the area, makes sure that they are structurally sound for the changes. If they widen a house, for instance, he would make the decision when you would go from a 4 x 8 rafter to a 4 x 10 rafter for the span.

Mr. Fleetwood: Do you use outside architects?

Mr. McPhee: We do build condominiums that have been designed by other architects outside of our company. We have built two or three different condominium projects. Once in a while, we'll get one house that's odd. We've done, in the last two and one half years I've been here, I'd say three houses that were designed by architects outside this firm.
Mr. Fleetwood: What are the manufacturing problems in triangular or trapezoidal panels?

Mr. McPhee: They take longer to pre-cut, basically. To lay out and pre-cut. We make a cutting list ahead on every house. In other words, a man will sit down and take a set of drawings for the house and make a cutting list of every stud, every piece of stock within the house. These panels take longer to do.

Mr. Fleetwood: Do they add significantly to the cost?

Mr. McPhee: Well, it's a necessity and of course they do cost more than a square panel. They cost more to build all the way down the line than a square panel. It takes more time to build straight through, more time to frame it, more time to cut it but it's a necessity. You have to build a gable panel to go along with a house.

Mr. Fleetwood: What are the size of you panels? Your panels are seven feet tall. What is the length and what do you feel is the maximum it could be?

Mr. McPhee: We are custom builders. This is something I should have mentioned in the beginning. Most of our work is custom work. We have panels that range from two feet wide in some cases and we have some 40 feet long on condominium type projects.

Mr. Fleetwood: Do you use heavy machinery in erection?
Mr. McPhee: In erection they do use a crane at times, yes, for the big panels, the 40 footers, the 30 footers. The normal house will take the normal panel which is usually a 12 footer.

Mr. Fleetwood: What is the price range of your houses? I'm talking about your package price and also the finish price. Your lowest price package and your highest price package.

Mr. McPhee: We sell it two ways. We sell a shell and we sell a finished house. The shells could range anywhere from, for a normal house, about $12,000. Some of them go up to $30,000 depending on the size of it. A finished package would probably go from around $18,000.

Mr. Fleetwood: How many houses do you manufacture a year?

Mr. McPhee: I think last year we manufactured about 200.

Mr. Fleetwood: Churches and condominiums?

Mr. McPhee: Condominiums we manufactured two buildings last year. This would amount to 16 units. We also built what we called the Roxbury Project in Boston which was duplex houses with five bedrooms and two baths in each, low income housing. They were good sized buildings. We built probably 15 of those last year. They used the forty foot long panels.

Mr. Fleetwood: By what arrangements are your houses built? Do you have builder-dealers or can anyone build your house?
Mr. McPhee: We have builder-dealers and also anyone can build out house. We sell the package. A package load of pre-fabricated, pre-cut components on a trailer. It's up to the individual owner to find their own builder. We recommend builders that have built them before for us. We also are split into two sections in this company. There is Space Makers division of AC & S which has salesmen all throughout the eastern part of the country sell our houses to individual people and then we have the community development project which we have under the name of Space Maker Developments, Space Maker Colington Harbor, Space Maker Stratford Harbor in Pennsylvania, Ohio and Michigan. They handle the condominium section. Now they are a separate part of this company. They have their erection crews on the job site. They're building more or less speck houses.

Mr. Fleetwood: You gave me the figure before, for the number of houses, approximately 200 a year. Does that include this parent corporation?

Mr. McPhee: Yes.

Mr. Fleetwood: What is the average size of an erection crew for a typical house and how long does it take them to build a house?

Mr. McPhee: Where we don't control the builder, these houses, some
of them spend six months on it. Some can erect the whole shell and be working on the finish in two days, three days. It depends on the builder. Some of the good builders put them up in two or three days and are inside working, doing the finish.

Mr. Fleetwood: How do you purchase your wood and is it pre-cut?

Mr. McPhee: We purchase our lumber from different suppliers. Carloads on things like 2 x 4 plywoods and so on. Heavy timbers we buy carloads when possible but most of the time we buy in lots of three or four lifts of 4 x 12's, 4 x 8's or whatever.

Mr. Fleetwood: Where does your heavy timber come from? Does it come from out west?

Mr. McPhee: We buy from a supplier in Massachusetts. Where he's getting it from, I don't know.

Mr. Fleetwood: How much of that is pre-cut on your 2 x 4's?

Mr. McPhee: When we buy it nothing is pre-cut.

Mr. Fleetwood: Do you find the wood accurate dimensionally?

Mr. McPhee: 2 x 4's and that type of thing, yes. On the 4 by stock on the timbers, no. We have a four sided planer that we use to plain all of our timbers to a size which is less by a quarter of an inch than the normal size it should be.

Mr. Fleetwood: What components, such as kitchen cabinets, metal chimneys, windows, doors, do you supply in your package?
Mr. McPhee: Windows, doors, that type of thing, are all within the shell. Anything used in the shell to close it in. Kitchen cabinets are sold when we sell the finished package with the house. We do not always sell the finished package. It can be sold either way, just the shell or both.

Mr. Fleetwood: Do you supply appliances and bathroom fixtures?

Mr. McPhee: No bathroom fixtures. We do supply appliances like stoves, refrigerators and that type of thing when we supply an interior package.

Mr. Fleetwood: Even though you're a custom builder, are your panels interchangeable?

Mr. McPhee: No. No. Really there's no other way to answer that. They're not interchangeable.

Mr. Fleetwood: What components would you like to see on the market? Are you having difficulty getting doors, windows, etc?

Mr. McPhee: No. Not that I can think of right now.

Mr. Fleetwood: What equipment do you use in manufacturing such as fork lifts, power saws, cranes?

Mr. McPhee: We use saws, straight line rip saws, four sided planer, miscellaneous material in handling equipment like low lifts, dollies with rollers on them, we have a track system where our material comes into the timber department on a track system, is cut and put on another set of dollies that it is rolled back on to.
Mr. Fleetwood: We have two fork lifts and we're contemplating a Third one.

Mr. McPhee: What volume do you consider necessary to justify this capital outlay here in terms of machinery and plant facilities? Approximately how many houses do you have to build a year or what is the dollar value?

Mr. McPhee: To break even we need to build about 250 houses a year for what we've got laid out here now.

Mr. Fleetwood: How much growth do you foresee here at Space Makers in the next few years?

Mr. McPhee: That really depends on the way lumber is going up right now. The cost of lumber has increased tremendously. It depends on how the market stands up. It's hard to speculate at this point, the way things are going up, what it will be. This year has been the best year we've ever had. We built more houses last month, the month of February, than we did in our top months last summer when building was really good.

Mr. Fleetwood: Do you see a rapid growth of the panelized housing industry?

Mr. McPhee: That's the way it is going mainly because of the savings involved in building that way.

Mr. Fleetwood: I'd like you to talk about what cost savings
you see in panelized housing and for whom. What are the advantages of panelized housing?

Mr. McPhee: In dollars and cents your saving by buying lumber in quantity, by buying by the carload. The individual contractor can't cut things by the hundreds like we can. We use a lower priced manpower. I can take a man for $2.25 to $2.75 an hour and have him do all the stapling, nailing and sheathing on the panels, where out in the field, I'd be paying him $5.00 an hour, at least. The hand nailing would take a man as long or longer with greater material handling costs. Labor-wise the savings is tremendous.

Mr. Fleetwood: In other words, you feel that panelized housing is cheaper than traditional stick-built houses.

Mr. McPhee: Yes.

Mr. Fleetwood: Even in the low priced range such as 18 to 20 thousand dollars?

Mr. McPhee: Yes. It still would be cheaper to build it pre-fabricated or modular because of your labor factor along while buying your material in bulk, you're going to get a substantial savings in your purchase. There's no doubt about it.
Mr. Fleetwood: Do you feel that the savings go up with the more expensive houses?

Mr. McPhee: Your savings go up but, let's just throw some figures in, not being accurate but just for the sake of having some figures, if you're savings was 10% on a low cost house, say a $20,000 house, I don't feel that you save 20% on a $40,000 house. I don't think it will go up that way. It will go up maybe 7% on a $40,000 house.

Mr. Fleetwood: You expressed a concern over the price increases in lumber. Do you feel that another material is going to supplant lumber as a traditional building material?

Mr. McPhee: I think that eventually it will, yes. Also, I've noticed, since I'm a building inspector in the town I live in, that in the last year people are remodeling houses instead of buying new ones. This has increased 75%. 75% more people are adding rooms on and less people are buying new houses than they were a year ago. This is what's coming because of the prices of new houses. One contractor in the town started off a year and a half ago building houses for $32,000. Now the same identical houses are $45,000.

Mr. Fleetwood: Do you see any cost savings in panelized housing?

Mr. Berry: I don't see any cost savings in panelized housing.

Mr. Fleetwood: Why are 13.5% of the houses produced panelized?
Mr. Berry: Mainly because a small builder or a large builder can produce more houses with less crew than he can by building conventional. In other words, his plans are made for him, material is cut, he can bring a small crew in and put that house up and have it under roof in 4, 5, 6 days maximum depending upon the size and he's ready for the next one.

Mr. Fleetwood: Do you think that cost savings that the builder realizes is passed on to the customer at some point or another?

Mr. Berry: A very small amount of dollars are passed on. What difference you're going to find is the labor in your plant is a little less than the labor in the field but as time goes on and unions get more prevalent, one is not going to outweigh the other because unions are getting the prefabricated industry. They will increase the cost of labor.
INTERVIEW WITH STANMAR, INC.
FRANK SPINNER, APRIL 17, 1973

Mr. Fleetwood: How do you use an architect here at Stanmar?

Mr. Spinner: We use an architect in many ways. We use a consulting architect and very shortly we'll have an in-house architect for design purposes and also to determine structural feasibility. We use an architect in our custom work like churches or camps, condominiums, for two reasons, for design and to determine the structural feasibility of our buildings. He also does the complete mechanicals with the aid of, in most cases, professional engineers to do the mechanicals, plumbing, electrical. In a house, I suppose we will use the architect for coming up with new designs, new concepts, new theories and reviewing customer requests. To see, number one, if they're feasible and, number two, to see if they make well oriented, well designed homes.

Mr. Fleetwood: You mentioned that you use architects presently. Do you use certain architects who understand your system or do you use any architect?

Mr. Spinner: No, always an architect that would understand our system, our building methods, our type of construction.

Mr. Fleetwood: How many architects are there?

Mr. Spinner: At the present time, just one. In about two weeks we'll have a second architect who will be working
in-house. The other one presently works on a combination retainer basis on the payroll. It's a working arrangement we have with him.

Mr. Fleetwood: Could you foresee having many architects who understand your system in designing houses?

Mr. Spinner: No, not at all.

Mr. Fleetwood: What are the manufacturing problems in designing triangular or trapezoidal panels?

Mr. Spinner: Not too many, really. They're laid our partially on a drafting board here and they're laid out in reality on our framing tables in the plant and there's no particular problem.

Mr. Fleetwood: What is the extra cost that you find in these panels?

Mr. Spinner: I imagine that your costs are about 50% greater than a standard rectangular panel that you do on a repetitive basis over and over again but the end result, needless to say, is to achieve a particular design and it is well worth the extra time and effort.

Mr. Fleetwood: What is the range of the size of panels you produce here at Stanmar and what do you believe to be the reasonable range of panels in the industry?

Mr. Spinner: Since we are primarily a prefabricator and not a modular builder and since our ultimate aim is to deliver to the site a panel which can be handled by four men, we will build panels anywhere from one foot
wide up to about fourteen feet wide, normal height
about six feet 10 inches. In some cases we will vary
the overall width because of loading and transportation
over the road to a maximum of eight feet wide and up
to, say, sixteen feet high but that's about the limit
of what we manufacture.

Mr. Fleetwood: In that range between one and eighteen feet, what do
you feel is the reasonable length of a panel at the
height of, let's say, six or seven feet?

Mr. Spinner: About twelve feet, but that's peculiar to our system
because being a post and beam fabricator we like to
place a post about every twelve feet because it cuts
down the depth needed for the continuous header
across the top of the panel. It wouldn't be any more
difficult for us to go 14, 16, 18 feet long. However
that presents two problems. It presents a problem in
the field itself and it presents a problem in posting
because you have to have larger posts and headers
in order to support such spans.

Mr. Fleetwood: How many houses do you manufacture here?

Mr. Spinner: At the present time about 250.

Mr. Fleetwood: By what arrangement are your houses built?

Mr. Spinner: About 85% are sold through Stammar dealers in the
field that actually have territories, they are
franchised to a certain extent. All of our national
leads go to them. Any referral customers that are
either write-ins or walk-ins, that are in that particular area, are referred to our local dealers.

Mr. Fleetwood: Do you offer your clients a fixed price or does your house price fluctuate in the winter as opposed to summer?

Mr. Spinner: No, we offer a turnkey price based on a particular locale. We attempt a national average between the south, New England and somewhere in-between, then publish a national average excluding such items as septic, water, landscaping, because those three items are the three that, quite frankly, can vary the most.

Mr. Fleetwood: What is your lowest and highest priced house?

Mr. Spinner: Our lowest priced house, again lets say on a retail basis excluding land, would be about $18,000. Our highest price, actually there is no limit to our highest house because we do a lot of custom work. We do a very good business in the 60, 70, 80 thousand dollars.

Mr. Fleetwood: How long does it take to finish the interior although I know this varies from house to house?

Mr. Spinner: Well, this will depend. Upon between 45 - 60 days I think will be a reasonable estimate based on the problems in lining up and scheduling sub-contractors. That's the biggest hangup, quite frankly, to attempt to coordinate all the sub-trades that have to come in
and do their phase of the work.

Mr. Fleetwood: How do you purchase your wood and is it pre-cut?

Mr. Spinner: A lot of our wood is pre-cut. The siding materials that we use, that is already pre-cut in height. We purchase a lot of our studs pre-cut but other than that most of our stuff is actually cut here in the plant.

Mr. Fleetwood: How much premium do you believe you're paying for pre-cut?

Mr. Spinner: Very little because of the fact that we do buy in large quantities and most companies, to get the business, will actually pre-cut it for us at a very nominal figure.

Mr. Fleetwood: Is the available pre-cut accurate dimensionally?

Mr. Spinner: Well, that's one of the reasons we don't buy too many pre-cut studs. Quite frankly the accuracy is not there so while we do buy some pre-cut studs a good many studs are actually cut here. The plywood that we do buy cut to a particular height is quite accurate. I would say probably within 1/16 of an inch which is close enough for our needs but the studs we found have not been, quite frankly, accurate and we've actually reverted, in a great many cases, to cutting them in-house.

Mr. Fleetwood: What components do you use, such as windows, kitchen
cabinets, metal chimneys, bathroom and kitchen fixtures?

Mr. Spinner: You mean that are completely fabricated and we act more or less as simply a receiving area and in turn ship it without any manufacturing? Well, kitchen cabinets we would, formica tops we do, interior doors we buy already pre-hung. Needless to say other stock items such as nails, metal fasteners, shingles, there's no manufacturing involved in any of these items. It's a case of simply bringing it in and shipping it back out again.

Mr. Fleetwood: Do you supply appliances and bathroom fixtures?

Mr. Spinner: No we don't.

Mr. Fleetwood: Why not?

Mr. Spinner: Mainly because people have too many individual tastes and preferences in those two particular items. Bathroom fixtures, as far as grade, color, brand and appliances the same thing. People, I think, have a fixation. If someone is happy with a G.E., they're not going to buy Hotpoint or Westinghouse. I think I would relate that probably to the same way people buy cars. I think you find that if people are Chevy owners, unless they've had some real problems, they'll continue to buy Chevys probably all their life. I think people relate the same way to appliances.

Mr. Fleetwood: How much inventory do you keep on windows?
Mr. Spinner: We probably keep 40 to 50 houses of windows in inventory at a given time. This will fluctuate and say down to 20 and we'll already have an order actually rolling because lag time on windows is presently somewhere between four and six weeks so we have to order well in advance.

Mr. Fleetwood: Are your panels interchangeable from house to house?

Mr. Spinner: No. We make no attempt to, lets say, develop a panel system that's interchangeable. Let's say they are to a certain extent but for the most part we do not stock pile panels for a particular job. We build every panel for every house on an individual per-house basis.

Mr. Fleetwood: What components would you like to see on the market or are having difficulty getting besides wood.

Mr. Spinner: Today that's the biggest problem, lets face it, is wood. Other than that, this part of the country, I think, probably is lacking in good specialty houses that you can actually turn to specialists that will manufacture, lets say, preassembled stairs for you to given rises and runs and different widths. You don't have your specialty houses that, as in other parts of the country, act more as a subcontractor or as a supplier of specialty items, especially in the millwork end of it there doesn't seem to be that much competition, lets say, for pre-hung doors and
window items. I think more competition and more flexibility along those lines would certainly help.

Mr. Fleetwood: What equipment do you use in manufacturing, such as fork lifts, power saws, cranes, dollies?

Mr. Spinner: Well, needless to say, we have a lot of our equipment in the shop. We do have six fork lifts, we have a planner that we use to remill all of our timbers, so that everything that we ship out in our "buy" stock is remilled roughly two days before it's actually sent out so all of our material is clean and bright. We have joiners, any number of saws, we hang all of our old exterior doors here. All of our equipment, although it's not fantastic, is sufficient for what we need. In addition to that, we do have, of course, a panel line which is hydrolically operated to actually manufacture all of our six foot ten panels. It's an adjustable panel line that will go anywhere down to six feet long and up to eight feet tall. Our standard panel is six feet 10 inches although we are capable in the same line of going up to eight feet tall.

Mr. Fleetwood: What volume of business or dollar volume do you consider necessary to justify this capital outlay in equipment?

Mr. Spinner: Well on a yearly basis we would have to do as a minimum about 150 homes at an average price of
about $15,000. In addition to that we would have to do probably about a million dollars in custom business. By that I mean condominiums, camp buildings, churches, things along that line. That would be actual minimum which is about a break-even point as far as this company is concerned.

Mr. Fleetwood: How much growth do you expect here at Stanmar and how much growth do you foresee in the industry of panelized housing?

Mr. Spinner: I think panelized housing, to answer your last question first, has got to continue because of your unstable labor market in the field, the increased prices in the field as far as skilled labor is concerned. The more you can do in a factory under controlled conditions at a much lesser labor rate the more a retail customer is bound to benefit. As far as our own personal growth, I would say that our goals are modest; what we're attempting to do is not increase business 60, 70, 80 percent every year. Our ultimate goal is to increase business probably 10 to 15 percent every year. So far in the last three years this is about what we've been doing and quite frankly management is happy with this type of growth. We don't anticipate any large growth this year other than within the confines of a 10 to 15 percent growth.
Mr. Fleetwood: There's certainly considerable discussion about how much costs savings panelized houses realize. What is your feeling about this?

Mr. Spinner: I think panelized houses, in terms of real savings, are quite neglegable. In terms of the net effect or net benefit that retail buyers can achieve, you can't really weigh it in terms of dollars and cents, I don't believe. For one, stick built houses are as well designed and well engineered. Number two, customers don't get the shifty type of builder that unfortunately is in every type of business today, that will attempt to cut corners, will use smaller members than he should for, lets say, joists, or rafters, items that aren't seen, that aren't readily picked up, that won't cause any problems lets say in the early years of the home but that the net effect over the years will be a roof that sags or floors that the floor bounces and squeeks. The retail customer is assured better quality material. He's assured that some material control has gone into his home. He has the satisfaction of knowing that he's dealing with a national corporation that does stand behind their product. Five years from today if he has a piece of glass broken he can go back to the company that manufactured the home and be assured of getting a replacement part at a reasonable price. In terms of
actual dollars, I don't see a 10 or 15 percent savings. Yes, he's going to save a few dollars. It depends, quite frankly, on the size of the home. If you want to compare say a prefabricated home to something designed by an architect, yes, then you can start to realize savings because he has the advantage of a well designed home, it can be customized to his likes and dislikes, his modes of living, at a very nominal figure. If he were to turn to an architect, and ask the architect to do the same thing, he would probably be spending 2, 3, 4 thousand dollars up and beyond what he would pay at most prefabricators today. So I think the ultimate savings depends on the price of the home. In the lower cost market, quite frankly, I don't think most prefabricators today can really compete that well, if your talking 18, 20, 22 thousand dollar houses. The tract builder today, quite frankly, can underprice most prefabricators. I think where most prefabricators shine is when you get up into the high 30's, the 40's and 50 and 60 thousand dollar houses. That's where I think you realize a savings and in the long run end up with a better designed home.
Mr. Fleetwood: How do you presently use an architect here?
Mr. Katchaturian: We use them to do the normal things an architect would do.
Mr. Fleetwood: Were your houses designed by an architect?
Mr. Katchaturian: They were designed in conjunction with an architect.
Mr. Fleetwood: Who else was responsible for the design of the houses?
Mr. Katchaturian: In-house people.
Mr. Fleetwood: Could you foresee using an architect in designing a house within your system for a specific client?
Mr. Katchaturian: That hasn't worked to date.
Mr. Fleetwood: Could you see that in the future as the company expands?
Mr. Katchaturian: Unless he was on the staff and was thoroughly familiar, on a subcontract bases. There are too many details and too many idocyncracies to the system to train a guy. It just doesn't work. What's going to happen is the architect is going to do the things he knows how to do best, floor plans, architectural consideration, take his house and cram it into our thinking; if it's compatible to what we want to do, fine.
Mr. Fleetwood: What are the manufacturing problems in producing triangular or trapezoidal panels?

Mr. Katchaturian: Time and extra cost. Any time you put an angle in anything it's extra time.

Mr. Fleetwood: Can you fit a trapezoidal panel into your production?

Mr. Katchaturian: We don't use trapezoidal panels.

Mr. Fleetwood? Triangular or gable panels?

Mr. Katchaturian: Triangular, yes, not trapezoidal. Oh yes, I guess we would use trapezoidal.

Mr. Fleetwood: What problem do you have specifically?

Mr. Katchaturian: None. Just the extra time to lay them out. It depends on the design. If it's a 45° cut and you end up using two pieces it's a lot quicker than if it's a 30° cut and you end up throwing one piece away. In other words, if you take a sheet and cut it down to a 45° angle you have two pieces. So if it's designed around the fact that you're going to use the waste then it goes twice as quickly. It takes longer than a straight cut but not as bad as setting a window.

Mr. Fleetwood: Do you try to avoid trapezoidal and triangular panels in your designs?

Mr. Katchaturian: We try to avoid anything we can avoid but it doesn't work out that way. If you're going to build a house it's got to have angles in it.
Mr. Fleetwood: In your opinion what is the reasonable range of the length and height of the panel in terms of cost, erection, manufacturing?

Mr. Katchaturian: If you're going to put it on a truck you've got to have an eight foot dimension. So you're stuck there. One of the dimensions has got to be eight feet. The length is determined by the economics of an eight foot sheet.

Mr. Fleetwood: What is the range of the panel length that you think is reasonable.

Mr. Katchaturian: Eight feet, economically, is the optimum sheet to use, if you could. It's the cheapest. Ten feet is a premium cost, a twelve footer is super premium cost. So if you can use something that's eight feet long fine but in many instances a design will call for something more than eight feet long so then it's a question of weight. It gets too heavy to pick up and we can't use it either. You have to use man power versus machinery. So the longest panel we make is eight feet wide and ten feet long - 10 ft. 6 in.

Mr. Fleetwood: How much labor savings is there with larger panels?

Mr. Katchaturian: Who knows. You're talking about an infinite number of variables when you're talking about people out there putting things together.
Mr. Fleetwood: What is the price range of your package and completed houses?

Mr. Katchaturian: Packages run from $8,995 to $17,993 for our basic houses and then you can add options to them which range from 13 to 14 hundred to 45 to 46 hundred dollars. If you add these options you can get a package that could potentially cost $17,993 plus 45 hundred dollars twice plus other options and you can build it up to 25 to 30 thousand dollars on our package. That package will represent a house of a value $70,000, about 3,000 square feet without putting in a lower level or basement. If you add that you have another 900 square feet.

Mr. Fleetwood: Do your prices fluctuate in the seasons?

Mr. Katchaturian: No. Our package price stays the same.

Mr. Fleetwood: How many houses do you manufacture each year?

Mr. Katchaturian: That varies, we are a relatively small manufacturer.

Mr. Fleetwood: By what arrangement are you're houses built? Do you have builder-dealers?

Mr. Katchaturian: We use builders, builder-dealers, customers. We don't erect anything. We don't put anything up. We don't have field responsibilities.

Mr. Fleetwood: Do you supply a site engineer

Mr. Katchaturian: At extra cost, if they desire, of $85 a day plus expenses. This is pre-determined before he goes.
Mr. Fleetwood: What is the average size of an erection crew?

Mr. Katchaturian: 4 to 6 men.

Mr. Fleetwood: How long does it take, then, to complete the house after the foundation is finished?

Mr. Katchaturian: It depends on the house. Anywhere from 3 days to 3 weeks. This is the shell.

Mr. Fleetwood: How do you purchase your wood and is it pre-cut?

Mr. Katchaturian: No, our wood is not pre-cut. We purchase wood in truck-load or car-load quantities. Our plywood comes from the coast and our post and beams are coming out of New England. We use used lumber from barns, etc.

Mr. Fleetwood: Is your wood accurate dimensionally?

Mr. Katchaturian: Our panels basically are more accurate than the dimensions of the stock we get. We're working to a greater degree of accuracy than the raw material. Which presents a problem. We have to do a certain amount of fitting and trimming on standard sheets. There is a variance there. The lumber people will deny that.

Mr. Fleetwood: What components do you supply, such as kitchen cabinets, pre-fab chimneys, pre-hung windows, pre-hung doors?

Mr. Katchaturian: Our windows are installed in the panels. The interior trim is basically incorporated in the way we frame the house so that's eliminated. We
Mr. Fleetwood: How much inventory do you keep for windows?

Mr. Katchaturian: We have a good supplier who inventories for us in his shop. We keep about four or five houses around in our shop at one time. He may have about ten or twelve. So we have a total of readily available inventory of anywhere from twelve to fifteen houses at once.

Mr. Fleetwood: Are your panels interchangeable from house to house?

Mr. Katchaturian: No.

Mr. Fleetwood: What type of components would you like to see on the market that you've been having problems getting?

Mr. Katchaturian: I'd like to see things that aren't made out of wood right now with the market the way it is.

Mr. Fleetwood: To restate that question, are your houses designed around the available sizes?

Mr. Katchaturian: We have a very, very cooperative window supplier who supplies anything. Basically we like to keep things as standard as possible. Not particularly because we can't get them but there will be problems later on for the customer. If he has a bunch of odd shaped windows in his house and he
wants to replace something or get screens or do anything later on he's stuck. For us we could put all kookie sizes in the house. It wouldn't make any difference because the suppliers will cut them for us. We buy enough windows so we do anything we want to do. We try to keep them as standard as possible for the sake of the customer, maintenance wise.

Mr. Fleetwood: What equipment do you use in manufacturing such as fork lifts, power saws, cranes, dollies?

Mr. Katchaturian: We have very little sophisticated equipment. The most sophisticated piece of equipment we have is probably our cut-off saws which are ordinary type pieces of equipment and we have a fork lift, and we use a couple of dollies. It's not an assembly line type of operation. Our people go to the components. Our components don't run by the people.

Mr. Fleetwood: How do they get to the people?

Mr. Katchaturian: Each section is responsible for keeping his own raw materials on stock.

Mr. Fleetwood: How many men do you have fabricating your houses?

Mr. Katchaturian: We average about ten or twelve people.

Mr. Fleetwood: What buying do you consider necessary to justify your capital outlay for equipment?

Mr. Katchaturian: Dollar-wise we have to do about $400,00 worth of business.
Mr. Fleetwood: How much growth do you see with this firm and with panelized housing over the next five to ten years?

Mr. Katchaturian: The growth we see for this firm is what we want to make it. We're not particularly interested in becoming a huge firm so our growth is going to be governed by what our desires are. As far as panelized housing goes, it's obviously one of the answers. I don't think we're going to revert back to conventional houses. If anything is going to happen it's going to be more and more of the manufactured houses in one form or another. With panels or modular units or whatever.

Mr. Fleetwood: How do you're builders feel about panelized houses? Do they feel the same way?

Mr. Katchaturian: Builders, from what I've seen, and I'm looking at a controlled bunch of people, are already considering. They're either sold or they're getting sold. So I'm not talking to the guy who says I don't even want to talk to you. Obviously if he's talking to me he's already considered it very seriously. The people I've talked to, they're very receptive. Basically what the manufactured house does for a guy is it takes two functions out of his operation. The two things we're taking away from him that he's glad
to get rid of is number 1 we take the sales responsibility away from him. We bring a customer to him ready to sign a contract. That is a big deal because the builders generally like to build and salesmen like to sell so therefore it's not a compatible thing for most builders. We're talking about the little operation where you've got a few people and maybe his wife is doing the books. Basically, they don't want to sell so we sell for them. They don't want design and we do designs for them. And the other thing we do for them on a package house is we do their buying for them and their specifications which is something they would like to avoid also. Builders generally just want to put things together, build and try to make money. That's all that really interests them. They don't seem to have any goals beyond that. So manufactured houses really helps. Secondly he knows exactly what the guy is going to end up with because it's all designed and there's no guess work so that's easy for him. Thirdly, all the materials that we aren't going to supply for him are specified so it's an easy purchase problem for him. The other advantage is that the builder can send a crew out there and they can work steadily from the beginning of the project to
the end of the project without having to be interrupted because of lack of materials either for one of two reasons, 1 - he forgot to order it and 2 - the supplier let him down. One of the two is what frequently happens.

Mr. Fleetwood: What sort of potential cost savings do you see in panelized housing and to whom?

Mr. Katchaturian: First of all there are several ways to save money. One way to save money is to design something so that it is so well designed that it's obviously going to save money. Materials that are economically used and so on. There's no more or less than what you're going to use, you utilize spaces that you wouldn't ordinarily utilize before, like our houses don't have attics. That's one way to save. It's just a question of design. We have a tendency to look at things hard because we have to design it once for every kind of consideration but that's a lot more thought then would go into a normal situation. The second way to save money is to be able to hold at the original cost estimate. What happens in conventional housing very often is that the guy doesn't know what he's estimating because he's never built that house before and the customer has never seen that house before so everybody is really guessing even though you have
a qualified architect, you're still guessing. So you get half way through the project and they say, "uh, uh, this is more expensive than I thought it was going to be." "Why, well we didn't count on this" or "we forgot about that." "It turned out that this didn't work out." These kinds of problems. Or the builder is just incompetant. One of the safeguards that manufactured housing has is a good company. We've got good information. We've got good spects. An ordinary house may have 30 different variables effecting construction. Major categories are framing, shingles, plumbing, heating, wireing, if you add them all up you have about 25 to 30 major variables. If you can nail down 20 of them before you start that only leaves 10 variables. 10 variables are still better than 30 variables. So if you start with manufactured housing, number 1 you can lock up the cost of the framing and the shell. That's what you're talking about. You can pretty much lock up plumbing and electrical before you start. You can lock up a lot of items because it's not a first time through. There are model houses a guy can go look at. So you can take this big problem and make a smaller problem so that helps keep costs down. People know what they're getting into before they start.
In some instances you can nail the whole thing down. Total cost of construction can be pre-determined before the guy starts. He knows exactly what it's going to be. He lets out a valid contract. There's no question about it. That's what it's going to cost and that's what it's going to look like. No more and no less. So you see, that's one way to save a guy money. You save him money because he doesn't have to spend more money. The other way to save money, obviously, is to take advantage of the buying power that a manufactured home guy has and pass it along to the customer and we do that. Even though we put our fair mark-up on something, we still get it to him cheaper than if he went to the lumber yard and bought the same piece because the lumber yard can't buy the way we do. Not because he's not as smart as we are but because we buy more than he does of this particular thing. Once you state your designs, like we do, we have standard designs, standard siding, standard everything, "any color black you want". This has a tremendous advantage. I'm the biggest single user of a certain texture of sidings for instance from U. S. Plywood and we're a little company but we use a tremendous amount of this one product. So therefore we have buying
power and leverage that we can exert on that one item. Whereas a lumber yard has 50 textured sidings so he's bickering with Diamond National and Georgia Pacific and U.S. Plywood and all these others all at one time and he really doesn't have the kind of leverage that we can exert. So we can buy it much cheaper than even a lumber yard can buy it. We can put our mark-up on it and still get it to the customer cheaper than what he could buy it because of the nature of what we're doing more than anything else. I'm just talking about the philosophy of the way we run things. There are a lot of custom pre-fabricators who have the same headache the builder has because they have so many options and so many variables that they can't inventory anything. They have to buy piece-meal and when they start to do that, unless they're absolutely huge, they have the same basic set of problems that the stick builder has.

Mr. Fleetwood: Yankee Barn uses stressed skin floor and roof panel. What advantages do you see here?

Mr. Katchaturian: It makes sense for the architecture we use. We're not in love with panels, they just happen to work out very well with the way we design our houses. First of all we're talking about what we sell. We don't sell a competitive product with any
of the other people. There's only one place you buy Yankee Barn and that's here and that design is our marketing bag. What we're hanging our hat on. There are other barn type structures you can buy and you can build but there's only one place you can buy our particular product. Basically barns were built with post and beam construction and floor decking. When they got the basic frame up they put barn boards on it and then nailed them to the berths and the lower berths and the horizontal pieces. Our system, instead of using barn boards one at a time, uses a wall panel which has got everything in it. It's got the inside skin, the outside skin, the insulation and the window is already installed, so O.K. if it's a stressed skin panel because it happens to work out nicely. But basically all we've done is taken the old barn board that the guy put on eight inches at a time and new we give him eight feet of it, fully insulated with a window and the full bit all done. The only take-off on the way a barn is built and the way we build them is our panel system which is an improvement over putting boards on one at a time. They look like boards from the outside and the inside and yet it has all the advantages of modern day construction. Panels are not going
warp or twist, they're easy to insulate. We've taken an old concept and put new ideas to it so it architecturally makes sense in today's living conditions. What people expect out of a house.
BIBLIOGRAPHY

Books and Reports

1. Ballelle Memorial Institute, Final Report on the State of the Art of Prefabrication


-166-
12. Gaffney, M., "Land as an Element of Housing Costs", Institute for Defense Analysis
17. International Council for Building Research, Towards Industrialized Building, Proceedings of the 3rd CIB Congress, Copenhagen, Denmark
27. President's Committee on Urban Housing (the Kaiser Report), A Decent Home, Washington D.C., U.S. Government Printing Office
30. Sumichrast, Michael and Frankel, S.D., Profile of the Builder and His Industry, Washington, NAHB, 1970

Articles, Pamphlets

37. "Has Big Money Helped Builders?", Automation in Housing, May 1971, pp. 48-63
43. "Industrialized Building in 73", Professional Builder and Apartment Business, Jan, 1973