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Systems building theory application within the residential housing construction market

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SYSTEMS BUILDING THEORY APPLICATION WITHIN THE RESIDENTIAL HOUSING CONSTRUCTION MARKET

by
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ABSTRACT

Title of Thesis: SYSTEMS BUILDING THEORY APPLICATION WITHIN THE RESIDENTIAL HOUSING CONSTRUCTION MARKET

Gary A. Newhard, Masters of Science, 1986

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The primary purpose of this report is to introduce the economical value in utilizing certain "systems building" applications. In this report I focus on integrated system methodologies that encourage residential building economy and submit such systems as a viable alternative to traditional labor intensive housing construction. The consumer market that could be particularly enhanced by these systems ranges from low income to middle income and the by-product would be classified as "affordable" housing.

This report focuses on the New Jersey real estate market and presents certain prefabricated housing systems as an economical means of meeting the large demand for residential housing. I particularly recommend traditional type wooden modular and component systems and

suggest ways of implementing their use into the New Jersey market. I also take the reader through a functional systems analysis exercise and illustrate the resulting functional design.

Throughout this paper I try and touch on many levels of building economy. Particular consideration is given to the following areas: function, cost, quality, value, control, productivity, computer application, and economies of scale.

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I. INTRODUCTION

A. Prefabricated Systems Building

Within traditional forms of construction there has long been a significant amount of standardization (bricks, blocks, two by fours, windows, doors, etc.). And along with the Industrial Revolution came the industrialized production of building components and subassemblies.

The development of the prefabricated building system implanted its roots at the turn of this century with the acceptance of prefabricated structural cast iron components such as those used in buildings like Joseph Paxton's Crystal Palace of London (1851).[1] Since that period, there has been controversy over the extent to which the role manufacturing should play in the construction process. In particular, there has been a debate as to the economics and practicality of certain types of prefabricated construction.

A British economist, Dr. P.A. Stone, in his book Building Economy, points to a study carried out by the Building Research Station in 1959 in which they concluded

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[1] Sigfried Giedion, Space, Time, And Architecture, The Growth Of A New Tradition (Cambridge: Harvard University Press, 1967), pages 115 - 224.

that prefabricated materials were more expensive than traditional materials. [2] Dr. Stone does not mention the prefab materials used nor does he state the building type the materials were to be used in, but he does give the impression that the materials were different than found in traditional building. He defined the system as panelization and concluded that the problem with this concept was that the system only replaced straightforward parts of the traditional work; the complicated work still had to be carried out traditionally. In conclusion he states that, "The introduction of factory-made components only appears likely to be economic if whole traditional operations are thereby eliminated." [3]

In my opinion, I don't think that generalizations can be made about the economy of prefabricated systems building. The economy achieved is dependant on: market size, building type, systems used, building materials selected, capital requirements, and location. Nevertheless, I do feel certain that, when utilizing specific applications to meet specific needs, systems building can and should be more economical

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[2] P.A. Stone, Building Economy: Design, Production, and Organization - A Synoptic View (Oxford: Pergamon Press, 1983), page 77.

[3] Ibid., page 78.

than traditional labor intensive construction.

The cost advantages of the prefab system are directly proportional to the cost difference between factory labor and trade labor. Semi-skilled labor is considerably cheaper than skilled trade labor. And within the manufacturing environment, through the use of efficient fabrication techniques (using jigs, fixtures, automation, etc.), along with team coordination, construction time becomes considerably less and therefore more productive than traditional labor intensive. Sophisticated material handling, plant layout, and production control also contribute to time and cost economy.

Dr. Stone cites the economic advantage to incorporating unskilled labor into the building process through transformation: "It may be possible to rationalise traditional building, that is, to industrialise it, so that new sources of labour could be used. Such a development could be a result of the division and specialisation of labour so that labour could be trained rapidly to carry out simple, standardised and limited operations."[4] "The main advantage lies in the possibility of increasing the national rate of building, during periods when this is required by

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[4] Ibid. (British spelling retained), page 84.

bringing into the industry additional sources of labor without the need for them to serve an appreticeship."[5]

I certainly do not want to discount the value of traditional skilled trade labor, for they are of particular necessity when it comes to rehabilitation work and custom construction. Though, I do feel that, today, particularly in the area of low cost housing, it would be most economical to utilize an unskilled and semi-skilled labor force within the controlled manufacturing environment. And all would agree that: the use of such labor in the manufacturing building process would be particularly good for the "national economy" if unemployed ranks were enlisted.

In terms of building life cycle, prefabricated buildings can last just as long as buildings built on site. Although, if for whatever reason (political, economic, etc.), the choice is made to create a building with a limited life cycle, it could be easily managed within the manufacturing plant.

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[5] Ibid. (British spelling retained), page 89.

B. Prefabricated Housing

The notion of prefabricated housing parts goes back to the seventeenth century. The English settlers of America used prefabricated wall parts consisting of wooden frames, which were easily stowed in the hold of a ship; they had little time at their disposal between their arrival in the New World and the onset of winter, and they wished to knock their houses together with a minimum output of labor. This emergency situation gave rise to the famous American timber frame system, known as the "Balloon Frame," which is employed to this day.[6]

Early in the 1900s, the "mail-order house" became popular on the frontiers. Between 1908 and 1937, Sears, Roebuck Company sold over 100,000 houses. The houses were precut and their production was important since it pioneered techniques for the production lines, the standardization, and the price packaging of the prefabricated housing industry. It was the American dream by mail order, and it couldn't have been much simpler. The home buyer provided masonry, labor and a building lot within hauling distance of

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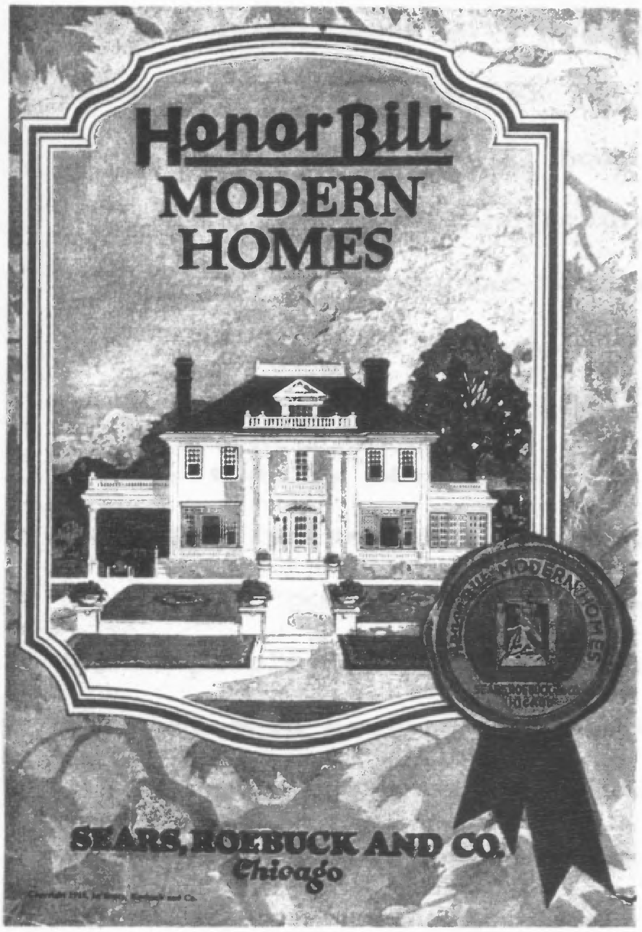
[6] Thomas Schmid and Carlo Testa, Systems Building: An International Survey of Methods (New York: Fredrick A. Praeger, Publishers, 1969), page 28.

a railroad siding. Every board, stud, rafter, joist and molding had been cut, notched or mitered to fit, and numbered to match the plans. All the novice builder (or contractor) had to do was follow the numbers while assembling the house together, and a 76 page manual told him just how to do that - right down to the spacing between the nails. [7]



Sears proudly displayed the Magnolia on the cover of it's 1918 catalog. With a kit price of $5,140.00, this ten room mansion was the Top-of-the-line. [8]

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[7] David M. Schwartz, "When Home Sweet Home Was Just A Mailbox Away," Smithsonian, November 1985, pages 90-101.

[8] Ibid., page 94.

The prefabricated housing industry actually began developing its present-day characteristics around 1930. With the establishment of the F.H.A. (Federal Housing Administration), it became possible to market homes in a mass volume in normal times of peace as buyers were now able to buy homes on terms they could afford. Buy 1940, there were about thirty firms manufacturing and selling prefabricated homes with approximately 10,000 units produced between 1935 and 1940.[9]

During World War II, home manufacturing met its severest test. The manufacturers were faced with a large demand for emergency war housing. With limited resources they were required to supply flexible low cost housing that could be erected quickly using minimal on-site labor. As a result, quality was sacrificed for quantity, and consequently, prefabrication gained a reputation as being "cheap" or "poor" construction. Up until the end of the decade people had a strong tendency to associate prefabricated housing with a Quonset hut type dwelling.

By the 1950's the prefabricated housing industry was well on its way to public acceptance. "Mobile home"

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[9] Laurence and Sherrie Cutler, Handbook Of Housing Systems For Designers And Developers (New York: Van Nostrand Reinhold Company, 1974), page 19.

sales in particular began to take off and to this day remain the highest volume manufactured housing systems sold. Although, it is important to note that the majority of mobile home buyers purchase these units because it is all that they can afford, it is more a matter of budget than choice. Modular and component/panel housing systems are typically of much higher quality than mobile home systems. And besides their quality limitations, there are many other disadvantages to owning a mobile home; difficult financing, poor appreciation, short life cycle, small resale market, etc., but it is not within the scope of this paper to discuss these issues. This paper is predominantly interested in permanent prefab housing of good quality.

Since the 1960's the prefabricated housing industry has only encountered minor set backs, which came through systems experimentation and periodic misuse of materials. The government has since become aware of the potential behind prefabricated housing and has frequently supported large systems ventures. Currently, new housing systems are being devised on a daily basis, in an effort to meet the ever increasing demand for low cost housing. But, to date, the houses that closely resemble the traditional stick-built home, but at a lower price, are and always have been the quality prefab choice among prefabricated home buyers.

Today, within the residential housing construction process, wooden components (floor and ceiling trusses, panels, etc.) and assemblies (modulars) are being widely marketed. Unfortunately, little attempt has been made to carry out scientific studies of the economics of such building systems.[10]

When considering the value associated with today's prefabricated housing industry, particular interest should lie in the following areas:

1. Market/User
    a.) Housing Supply and Demand
    b.) Building Codes
    c.) Lender Rates
    d.) Material Availability

2. <u>Cost Considerations</u>
    a.) Quantity Price Breaks
    b.) Standard Cost Estimating
    c.) Scrap Control
    d.) Carrying Costs
    e.) Standard Materials
    f.) Standard Overhead Costs
    g.) Indirect Costs
    h.) Control of Labor Costs
    i.) Transportation, Staging, & Installation

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[10] P.A. Stone, <u>Building Economy</u>, page 77.

3. Control Considerations

a.) Computerized Material Requirements Planning

b.) " Inventory Control

c.) " Job Costing

d.) " Job Scheduling

e.) Control Over Contingencies (Weather, Productivity, etc.)

f.) Manufacturing Unions vs. Trade Unions

4. Sociological Implications For Labor

a.) Job Satisfaction

b.) Team Motivation

c.) Labor Relations

II. THE PREFABRICATED HOUSING MARKET

Within the past five years prefabricated housing has become a very popular economic alternative. In 1981, according to the National Home Manufacturers Council, American factories produced nearly 400,000 homes, and in addition, made prefabricated pieces such as roof trusses for 85 percent of conventionally built homes.[11]

For the most part, prefabricated home manufacturers have been predominantly dealing with a marketing group consisting of dealer/builders. Dealer/builders operate as franchises and/or contractors, and typically represent one or more manufacturer(s). These middle men market the prefabricated homes directly to the consumer or developer for a modest sales commission. Most of the dealer business revolves around the consumer market and the dealer/builder services range from simple delivery to complete general contracting.

In January of this year, I interviewed with John Harnik, general manager of Van D. Yetter, Inc., a small

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[11] Frances Cerra, "Factory-Built Houses: Ticky-Tacky No More," New York Times, 27 June 1982, section 8, page 1, cols. 2-3, and page 14, cols. 1-4.

dealer/builder in East Stroudsburg, Pennsylvania.[12] The company consisted of a small staff working out of a 2,000 square foot office. John stated that up until 1980, most of his sales were mobile homes, but that now, due to new public awareness and falling interest rates, his market has shifted to modular housing. In 1985, the company sold over 150 modular houses and only 80 mobile homes.

Within the modular housing sector, the Van D. Yetter company caters to both the consumer and the consumer/builder. In other words, the consumer can hire Van D. Yetter to perform all the necessary subcontracting (masonry, installation, mechanical/electrical hook-ups, etc.) or the consumer can do the subcontracting himself, utilizing the free guidance offered by the Yetter staff.

Van D. Yetter is strategically located on the Pennsylvania/New Jersey border, and it is easy to understand why. Van D. Yetter distributes modular houses that are manufactured in central Pennsylvania where the labor market is considerably less expensive than New Jersey labor. Due to the ridiculously high traditional contracting costs faced

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[12] Interview with John Harnik, General Manager, Van D. Yetter, Inc., East Stroudsburg, Pennsylvania, January 15, 1986.

by the New Jersey consumer market, Van D. Yetter sees a larger and larger volume of New Jersey consumers walking through the door looking for an economical alternative. The majority of Van D. Yetters modular home buyers are New Jersey residents.

In 1983 manufactured houses accounted for 36 percent of all single-family housing built in the United States, according to the annual Red Book of Housing. Of the 437,400 single-family manufactured homes built in 1983, 17,000 were precut houses, 72,000 were component/panelized, 56,000 were modular and 292,400 were mobile homes.[13] I was unable to obtain any specific industry documentation relative to the last three years, but in talking to prefab vendors, I have found that there is a strong two-tier market developing.

The first tier is the prefab consumer market which, with the recent drop in interest rates, has increased substantially. This consumer market is predominantly buying wooden stick-frame type modular houses from builder/dealers, due to their quality, availability, affordability,

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[13] Joseph Giovannini, "The Factory-Built House: Design Diversity," New York Times, 26 January 1984, section C, page 1, col. 1, and page 6, cols. 1-3.

acceptability, and ease of purchase. The second tier is the prefab builder/developer market which predominantly utilizes component/panelization systems.

The prefab builder/developer is the fastest growing prefab market, and it is this market that all prefab manufacturers are trying to capture. John Kupferer, executive director of the Home Manufacturers Council stated in a New York Times article: "We don't market ourselves to consumers, because if you can sell a builder on using your product, he'll buy 10 or 15 houses a year, whereas the same marketing effort directed to the consumer will sell only one house."[14]

In terms of regional markets, the greatest necessity for prefabricated housing exists within the northeast region of the United States. Within this region, the demand for housing is particularly high within the New York metropolitan and tri-state areas, where traditional construction costs have become astronomical. New Jersey is the hottest residential real estate market in the country today and there just isn't enough trade labor available within the state to meet the existing demand for housing.

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[14] Frances Cerra, "Factory-Built Houses: Ticky-Tacky No More," New York Times, 27 June 1982, section 8, page 14, col. 1.

As of March 30, of this year, construction of single family homes in New Jersey hit a 25-year high, according to figures compiled by the state Department of Labor. A front page article recently presented in the Star Ledger details the unprecedented demand for housing and quotes Connie Hughes, director of the Data Center of the State Labor Department as saying "We're in a real construction boom, and we're really outpacing the nation." New construction on all kinds of housing, Hughes noted, rose 25 percent from 1984 to 1985 in New Jersey, compared with a 3 percent rise nationally.[15] The article goes on to note a host of demographic and economic factors influencing the incredible demand and states that the majority of the homes are being built in suburban residential areas, particularly along the northwest and southwest corridors of routes 78, 73, and 70. The article concludes by saying that most housing analysts believe the single family housing boom will continue with 1986 outpacing 1985, and that with the declining interest rate situation, there'll be even more action.

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[15] Mary Jo Patterson, "Home building in New Jersey at 25-year high," Newark Star-Ledger, 30 March 1986, pages 1, cols. 5-6, and page 18, cols. 1-6.

The main prerequisite to considering the application of systems building is the market condition. There must be a large enough market to justify the capitalization required. Based on my market analysis, I see a strong need for the development and/or utilization of housing systems building within the state of New Jersey. Not only to help meet the state's tremendous demand for housing, but also to meet the consumer markets demand for affordable housing.

During my recent interview with Mr. Andrew Aldi, a New Jersey real estate developer, Mr. Aldi complained that "there just aren't enough good on-site stick-framers in the state of New Jersey to meet the current housing demand, we just can't build houses fast enough."[16] When I recommended prefabricated housing to him, he agreed that it would be a good idea, but complained that he typically has problems convincing investors to go along with using prefab, "they just don't know enough about it." Mr. Aldi said that he's seen some quality prefabricated housing work done in the state and that he felt it's application to be particularly economical in the building of condominiums and

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[16] Interview with Andrew Aldi, President of HOWCO investment Corp., A Subsidiary of The Howard Savings Bank, Livingston, New Jersey, Intermittent Interviews between January and April, 1986.

townhouses.

Mr. Aldi thinks that the biggest constraint to using prefab in New Jersey is the limited number of builders experienced with prefabricated housing construction. I personally couldn't see that as an obstacle, since prefab housing construction is far less complicated than traditional building techniques.

I recommended to Mr. Aldi that, given the opportunity to use prefab, he should start out simple, using modular housing first and then eventually shifting to the more complicated (also more economical) use of component/ panelization. Mr. Aldi said that he had used roof trusses in the past and that they proved to be economical, but that given a choice, he would prefer to use modular.

III. EXISTING ECONOMICAL PREFABRICATED HOUSING SYSTEMS: WOODEN "MODULARS" AND "COMPONENTS"

A. The Sectionally Prefabricated Traditional Type Modular House

The most popular prefabricated units of choice on the "consumer market" today are the wooden "sectionally built" modular homes. Builders see the potential in using this technology and more and more developers are becoming production oriented. The terms modular and sectional within this context are synonymous and should not to be confused or associated with the lesser quality, but economical, mobile home market.

Presently, within the prefabricated housing industry there are companies that are preforming industrialized operations in the shop using traditional housing materials (two by fours's, plywood, etc.) to fabricate complete house sections. Modular manufacturing companies such as Medallion Inc. and Haven Inc. of Pennsylvania are presently involved in manufacturing traditional stick frame homes in sections for approximately $23 per square foot. Due to highway restrictions, they deliver a Ranch style house in two sections, a Split Level house in four sections, etc. The sections would come with all the plumbing, electrical, and heating (baseboards or ducts) installed and the joining of the sections would require the use of a crane and one days worth of labor. The one day rental of a crane would be at the customers expense, but the labor cost for the joining process is included in the purchase price.

These modular housing companies promise to deliver a house within six weeks of the order date. And as a customer, you have the option of either having them do the foundation work (an extra) or you can subcontract the foundation work yourself. Mechanical system and utility hook up would also be an extra or your own responsibility; including hot water heater, boiler, electric service box, water tap, and sewer tap. Prior to ordering the house the customer, of course, would have to purchase a building lot, choose a design, and obtain a building permit.

When investigating the modular housing market some of the prices quoted tend to be misleading ($/sq.ft.) since they relate to the building without foundation, site services, and land, whereas the prices for the traditional product usually include these things. And, as in all capitalistic markets, prices can sometimes be influenced merely by profit motives or the real estate market.

In terms of liability, the sectionally manufactured modular home automatically carries with it an implied warranty based on its nature as a sale (Uniform Commercial

Code). On the other hand the construction of the traditional site-built home, contracted by the owner, is commonly negotiated by the use of a service agreement rather than a sales agreement. The standard service agreement, unless otherwise defined, carries very limited liability (outside of gross negligence).

1. Quality/Cost Consumer Trade-offs

As mentioned, there are many variables that influence the cost of a prefabricated home. The manufacturer selected as well as personal taste are big factors. There are good and bad prefabricated homes types, and usually the bad is attributed to cheap materials selected to keep the cost down for a low income market. For example, one ranch style modular home that I visited in Randolph, New Jersey was of stick frame construction but the ceiling and wall surfaces were made of plastic. I considered this house "bad" not only aesthetically but also in relation to safety. For if there were a fire in this house it would burn quickly and emit deadly noxious gases.

Of all the "consumer oriented" manufactured homes that I investigated (mobile, modular, precut, panel, etc.) the type I valued the most were the ones that used traditional design and materials. Homes built by companies like

Haven Inc. and Medallion Inc. in particular were among the best examples. Both Haven and Medallion are strictly wooden modular home manufacturers. Their houses are of wooden stick-built construction and all of their available models are traditional in design. The main difference between these two companies is in the area of modification and customization.

Medallion home designs are somewhat restrictive. They let you choose between many styles (colonial, split, ranch, bilevel, cape, etc.) and within each style there are a half dozen floor plans, but you can only marginally deviate from the standard. For instance, the consumer can request increased square footage in any room or specify a certain size floor joist. You can even choose between various grades of their traditional materials; medium grade plywood is their standard exterior sheathing, you can either downgrade to particle board (credit) or upgrade to high grade plywood (debit). But if you need a major modification or would like to build a custom design, Medallion may not be able to accommodate you.[17]

On the other hand Haven Inc. does accommodate major

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[17] Interview with Dick Row, Chief Engineer, Medallion Homes Inc. (Ritz-Craft), Miffinburg, Pennsylvania, November 21, 1985.

modification and customization. They offer the same standard product options as Medallion plus they cater to custom customer designs. Haven sales representatives claim that they can manufacture any custom design and that it will only cost around $3 extra per square foot (approximately $26/sq.ft. total).[18] I am somewhat skeptical as to just how elaborate a design can get. For I am sure that once you reach a certain point of elaboration you would find it more advantageous (cost wise) to forget about Haven and instead build your house on site using specialized tradesmen.

I toured a "standard" Haven built home owned by a friend of mine in Greenbrook, New Jersey and was very impressed with it's quality of construction. The house is indistinguishable from a traditional stick-built house and it is of slightly better quality. The house joints are tighter than traditional stick-built and there are no signs of workmanship defects. The only problem my friend had with the house was during the first two weeks of settling where a small seven inch hair-line crack developed in the wall between the living room and the dining room. He said that

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[18] Interview with Fredrick Terry, Sales Representative, Haven Homes, Inc., Beech Creek, Pennsylvania, November 20, 1985.

Haven told him to expect a certain amount of settling but that it would only settle for approximately two weeks. The owner waited one month before spackling up the crack and since then has not experienced any more problems. To date he has occupied the house 20 months and is very happy with his new home.

2. Consumer price sample: traditional vs. modular

As with all manufacturing companies, costing information is kept confidential. So much so that one prefab manufacturing company refused to even let me in the plant for fear I might represent the competition. For the sake of presenting a relative cost comparison between traditional home contracting and the purchase of a prefabricated home, I will illustrate the consumer cost differences relative to a consumer seeking to build a home in Cranford, N.J. (my home town).

Many configurations could be considered for this analysis but for the sake of simplicity I will compare a standard wooden modular design with a standard stick-built house. To keep everything constant, the houses being analyzed are the same house type and are constructed of identical materials. Since Haven homes are virtually indistinguishable from conventional on-site stick built construction, it is most appropriate to use one of their homes for this analysis. The modular example I have chosen is a Haven 1,252 square foot Winchester colonial split level, floor plan A (see drawings and spec's in Appendix 1 located in back section of this book). The following are the consumer prices that would be associated with the building of the Winchester plan A:

Haven Modular House 1,252 sq.ft.	$40,000	includes
(1,920 sq.ft gross living area)		transport of
<u>EXTRAS</u>:		4 sections
Haven Foundation Turnkey Package	17,300	
(could subcontract)		
One Day Crane Rental	1,560	
Panel Box Service	500	
Boiler (or furnace)	1,500	
Hot Water Heater	250	
Water Heater Hookup	1,000	
Sewer Hook-up	1,000	
Water Hook-up	<u>1,000</u>	
Approximate Total (less land)	$54,110	
Building Lot (Cranford, N.J.)	<u>35,000</u>	
Total Cost if built in Cranford	$<u>99,110</u>	

Consumer price of similar home if built in Cranford by local contractor: approx. $130,000 with land. [19]

Approx. price if similar house was bought in Cranford from the secondary real estate market: $140,000. [20]

Therefore, this particular Haven home could conceivably run between 20% and 30% cheaper than the traditional alternatives available to the home buyer. The cost savings will vary depending on location. In the case of New Jersey, the further west you go, the smaller the savings. And generally speaking, the closer to New York the greater the savings. This difference is relative to real estate demand, land availability, and trade labor costs. You also must consider your proximity to the nearest distribution point. Most distributors will transport free of charge within a certain radius (varies between 50 and 100 miles).

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[19] Based on quote from William S. Drejka, Building Contractor, Garwood, New Jersey. (1,920 sq.ft. x $60/sq.ft.) April 1986.

[20] Based on multiple listing comps. and similar houses that sold in town. November 1985.

The main difference between the modular and the traditional stick-built house is in the wall sections. Glue and nailing machines make modular wall sections tighter and stronger, and through the use of jigs and fixtures, more precise.

As a further reference to the contractor costs associated with the traditional stick-built house example, refer to Appendix 3, where I have prepared a cost estimate using a design estimating software package. The cost data base, unfortunately, was from 1984. Adjust up for inflation (the costs do not include builders profit).

I have included in Appendix 1 of this book, examples of some standard options available at Haven. There were more split level options available than what is included here but you can see the various choices present just within the Winchester model.

B. Wooden "Components"

One of the most successful builders presently developing residential housing in the state of New Jersey is the K. Hovnanian Company of Red Bank, New Jersey. K. Hovnanian is a "production" builder specializing in the development of condominiums and townhouses, and their units are so popular, that they have been known to sell out a project before a single unit is completed.

The company functions predominantly as a construction management organization and has utilized various forms of systems building. At this point in time, the company feels comfortable with it's somewhat refined housing building system which basically consists of a component/panel building system. The main components of their housing system are ceiling trusses, floor trusses, and interior and exterior wall panels.[21]

While interviewing with Frank Inzinna, K. Hovnanians Vice President of Construction, I was given permission to photograph the housing system presently utilized by the company. I visited a K. Hovnanian housing development site in Bernards Township named Society Hill and present my personal photographs of their on-site systems in Appendix 2.

Through my investigation, I found the K. Hovnanian company to be a very efficient organization that operates with minimal capitalization relative to their share of the market. Their production system basically involves the management of on-site prefab assembly and the coordination of traditional type sub-contracting. Outside of service

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[21] Interview with Frank Inzinna, Vice President of Construction, K. Hovnanian Companies, Red Bank, New Jersey, March 20, 1986.

personnel, the company is strictly management and accounting. They sub-contract out all of the on-site labor and typically avoid having to deal with trade unions.

For the assembly of the prefab components, the company uses semi-skilled labor. The assembly does not require the use of a crane, and any component can be handled and positioned by two men. All of the components are numbered to correspond with numbers on the assembly plans and the operation is no more complicated than putting together a kit of parts. The assembly takes place very quickly and the resulting structure is of high quality.

There are many vendors that manufacture and sell prefabricated wooden components. Companies are located in northern New Jersey, eastern Pennsylvania, and southeastern New York. Therefore, the availability to New Jersey builders is competitive and quite economical. Frank Inzinna estimates his cost savings at between 20 and 30 percent compared to traditional on-site stick built construction.

1. Modular Application

I think there is potential in utilizing wooden prefabricated components as part of the modular housing manufacturing process. There application would be particularly an asset to the new modular housing company limited by capital restraints. A modular company such as this could start out purchasing components and assembling modules, then, after a period of growth, could begin manufacturing their own components.

I think that this usage of components for off-site modular prefabrication would be particularly economical within the state of New Jersey. To my knowledge, the are no modular housing companies presently "manufacturing" in the state, which is somewhat understandable based on the states high labor costs. But given the limited labor requirements (quality and quantity) for such assembly, in conjunction with the savings in modular transportation costs (competitive with states like Pennsylvania that ship modulars 200 - 400 miles), and it becomes clear that an operation such as this could be very successful.

IV. BUILDING SYSTEMS DESIGN ANALYSIS:

When evaluating the concept of prefabricated housing, both functional and economic analysis must be performed. The result of such analysis will first, help the builder determine the overall feasibility of prefabricated construction, and second, help him design and/or select the "system" of optimal value. Building systems analysis should be performed sequentially, where the functional requirements are determined first and the economical requirements second. A double standard exists during the analysis such that when you are determining functional requirements, economics should not be of concern, but when determining economic requirements, function must be considered.

There are many different types of building systems being used for residential housing (modular, precut, component/panelization, etc.), and within each type there are numerous production and material variations. Rather than evaluating every system on the market, it is more efficient to respond to the user requirements through the application of a design exercise.

Through this exercise it is hoped that an optimal functional design is found. If the result is functional, and through further analysis it is also determined to be the optimal economically, then the system should be put into production. But, on the other hand, if the design proves to be functional but not optimal economically, it will still be an asset, for it can be used to help make an alternative existing economical design more functional; through unit modification or system enhancement.

A. Definition of House Sub-systems

In developing your design concerns for a prefabricated residential housing system you must first determine all the building sub-systems necessary to form a complete unit ready for use.

Sub-systems required for a prefabricated residential housing unit are as follows:

1. Structure
2. Environmental Control (HVAC,etc.)
3. Enclosure
4. Plumbing
5. Space Divisions
6. Finishes (could be part of enclosure)
7. Illumination and Electrical
8. Furnishings/Appliances
9. Cabinets
10. Site Work
11. Transport, Staging, & Installation

B. Definition of Performance Requirements

Next, performance criteria needs to be determined for each sub-system. Within the scope of this paper, the structural and enclosure sub-systems are really our main concern, for they are the crux of prefabricated production and their design is the most interface provision dependent.

Building performance requirements for the structural sub-system are as follows:

1. Rigid
2. Fire resistant
3. Durable
4. Short spans
5. Enclosure support
6. Support mechanical systems (HVAC, plumbing, elec., etc.)
7. Vertical and horizontal members
8. Vibration absorber
9. Should not inhibit flow and routing of mechanicals
10. Plenum Allocation
11. Unbulky connections
12. Material compatible with interfaces

Building performance requirements for the enclosure sub-system are as follows:

1. Warm/non-institutional
2. Elastic and/or impact absorbing
3. Fire resistant
4. Thermal resistant
5. Durable
6. Smooth surface
7. Easy to clean and maintain
8. Firm weather shield
9. 30% Transparent
10. Moisture resistant
11. Able to take nail or screw (for picture hanging, etc.)
12. Material compatible with interfaces
13. Non-glare surface
14. Sound absorbing
15. Flexibility (surfaces)
16. Total Floor Requirements: 900 - 1,300 sq.ft.

C. Functional Housing System: An Idealistic Design Exercise

It is not within the scope of this paper to propose an entire systems design scheme. The intention here is to illustrate how design analysis can contribute to better meeting home user needs.

The market being addressed with this particular design proposal could be senior citizen housing. My proposal is a single story multi-family condominium housing system with four condo's per building. Two condo's form a structure which is connected to two other condo's by a common circulation breeze-way (outdoor roofed hall). On each side of the breeze-way two condo's are separated and joined by a fire wall panel system.

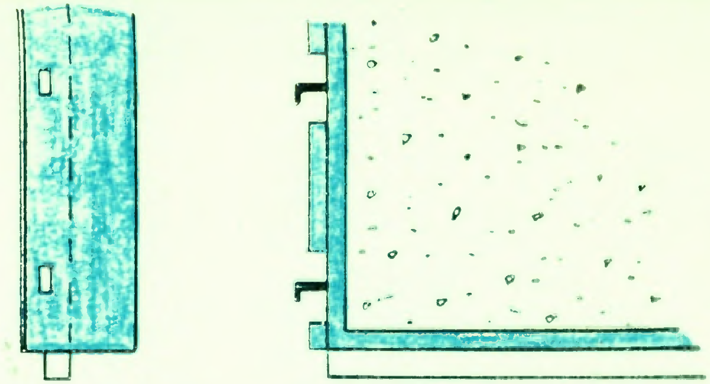
Preliminary concerns in choosing functional housing materials are: sound proofing, fire resistance, and thermal resistance. Concrete is the ideal material for meeting these concerns, but generally concrete contributes to creating an undesirable institutional character. Since one of my performance requirements is "warm/non-institutional" I choose to design a concrete wall system that allows a variety of interior wall coverings. The wall system features the use of prefabricated steel framed reinforced concrete panels. The frame is made from galvanized cold rolled steel and it functions as a stud assembly, edge protector, plenum allocator, and joining system.

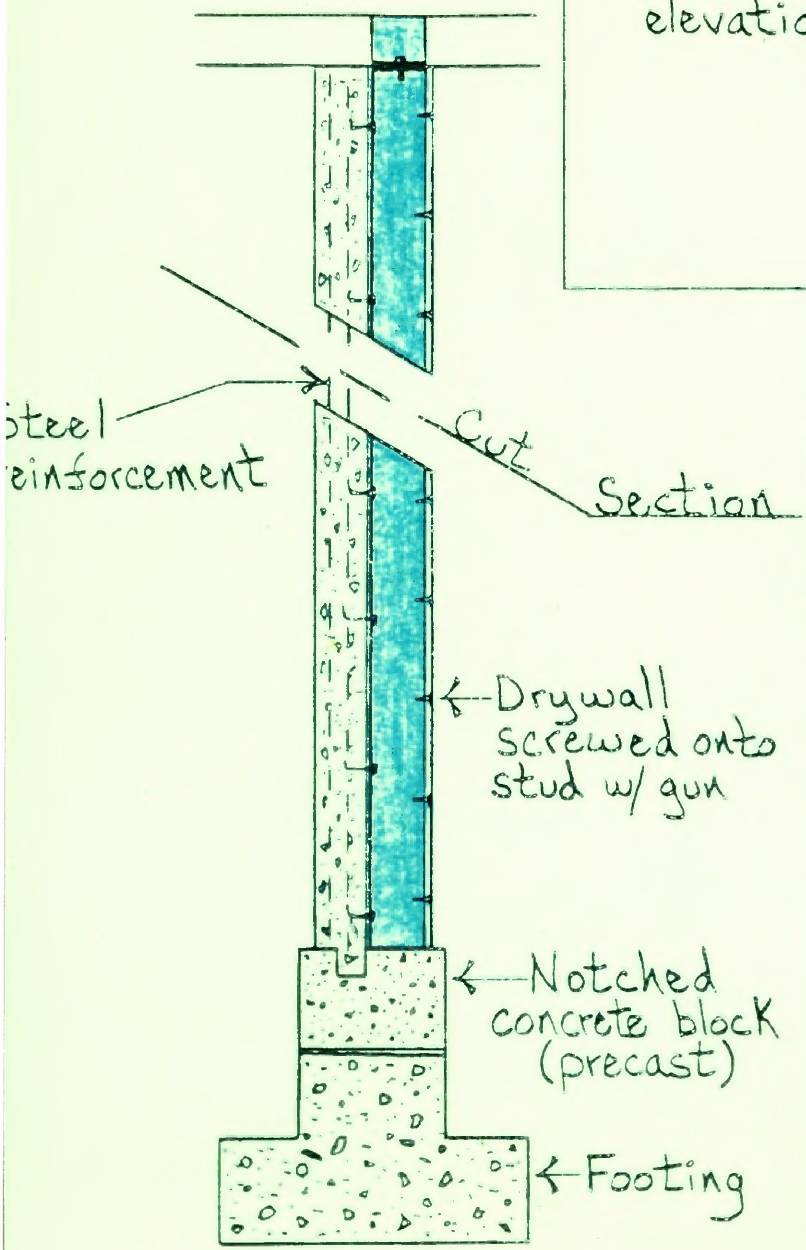
On the following pages I present detail drawings and the general specifications of my resulting functionally idealistic design proposal. The drawings illustrate the main structural characteristics of my design and also present creative rationalization and prefabrication concepts.

SECTION THROUGH DINING ROOM

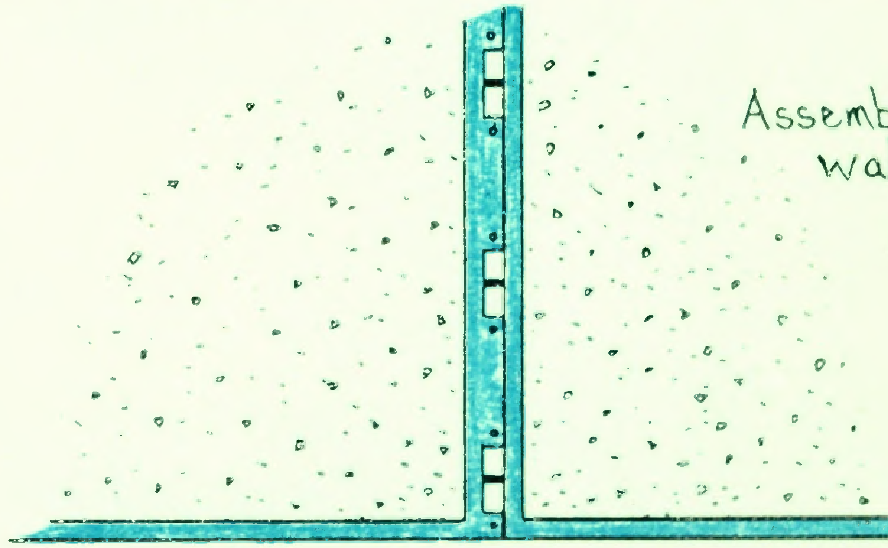
DETAILS:

Perpendicular views of panel elevations

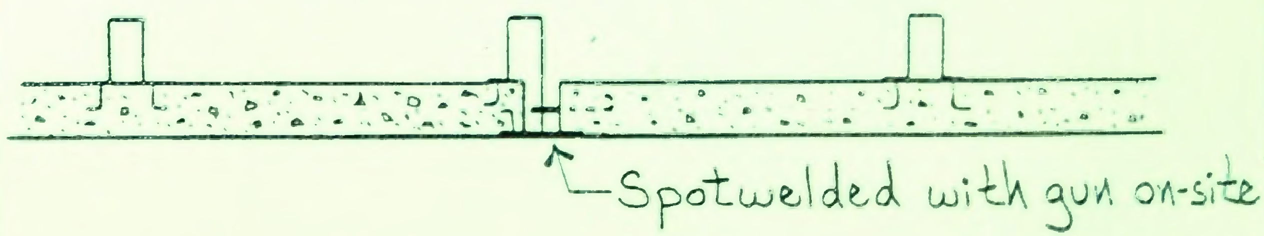




Wall Section

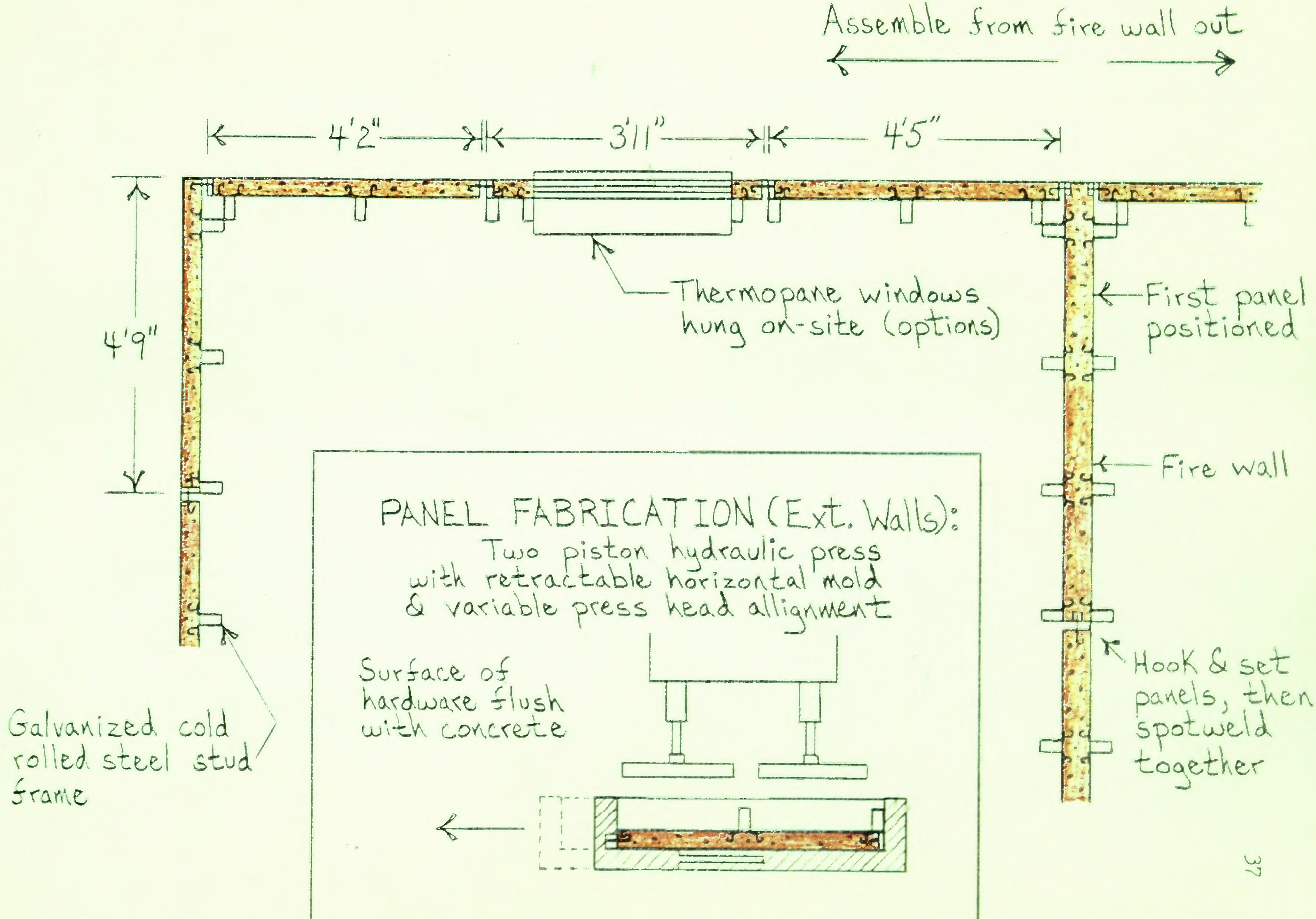


Assembled ext. wall elevation



Assembled exterior wall section

SECTIONAL PLAN (DINING ROOM)



STRUCTURAL SUB-SYSTEM

GENERAL SPECIFICATIONS:

Steel-framed Concrete Wall Panels (Prefab)

Standard Exterior:	Reinforced	concrete:	3"x 3'11" x 9'
Corner Wall Panels:			
Perpendicular to firewall	"	"	3"x 4'2" x 9'
Parallel to firewall	"	"	3"x 4'9" x 9'
Firewall Interface Panel	"	"	3"x 4'5" x 9'
Window & Sandwiched Panels	"	"	3"x 3'11"x 9'

Panel Thickness (including stud framing): 7"

* Steel Stud & frame assemblies fabricated from cold rolled galvanized steel sheets & fastened to concrete with stirrups. All studs 24" off center.

Steel-framed Fire Wall Concrete Panels (Prefab)

Standard Panel:	Reinforced	concrete:	5"x 5'11"x 13'
End Wall Panels:	"	"	5"x 6'9" x 13'

Panel Thickness (including stud framing): 13"

Continuously Notched Precast Concrete Blocks
8" thick below exterior walls
9" thick below fire walls

Concrete floor on grade (Formed on-site)
5" reinforced concrete slab above 4" crushed stone and firmly compact soil.

Concrete Footings (Formed on-site)
8" thick continuous reinforced concrete footing below exterior walls.
9" thick continuous reinforced concrete footing below fire walls.

Wood Roof Trusses (Prefab)
Components of assembly fastened with gang nail plates.
Component members 2"x 3" and 2"x 4" depending on span.

The panels are kept relatively small to allow a variety of floor plans and ease in transport. The panels could be stacked on fork-lift pallets (skids) for transport and may require the use of a small crane once on-site.

Off-site in the fabrication plant, the steel stud-frame assembly is set into a production mold, reinforcing wire mesh is placed, then freshly mixed (wet) concrete is poured into the mold. Next, a two or three piston (depending on panel type) horizontal hydraulic press is used to compress, form, vibrate, cure, and dry the complete panel. A two piston press would be used for exterior wall panels and a three piston press would be used for fire wall panels.

On site, the panels are hooked together while being set into precast notched concrete foundation blocks. The panels are then spot welded together using a portable spot welding gun. Next, the prefab wood ceiling joists are bolted to plates and insulated roofing panels are screwed in place. Grout and moisture barrier are placed in wall joints, windows and doors are hung, plumbing and electrical are installed, insulation is placed, vapor barrier is applied, the interior wall system is screwed onto the studs using a portable screw gun, etc.

The gauge (thickness) of the sheet metal studs is thin enough to allow easy penetration into the stud with screw gun, but, is thick enough to take abuse without denting or deforming during transport and positioning.

The panel system is somewhat unique and is really the crux of this prefabricated system. The ends of each panel are complicated welded assemblies, therefore, the wider the panel, the lower the cost per perimeter foot. Since cost does not have to be justified within this design exercise, I decided to allow alot of flexibility by incorporating a relatively small panel width (approx. 4'-6').

You start the on-site wall assembly process by positioning an end fire wall panel into the notched sill and then hooking an exterior wall panel to each side of the fire wall panel. At this point the walls would hold themselves up and could then be spotwelded together. The wall assembly process would now continue in a direction away from the end firewall panel; hooking and spotwelding one panel at a time.

It is not within the scope of this thesis to evaluate the economics of this particular functional building system, for it would involve too much speculation regarding manufacturing methods and techniques. To accurately determine the economics of this design, a prototype unit would have to be built, developed, and refined.

On the following page I have prepared an evaluation matrix which compares the functional performance response of my design to the functional performance of a traditional stick-built design. The value indicated by the legend represents "functional value."

DESIGN EVALUATION MATRIX

Value Legend: ++ = Excellent
+ = Good
o = Satisfactory
− = Poor

PERFORMANCE CRITERIA	MY DESIGN	TRADITIONAL STICK-BUILT
STRUCTURAL PERFORMANCE		
Rigid	++	+
Fire resistant	++	o
Sound absorbing	++	−
Durable	++	+
Vibration absorber	++	−
Enclosure support	++	+
Support mechanical systems (HVAC, plumbing, elec., etc.)	+	+
Plenum Allocation	+	+
ENCLOSURE PERFORMANCE		
Warm/non-institutional	+	++
Impact absorbing	++	o
Fire resistant	++	o
Thermal resistant	+	+
Sound Proof	++	o
Firm weather shield	+	+
Moisture resistant	+	+
Flexibility (surfaces)	+	+

The primary purpose of this design exercise was to introduce the concept of building systems design analysis, and to demonstrate its functional application.

V. OPERATION CONSIDERATIONS

The type of operation required by a residential systems builder varies with the type of market he is addressing, the type of building system he wishes to manage, and the amount of capital at his disposal.

In using a systems approach to residential building construction one should be concerned with utilizing an economical balance of prefabrication techniques (within an off-site manufacturing environment) and rationalization techniques (on-site assembly). A practical goal would be to incorporate a production system that will provide an aesthetic dwelling at an affordable price.

A. National, State, and Local Codes

In planning the use or manufacture of prefabricated housing systems, one must keep abreast of the dynamic codes governing the manufacture, transport, and erection of prefabricated housing systems. For through thorough examination of the codes affecting a certain area, one may find limiting restrictions as well as encouraging benefits to certain types of prefabricated housing.

Just in terms of building codes, the prefabricated housing builder will be operating under at least one of three regional codes: International Conference of Building Officials (ICBO); Building Officials and Code Administrators (BOCA); and the Southern Building Code Congress (SBCC). In addition, there is FHA, one or more of the state codes, and innumerable local codes or local variations of the regional codes.[22]

Building codes are commonly accused of being archaic, unchanging and rigid. Certainly this has long been the case in their application against prefabricated housing, but yet, in recent years, national and state codes have become encouraging.

It is typically the local codes that pose a problem for prefabricated housing construction and, being of low level, should not inhibit the manufacturer, but should be of particular interest to the consumer or developer. A systems developer up against an unreasonable local code or zoning, will find it a frustrating dilemma, but he can always apply for a variance, appeal to the state, or, if worse comes to worse, sue the municipality.

Residential building codes are merely standards of performance which are actually designed to benefit the consumer by insuring safe and sanitary housing. The problem

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[22] R.J. Lytle, Industrialized Builders Handbook (Farmington: Structures Publishing Co., 1971), page xi.

with local codes though, is that they're not uniform, they're inconsistent, and are often contradictory. Unfortunately, alot of the problems with local codes are due to political motive or a general misconception of prefabricated housing.

The housing system "manufacturer" should be concerned with meeting national and state building codes, since these codes are typically the basis for the local codes, and because national and state codes are the codes that officially regulate the manufacturers operation. Within the state of New Jersey, the manufacturer needs to focus on the BOCA codes and the New Jersey Uniform Construction Code.

The BOCA code is general and, with respect to the prefabricated manufacturer, focuses on the application of mobile housing. BOCA is primarily concerned with plant inspections, item documentation, and item evaluation. [23] The New Jersey Uniform Construction Code (an extension of BOCA) is more specific, and has sections which outline detailed rules and regulations governing the inspection, documentation, storage, transportation, and approval of

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[23] BOCA Publication, The BOCA Basic National Building Code/1984, (Country Club Hills: Building Officials and Code Administrators, Inc., 1983), page 12.

prefabricated components and subassemblies.[24]

Other sets of codes the manufacturer must consider are the HUD and FHA type codes, which enable reputable consumer financing. For example, in order to qualify for the popular Fannie Mae mortgage, a home must be built to HUD code, be installed on a Fannie Mae-approved permanent foundation system, must be a minimum of 700 square feet and at least 12 feet wide. The home must also look like residential property and be comparable to site-built housing in the marketplace.[25]

If one is considering the use or manufacture of large prefabricated housing systems (modulars, etc.), it is important to be aware of the state highway restrictions associated with unit transport. In New Jersey for instance, a unit being transported on a public highway cannot, without a permit, exceed the dimensions: 8 feet wide by 63 feet long by 13.5 feet high. Fourteen feet is the most common modular width coming into New Jersey; anything beyond a 14 foot width will result in a State penalty fee.

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[24] State of New Jersey Publication, Uniform Construction Code, Chapter 23, Title 5, (Trenton: Division of Administrative Procedure, 1979) page 484.1 - 491.

[25] Craig E. White, "The Right Financing Can Make A Project," Professional Builder, August 1985, page 70.

A permit can be easily obtained through a phone call to the Division of Motor Vehicles; Special Permits Section.[26]

It is important to note that the New Jersey state code encourages innovation and economy, and states in the Uniform Construction Code that it "permits to the fullest extent feasible, the use of modern technical methods, devices and improvements, including premanufactured systems," and intends to "eliminate restrictive, obsolete, conflicting and unnecessary construction regulations that tend to unnecessarily retard the use of new materials, products or methods of construction." This declaration is not only a benefit for building codes, but should also help to encourage the change of inappropriate local codes and zoning.

For the prefabricated housing builder, dealing with code restrictions can be one big nuisance. And even though governmental efforts have been made to encourage the use of prefabricated housing, enough has not yet been done to solve the problem. What is needed is the mandatory acceptance in all parts of the country, of a National Housing Code with specific provisions for prefabricated housing systems.

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[26] Telephone Interview with Special Permits Section, Division of Motor Vehicles, Trenton, N.J., March 14, 1986.

B. Plant Design and Human Factors

One of the major obstacles in recommending industrialized housing as an alternative to traditional on-site construction, is the monotonous character associated with the manufacturing environment. When given a choice between working on-site or in a factory, a worker may very well prefer the less strict on-site environment.

The entrepreneur going into the manufacturing end of the prefabricated housing business must be concerned with attracting the best possible labor force available, and therefore, when considering his plant operation, must try to create an attractive humane environment.

Recently, labor relations personnel as well as social scientists have become more and more concerned with humanizing the industrial environment.[27] They point out that management needs to begin focusing on the industrial organization as a social system; where employees are no longer just factors of production, but are people with valuable ideas and potential. In particular they are striving to increase communication, interaction, and team effort within the plant. They site the importance of

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[27] Keith Davis, Human Relation at Work (New York: McGraw-Hill Book Company, 1967)

trying to satisfy some of the employees basic human needs. They also emphasize the significance of effective human relations within the plant environment and site it's potential to relieve tensions, improve motivation, and increase productivity.

Through my study of existing plant layout schemes, I have continually noticed related problems in their spatial organization. Most layouts are primarily concerned with the flow of work and have little or no concern for it's human inhabitants. The majority of plant designs are over-structured functional layouts which claim to strive for economical efficiency, while in reality are in some respects, very uneconomical in terms of labor costs and productivity. As a systems design student, I see this issue as a challenging design problem. The industrial plant is a social system as well as an economic system and I feel it should be designed as such.

While I was an undergraduate student, I proposed a plant design concept that tries to deal with this problem by promoting "team effort" within the factory. I think this design concept is relative to manufacturing housing systems because the operating success of prefab manufacturers is greatly dependent on cooperative effort.

I present my idealistic community space design concept in Appendix 4. This design is not intended to illustrate a prefabricated housing plant, but is intended to illustrate a prototypical human factors design concept that could conceivably be incorporated into any manufacturing environment. The drawings are not to scale and are only intended to demonstrate spatial relationships. To apply this design to a real manufacturing environment, you would obviously have to dramatically increase the production area. To be realistic, the production area would roughly, be multiplied by four, and all other spaces, including the community space, multiplied by two.

C. Computer Applications

One of the most significant advantages to prefabricated housing is the cost control that one can accomplish within the manufacturing environment. Such control advantages can be particularly enhanced by the use of computerized production control database systems. The companies that I investigated all use computers to some extent but their applications were limited to simple cost accounting functions.

The computer has various economic application within the prefabricated housing industry. The ideal system would be one which incorporates the interaction between Production Management, Cost Accounting, Computer Aided Design (CAD), Computer Aided Manufacture (CAM), and Design Estimating.

Theoretically this type of interactive system could contribute to significant cost savings, but theory and reality can sometimes be far apart. The system will only be successful if it generates accurate, timely, relevant, and concise information.

Computer implementers can sometimes be a little too optimistic. When planning any computer system one must be very careful in choosing hardware, software, and personnel. But given that you chose the right system the main obstacle is obtaining information accuracy.

Limitations are inherent in any data base system due to input errors. It is important to have good online editing during input. It is also appropriate to have a responsible supervisor review the data prior to being batched. Input could be entered in batch or directly online.

If large volumes of data are entered daily (greater than 100 records per sitting), transactions should be separated by application into batches of like significance. This will make it easier for processing, error correction, and input verification.

A proven software package that has been on the market a number of years should be completely debugged by the time you purchase it and will typically perform based on standard practices. Errors in accuracy are seldom caused by programming but are predominantly due to bad input data.

1. Design Estimator: A Systems Building Estimating Package (Critique)

The Design Estimator Package from Dodge MicroSystems is a design tool for estimating the approximate cost of "systems oriented" building types. The system requires the input of percentage and profile data broken down by building component category. Each category falls within a standard building subsystem (Exterior Wall, Roof Structure, partitions, etc.). After filling out the data sheets and entering the information, you process the data against a standard labor and material database (See Appendix 3).

On page 1-1 of the Design Estimator Manual the documentation claims to incorporate the ideas of modular building construction, although the direct costs are based on traditional labor intensive building construction techniques. [28]

The package is not accurate for estimating "Non-Standard" or unique buildings. Design Estimator could be helpful for certain types of "pre-engineered" buildings but, in the case of manufactured housing you would have to at least override the labor costs. Though for manufactured

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[28] Dodge Microsystems Publication, Design Estimator: Building Design Estimating System, (McGraw Hill, 1984)

housing, even with the overrides, material costs would be exaggerated and on-site equipment costs would be in error.

Using the Design estimator is a good orientation to systems concepts and is a good introduction to common sub-system catagorization and consideration. To help illustrate this systems oriented estimating software package, I used the package to estimate the cost of a traditonal split-level residential house, similar to the Haven Winchester plan "A" presented in chapter III. The resulting estimate was a fairly good ball park cost but the output shows little detail. The package is so general in fact that it doesn't even consider stairways. I could have included the stairwells as write-in components but seeing how general the package is I feel that it's cost will balance into the total (+ cost of floor area - cost of stairs).

2. Computerized Modular Manufacturing In Japan

There are a couple of large Japanese modular housing Companies that have perfected the usage of computerized housing systems. Sekisui Heim Company and Daiwa House Company have modular housing manufacturing systems that integrate CAD (Computer Aided Design) with Sales and Order Control. This connection provides the companies with an interface to Production Management and Cost Accounting applications, and basically permits the monitoring and control of the prefabricated house from customer ordering through to on-site assembly.

Daiwa House Company, Japan's third-largest prefab maker after Misawa Company and Sekisui Company, uses computer graphics in their walk-in sales offices to let a buyer help design his own house. The buyer sits alongside a Daiwa sales technician in front of a terminal that displays in plan, elevation, and three dimensions, any one of the Companies standard houses. If the buyer wants to see what the house would look like if the living room were enlarged or the style of roof changed, the sales technician would just finger the keyboard, and in a few seconds a modified version would appear on the screen along with the new adjusted costs. [29]

In the case of house additions, both Daiwa and Sekisui access standard options from their data base (roofs, bedrooms, bathrooms, kitchens, etc.), and the computer system automatically modifies the specifications of an option to interface and join the main body of the house.

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[29] Lee Smith, "Now Japan Moves Ahead In Prefabs," Fortune, 17 October 1983, page 162.

If the new cost figure for extra options is determined by the customer to be over his budget, he can subtract square footage from a room or remove and option and the computer will again modify the house and calculate the new cost.

At the Sekisui Company, when the customer has finished his design, the sales technician just presses a button and the printer next to him runs off a house portfolio which consists of: three-dimensional drawings of the house viewed from eight different perspectives; detailed floor and foundation plans; a construction schedule; and, of course, an estimate. The house order, with modifications, automatically goes out to a regional factory. There it is processed and sent down to the factory floor. The equivalent of a completed house in the form of room-sized modular units, with windows, doors, and plumbing installed, comes off the production line only a few hours later.[30]

By their size alone the Japanese modular builders are intimidating. Misawa Homes produces about 25,000 prefabricated single-family homes a year, Sekisui about 23,000. Three other Japanese companies make between 9,000 and 12,000. While the largest American builder, U.S. Home

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[30] Tim Onosko, "Digitized Dream Dwelling," Omni, June 1985, page 54.

Corp., produces about 12,600 homes a year.[31]

The modular homes made by the Japanese range in materials and construction and include: wood stick-frame, steel frame and concrete, and ceramic modules. Thousands of Japanese are continuously ordering these new-tech, prefabricated homes. By the year 2000 these same homes, designed by computers and built by robots in Japan, may be as common along the sidewalks of U.S. towns as Toyotas and Datsuns are on our streets.

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[31] Lee Smith, page 162.

VII. CONCLUSION

It is not the purpose of this paper to recommend all prefabricated housing over traditional labor intensive. My intention was to introduce prefabricated housing and to present the particular character and economy of specific systems building applications.

As mentioned, the economy associated with any housing system can only be determined through careful evaluation of many variables. And, even though the companies I investigated are quite successful, their success is in part due to the recent demand for economical residential housing. Without demand as such, the companies might not have enough orders to create their necessary "economies of scale." Traditional labor intensive with its low overhead is more flexible in dealing with shifts in construction demand.

Nevertheless, since the demand for housing in the United States is expected to be constant for quite some time, and since prefabricated housing is becoming more attractive to both the consumer and the builder, it is certain that the number of prefabricated housing manufacturers will continue to grow. And without question, the intriguing market challenge for the industry's future will be to see which manufacturers are successful in distributing their product to both tiers of this market.

In the long run, I see a special growth market for prefabs in rural housing. On-site stick builders incur extra costs in transporting materials and workers to isolated single-house sites. Here prefabs have an edge that they don't have at sites where the builder is putting up several houses.

Overall, a positive sign for the future of prefabricated housing in the U.S. is that big on-site builders are begining to move into the prefab market. In 1983, for instance, U.S. Home Corp., the largest on-site builder of them all, acquired Interstate Homes Inc., a Salt Lake City company that is the number five builder of modulars.[32]

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[32] Susan Franker, "Prefabs Are Beginning To Get It Together In The U.S. Too," Fortune, 17 October 1983, page 171.

APPENDIX 1

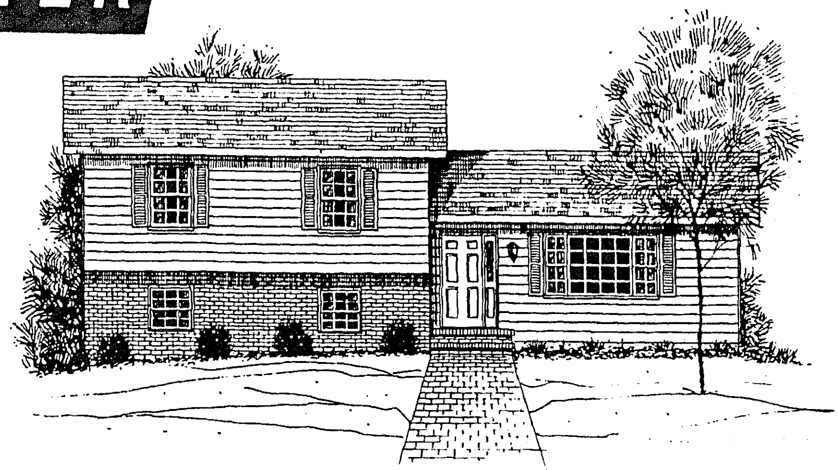
"MODULAR" HOME EXAMPLES

SAMPLE OPTIONS AND SPECIFICATIONS

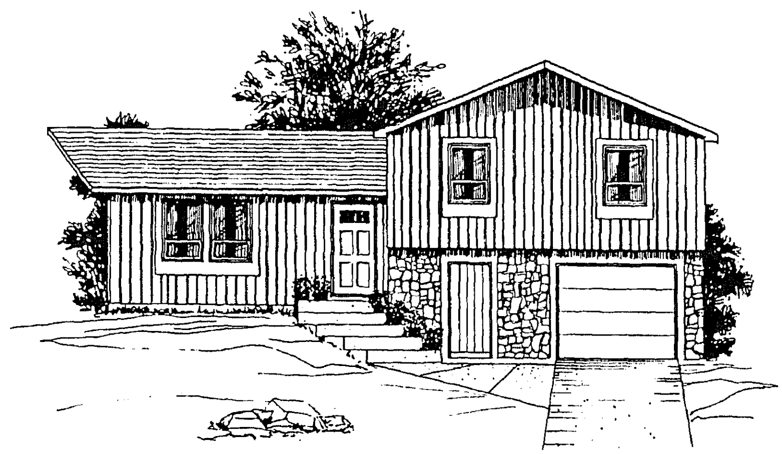
FROM HAVEN HOMES

* Includes drawings and spec's of the "Winchester A" example discussed in chapter III.

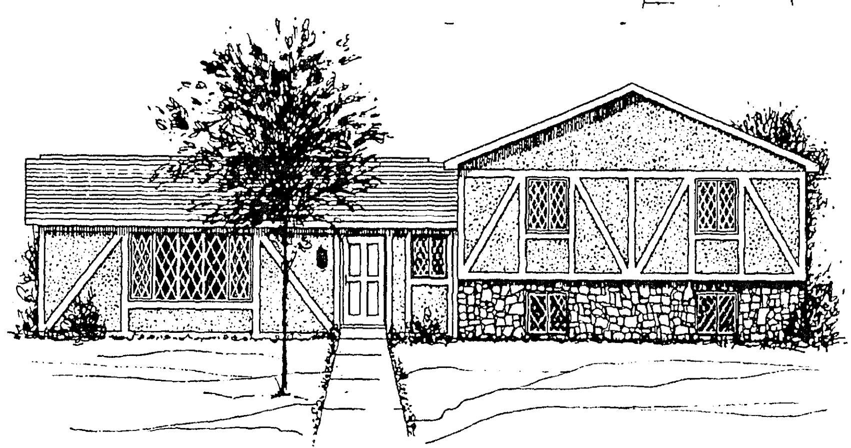
WINCHESTER



COLONIAL

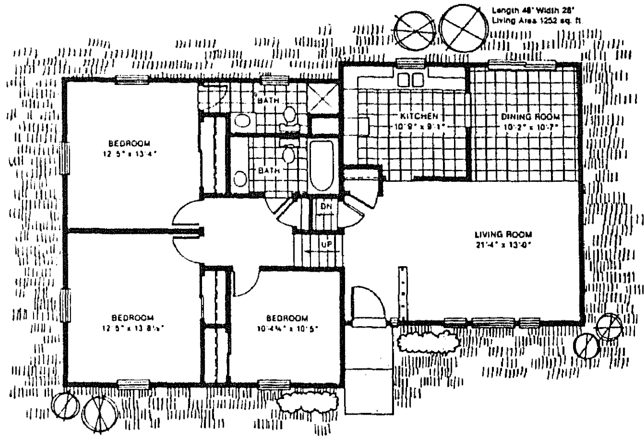


PROW,
MODERN

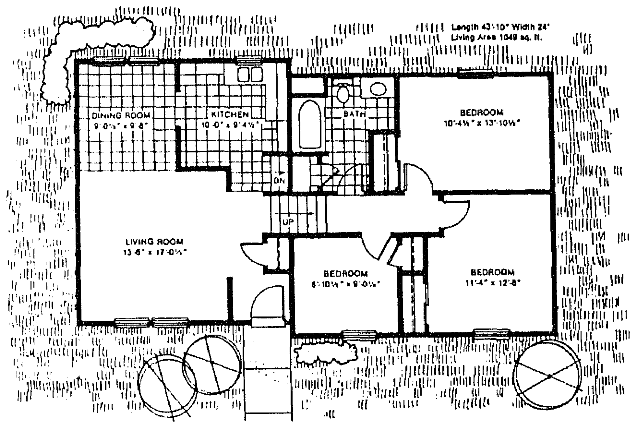


TUDOR

Haven Homes, Inc.



A.



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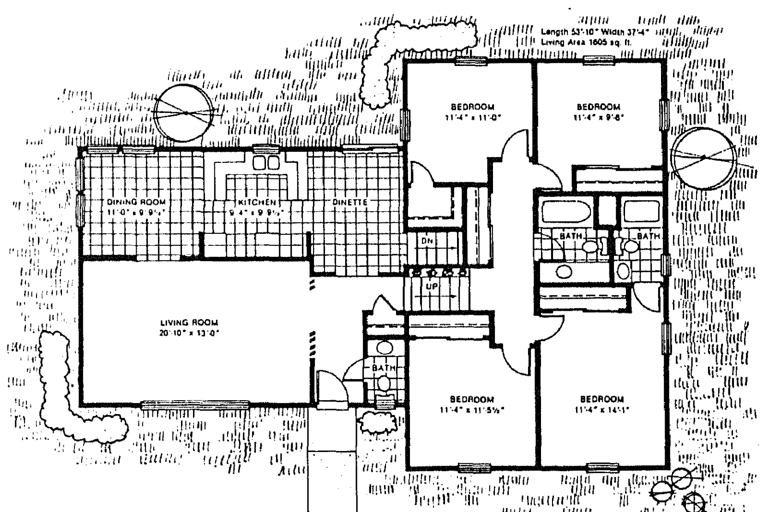


C.

PHONE 717 / 962-2111

Haven Homes, Inc. P. O. BOX 178, BEECH CREEK, PENNSYLVANIA 16822

STANDARD SPECIFICATION SHEET FOR WINCHESTER, JAMESTOWN & HERITAGE MODELS

GENERAL:

See Literature
Expandable in 2' Increments
Ceiling HGT- 7'6" except Cathedral Areas
5/12 Pitch Std.

FLOORS:

Double Floor Construction
 1 Layer ½" Ply Underlayment
 1 Layer 7/6" O.S. Board
 Glued & Nailed
2X8 Floor Joists 16" O.C.
Metal Cross Bridging
R-19 Insulation Shipped Loose
Single 2" X 10" Perimeter Box
 Triple 2 X10 under each half
 Total 6-2X10 form Center Beam

WALLS:

½" Sheetrock throughout taped & Prime Coated Off-White
Sheetrock Glued & Nailed to Studs
Painted Walls & Trim
3/8" Plywood Exterior Sheathing
Sheathing locked to floor and plates
Sheathing glued 4' up walls
R-19 Insulation in Exterior Walls

INSULATION:

Ceilings 12" R-38
Walls 3½" Fiberglass, R-13 W/Vapor Barrier & 3/4" Styrofoam
Floors 6" R-19 W/Vapor Barrier
Sill Sealer - 3/4" X 6" - By Builder
Energy Insulation PAckages Standard

VENTILATION:

Soffit Vented on all Four Sides
Ridge-Vent is Standard

WIRING:

Grounded Electrical System
200 Amp Circuit Breaker Panel
Smoke Detector
Ground Fault Circuit Wired to National Electric Code
2 Exterior Receptacles
Elec. Baseboard Heat System W/ Double Pole Thermostats
Devices U.L. Approved
Door Bell Standard
Lighting- Kitchen, Dining & at Exterior Doors
Pa., New Jersey, New York, Connecticut, Vermont, Delaware, Maine, W. Va., Va. & Maryland State Approval
FmHa, FHA, & VA Approved
PFS 3RD Party Inspection

ROOF AND CEILINGS:

2X6 Roof Rafters & Ceiling Joists spaced 16" on centers
½" Sheetrock on ceilings, taped & prime coated Off-White
Cathedral Ceilings in Living, Dining & Kitchen Areas/Per Plan
½" Plywood Roof Sheathing
15# Felt Underlay
Aluminum Soffit System
235# Self Seal Fiberglass Shingles
Aluminum Drip Edge
10 3/4" Overhang Front & Rear, 16" on Ends

SIDING & WINDOWS:

Andersen Norrowline Perma Shield Double Hung W/Screens
Insulated Aluminum Siding 8" W/Backer or D/4 Vinyl Siding
Siding installed W/Aluminum Nails
Interior Window Trim Painted 2 Coats
Shutters Front Only
Aluminum Soffit
Storm Windows or High Performance Glass Available
Casement or Awning Windows Available

"Built by men of Experience"

3/85

PHONE 717/962-2111

Haven Homes, Inc. P. O. BOX 178, BEECH CREEK, PENNSYLVANIA 16822

DOORS:

3/0 X 6/8 Foam Core Metal Clad Front Door
2/8 X 6/8 W/Glass & Foam Core for Kitchen
6/0 X 6/8 Thermal Break Patio Door as shown on plan
Others Available

PLUMBING:

Single Acting Faucets in Kitchen
Fiberglass Bath Tub
High Pressure Post Formed Laminated Vanity
Reverse Trap & Water Saving Commode
52 Gallon Hot Water Heater, Energy Saver
3" Main Soil Line - ABS
½" Water Supply Lines, Copper
1½" Fixture Drain- ABS

PASSAGE SET:

Exterior Door Hardware
Bathroom & Master Bedroom shall have Privacy Sets
All other Interior Doors shall have a passage set.

LAVATORY FIXTURES:

60" Fiberglass Shower/Tub
20 X 17 China Sink
1 Water Closet
Combination Exhaust & Light
Mirror & Cosmetic Box & Light
Optional- 3/4 Bath W/Shower

KITCHEN FIXTURES:

Double Bowl Stainless Steel Sink W/Faucet
Vented Kitchen Range Hood 30"
High Pressure Post Formed Laminated Countertop
Cabinets - All Wood

INTERIOR FLOORS:

100% Nylon Continuous Filament Carpeting
Linoleum- Kitchem, Bath & Dining Room
Vermont Slate Foyer Area Optional except on Heritage & Winchesters

TRIM:

Wood Beams are Optional in the Cathedral Ceilings
Center Beam always remains white Drywall

HEAT:

Electric Baseboard is standard
Oil or Gas Hot Air Heat is Available, as well as Oil or Gas Hot Water Baseboard

FOYER MODELS:

Landing W/Slate Foyer and Door W/2 Sidelites Standard.
Other Options Available on Request

TURN KEY FOUNDATION PACKAGE

	PA	N. NJ	S. NJ
FULL FOUNDATION 24X40			
min. of 7'2" high			
sealer to grade			
concrete floor			
4 - 16 X 32 Anderson windows			
EXTERIOR ENTRANCE			
steel bilco doors with precast concrete steps			
BASEMENT STEPS			
wood steps from house to basement			
FRONT STEPS			
precast concrete steps, 21" high, attached to foundation where possible, with aluminum rail			
BACK STEPS DECK			
10' x 10' patio deck with rail			
steps to ground level			
treated wood - not stained			
ELECTRIC CONNECTION			
electric service installation			
4 lights in basement			
wire for electric dryer and washer			
PLUMBING CONNECTION			
hot,cold and sewer line connection			
plumbing for washer in basement			
DOES NOT INCLUDE plumbing outside of foundation wall			
EXCAVATION			
dig and backfill foundation			
water line up to 75'			
driveway up to 50'			
stone under concrete floor			
rough grade around house			
footer drains	NONE		
DOES NOT INCLUDE blasting or pumping			
TOTAL COST FOR 24X40 FOUNDATION PACKAGE:	$12,629	$17,331	$19,064

PHONE 717 / 962-2111

Haven Homes, Inc. P. O. BOX 178, BEECH CREEK, PENNSYLVANIA 16822

Thank you for your interest in Haven Homes Inc. Enclosed you will find our most recent literature on our homes. I would like to point out however that 95% of the homes we build are built to customer specifications. This gives you , the dealer, a tremendous amount of flexibility when trying to provide for your customers' wants.

After reviewing our literature, please feel free to call me in regard to prices and options anytime. I look forward to hearing from you in the near future and thank you again for your interest in Haven Homes.

Sincerely,

Rick

Frederick G. Terry III

BUS (717) 962-2111 RES. (717) 726-3646

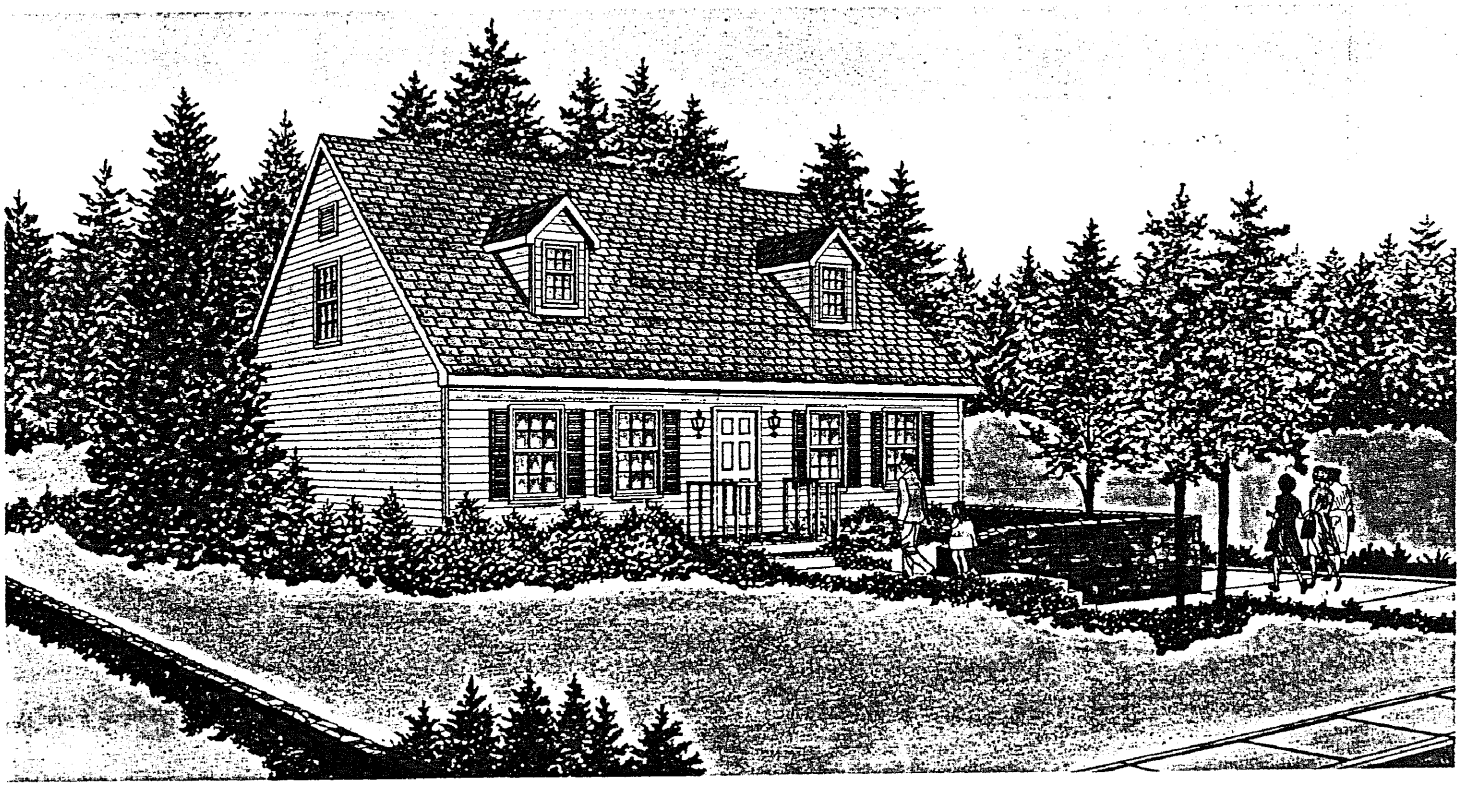
Haven Homes, Inc.

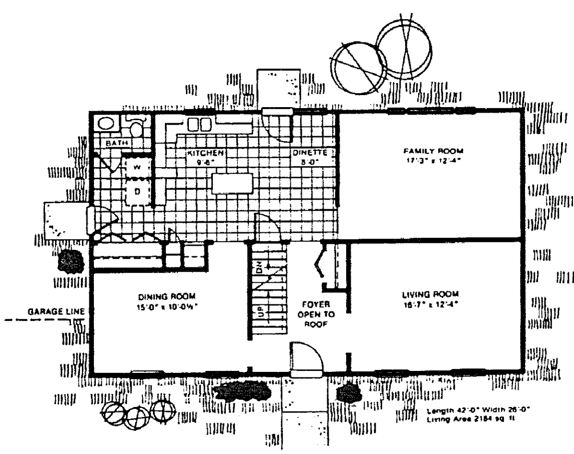
"Built by men of Experience"

FREDERICK G. TERRY III
SALES REPRESENTATIVE

ROUTE 150
BEECH CREEK, PA 16822

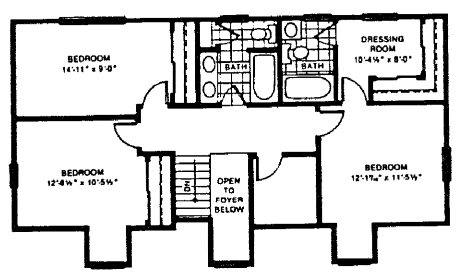
CAPE COD





THE CAPE COD

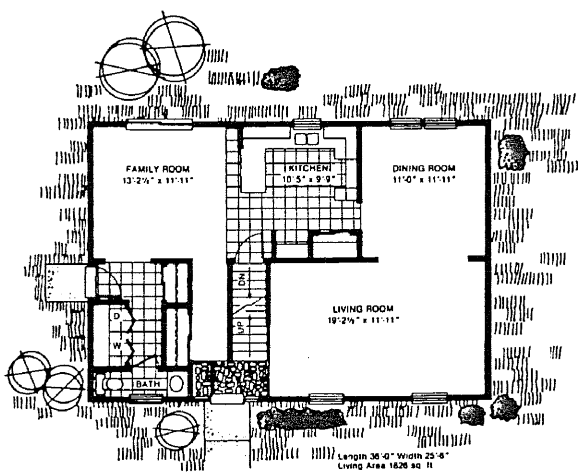
Enjoy the best of both worlds!



The authentic Cape Cod is both practical and charming. Another of our growing expandable homes. This traditional story-and-a-half home is designed with efficient traffic patterns and offers maximum liveability at minimum cost with the possibility of future expansion. Ideal for the young newly weds. Optional full shed dormers on the rear with traditional gable dormers on the front provide a touch of elegance on the compact home. The choice is yours.

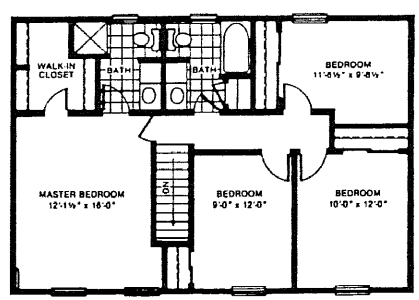
- Formal Living Room
- Two Bedrooms — Expandable to Four
- One Bath — Expandable to Two or Three
- Formal Dining or Family Kitchens
- Closet and Storage Space
- Entry Foyers Available

BEDFORD



BEDFORD SERIES

Two Story Colonials



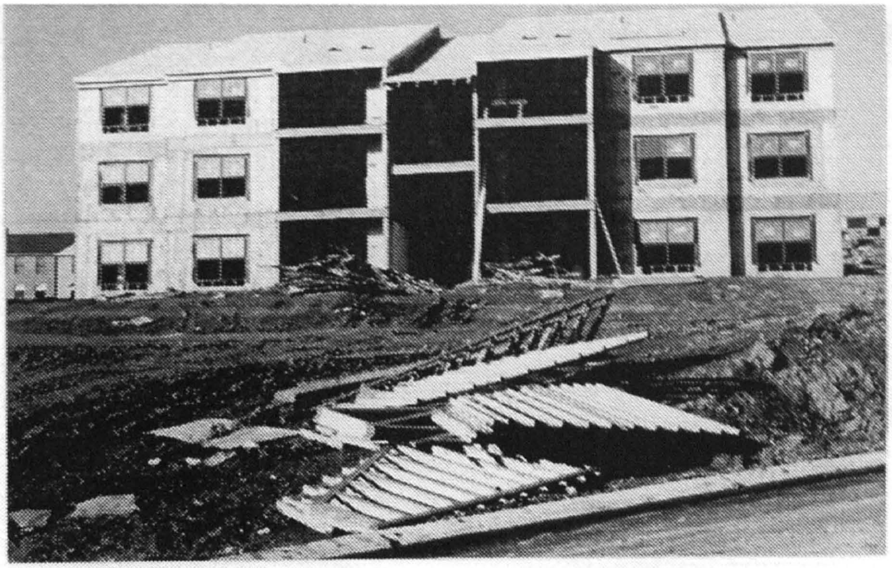
These prestigeous homes will never lose their appeal for those who truly appreciate these rich classical colonial designs. This home features two full stories for maximum living space. An abundance of windows, formal colonial entrances, formal dining, formal living rooms and spacious kitchens! and baths make this Haven Home an exceptional value which will provide spaciousness and comfort for many years.

- Formal Living Room
- Formal dining with Eat at Family Bar
- 2½ Baths w/Built in Vanities
- Master Bedroom with Private Bath
- Large Closets — Utility and Storage Space
- Formal Entry Foyer

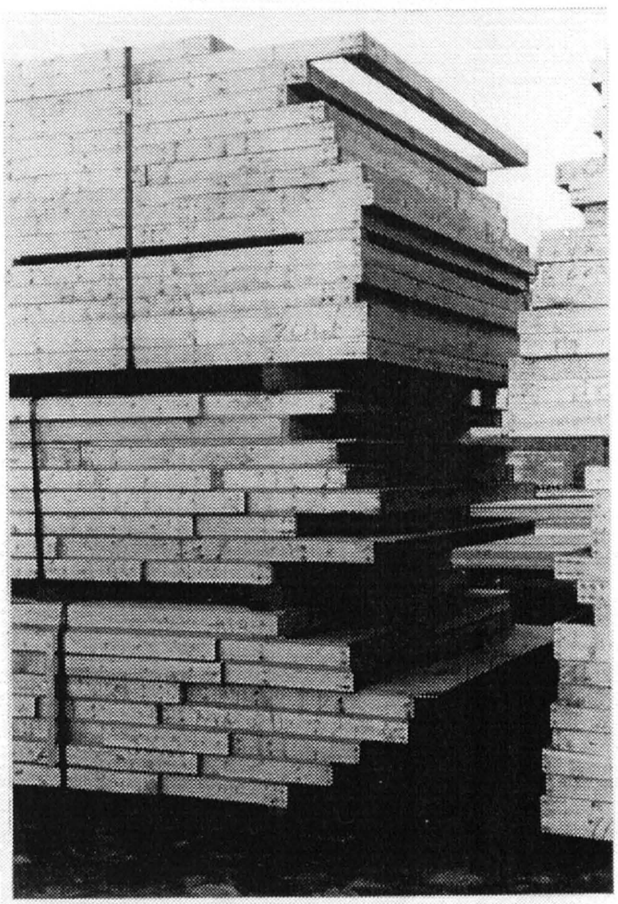
APPENDIX 2

EXAMPLES OF PREFABRICATED "COMPONENTS"

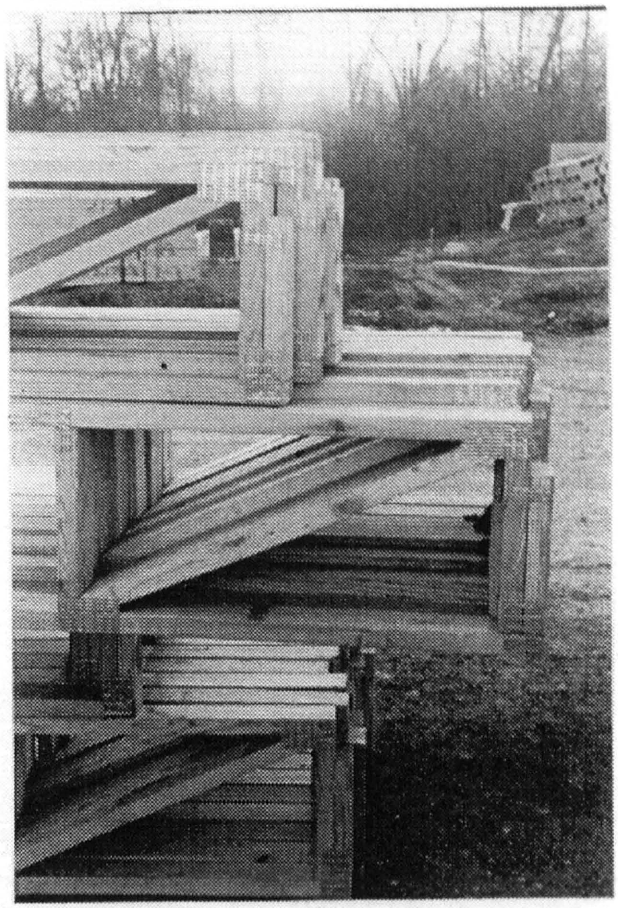
PHOTOGRAPHS OF THE COMPONENT ORIENTED
PREFAB SYSTEM USED BY THE K. HOVNANIAN COMPANY



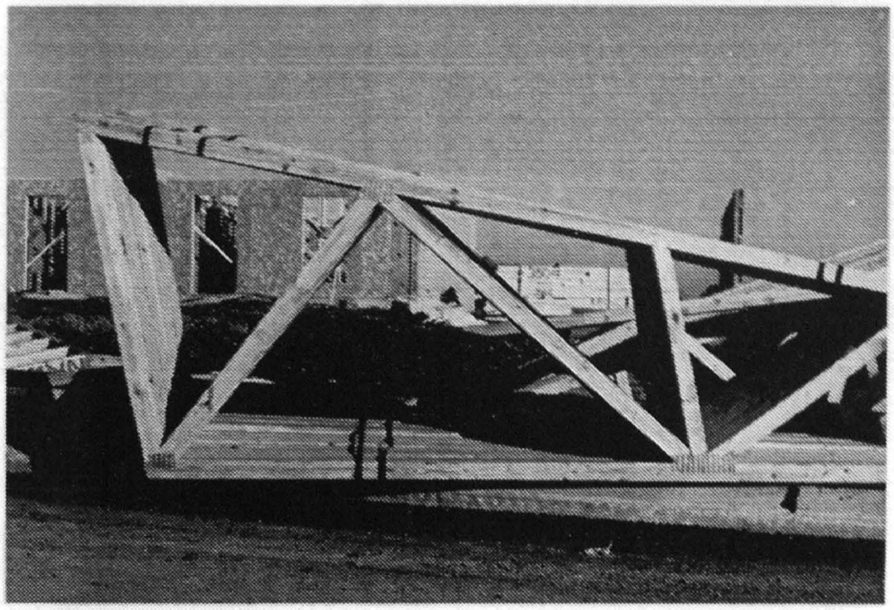
Assembled Condominium Units



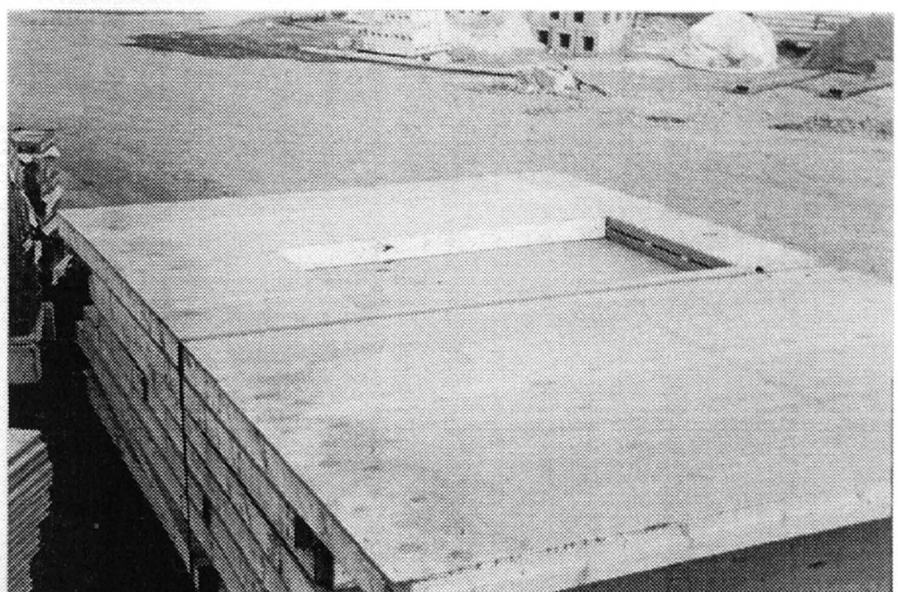
Interior & Exterior Wall Panels Stacked On Fork-Lift Pallots



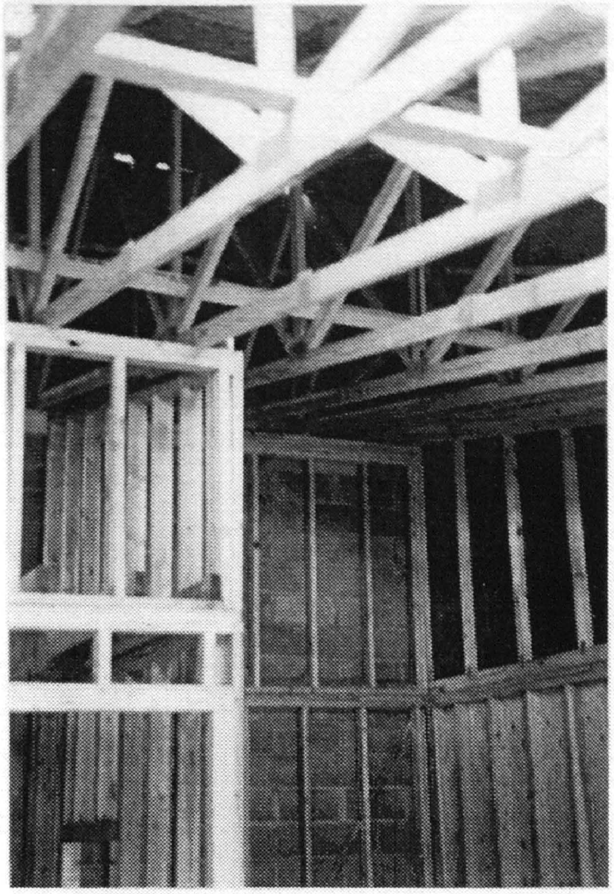
Floor Trusses



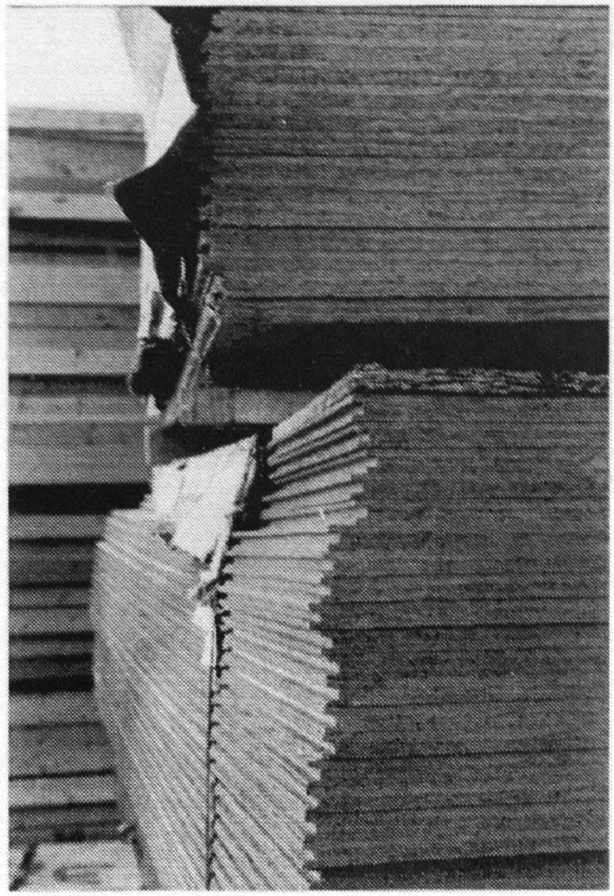
Ceiling Truss Components



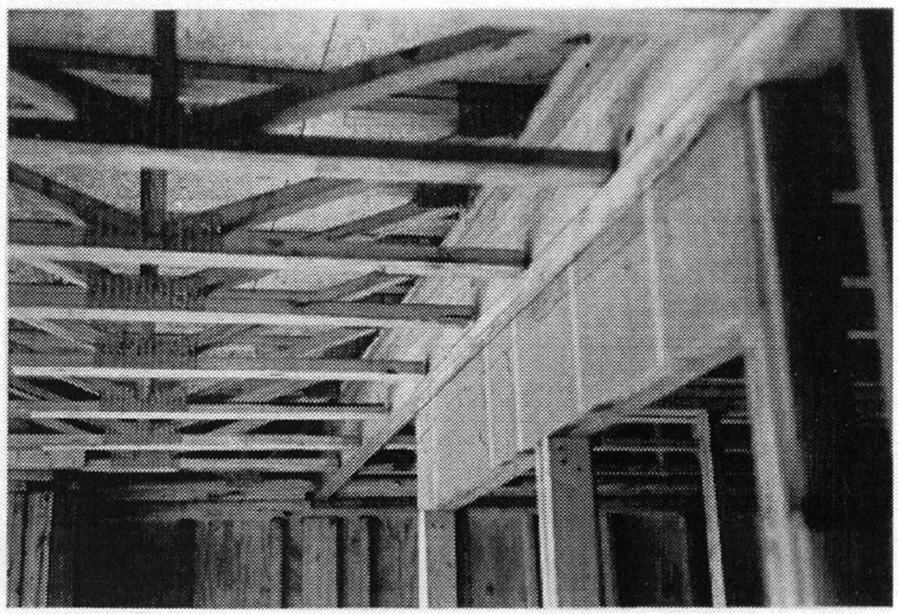
Exterior Wall Panel With Window Opening



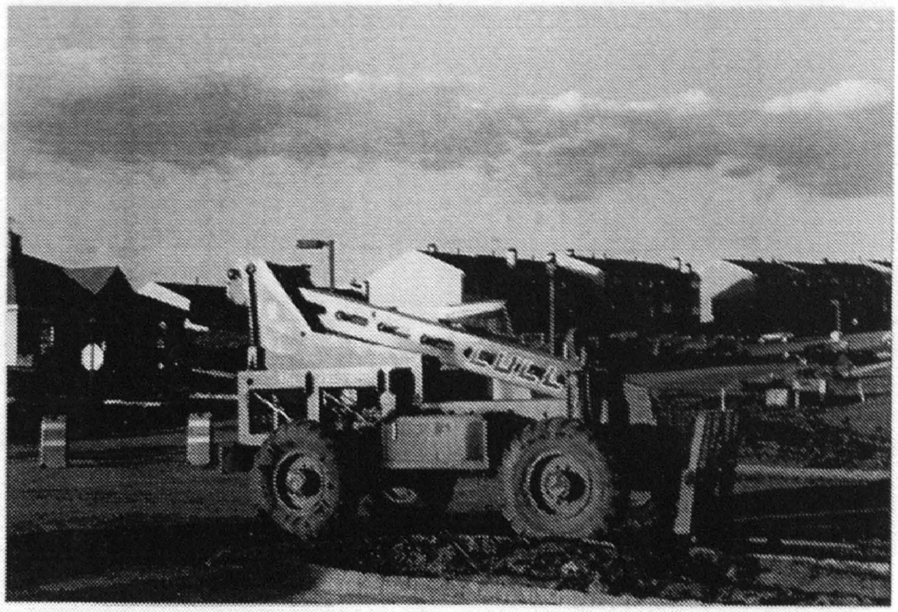
Installed Ceiling Trusses



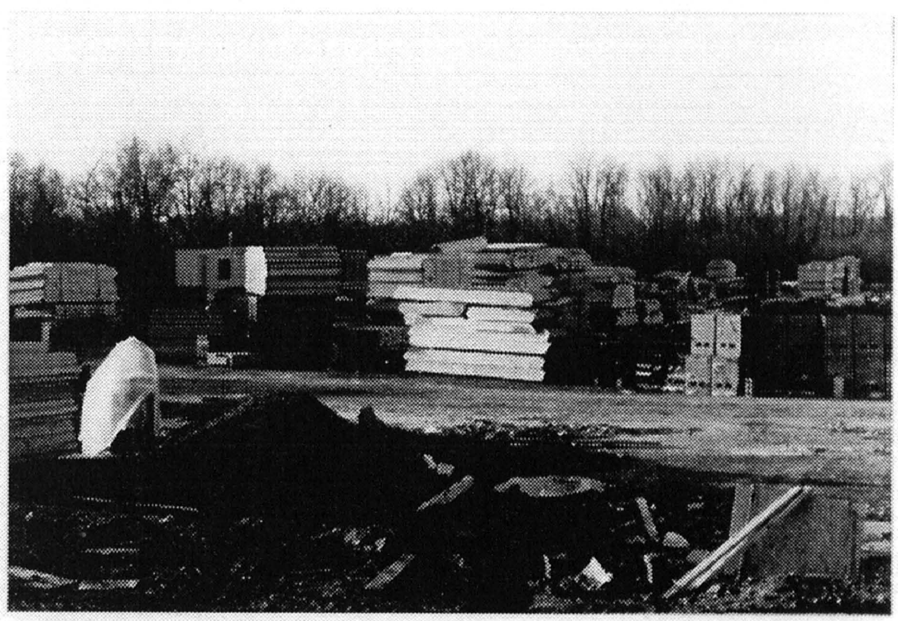
Tongue & Groove Subflooring



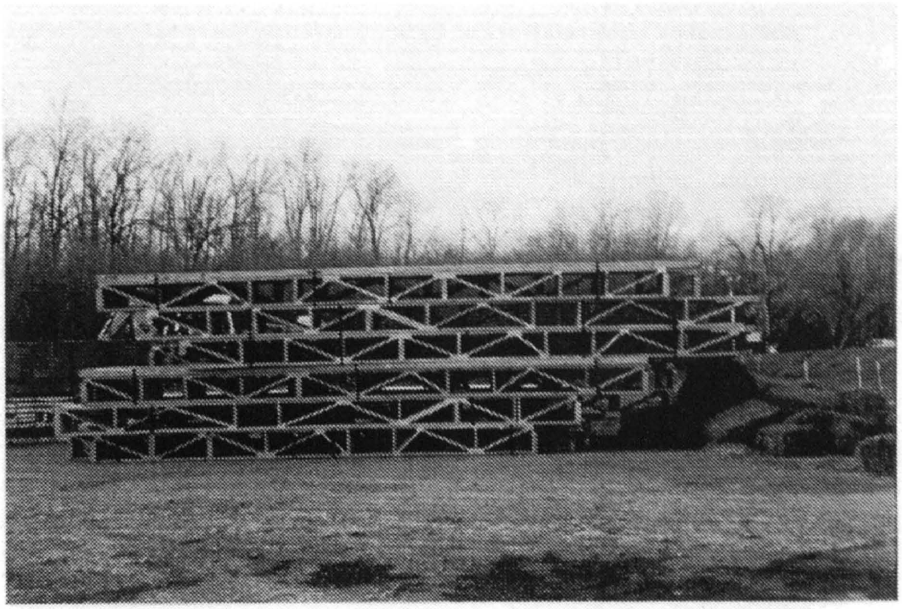
Installed Floor Trusses & Subflooring

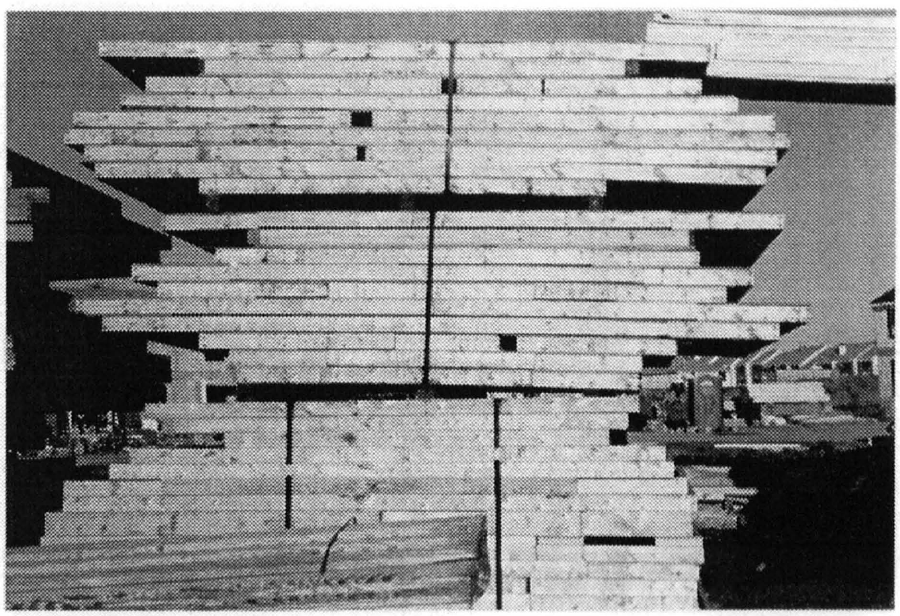


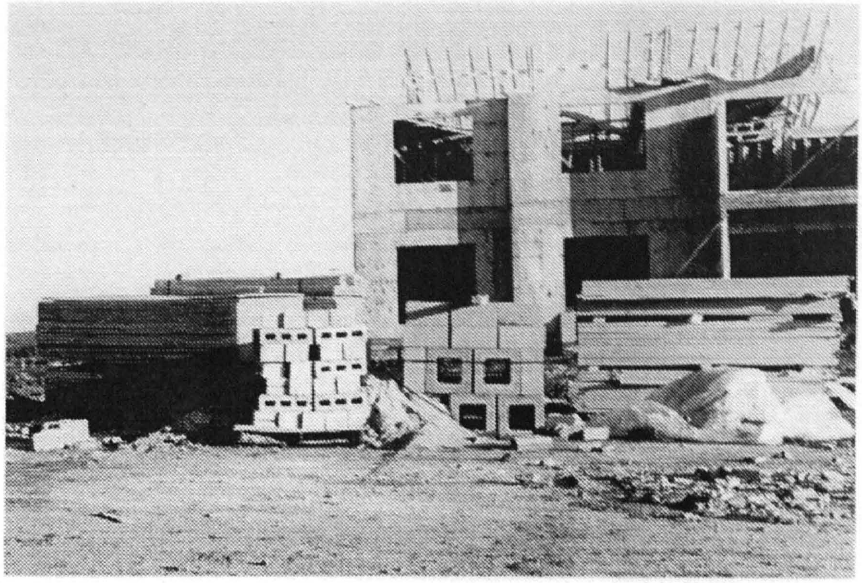
On-site Material Handling Fork-Lift

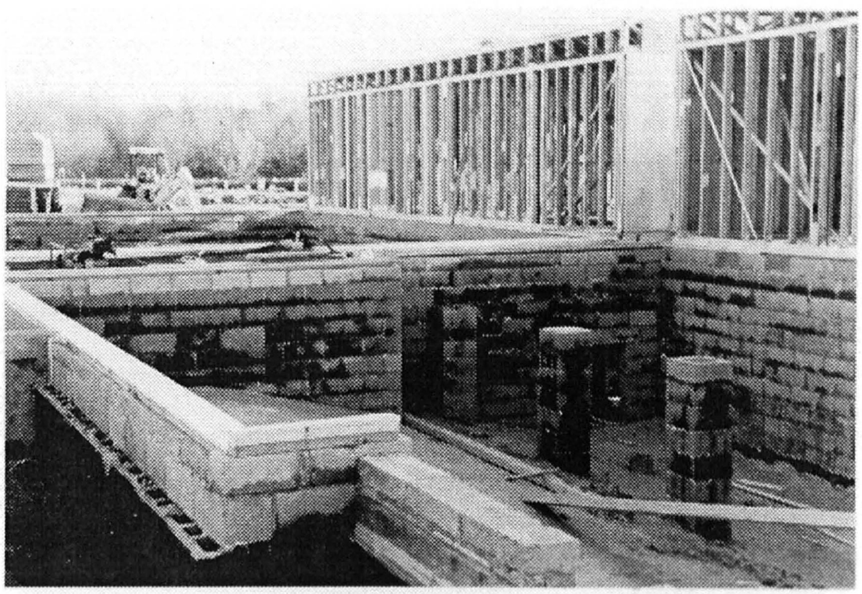


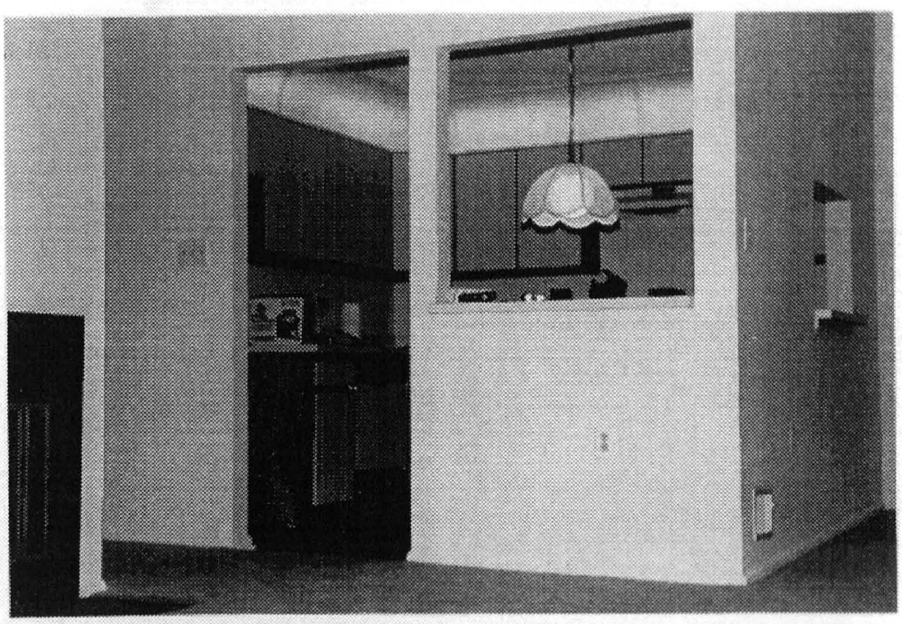
Inventory Staging
Breeze-way Stair Components: Front center of picture











APPENDIX 3

DESIGN ESTIMATOR EXAMPLE

* Includes input forms, detailed report, and summary report for an estimate done on a traditional stick-built split level house similar to the Haven Winchester plan A.

(I)

DESIGN ESTIMATOR

77

WORKSHEET

GENERAL DATA

Estimate Number	001–	701
Client Name	006–	GARY NEWHARD
Address	007–	RESIDENTIAL DESIGN ESTIMATE
	008–	MASTERS THESIS ILLUSTRATATION
• Building Name	003–	SPLIT LEVEL RESIDENTIAL HOUSE
• Building Location	004–	CRANFORD
• Building Zip Code	016–	

OH & P/WAGE/AREA DATA

Overhead & Profit 023–
- 1 ☐ 20%
- 2 ☐ 15%
- 3 ☒ 10%
- 4 ☐ 05%

Wage Rates 026–
- 1 ☐ Union
- 2 ☒ Non-Union

• Gross Area 017– 1,920 ft²

FEES/TAXES DATA

Architects Fees	019–	6 %
Sales Tax	022–	6 %
Escalation		
Labor	024–	%
Material	025–	%
Inflation	027–	2 %
General Conditions	031–	3 %

PROFILE DATA

Enter Section Descriptions

† Do Not duplicate common walls

†† Do not duplicate fixtures included in Baths

		A (House)	B	C	D
Perimeter at ground–Ln. Ft. † •	001	158'			
Ground area–Sq. Ft. •	002	1,247			
Floor to floor height or eave height •	003	9'			
Number of floors (except basement) •	004	1.5			
Basement–%	005	50			
Dept–Ln Ft	006	8'			
Number of Levels	027	.5			
Crawl Space–%	007				
Grade Slab–%	008				
Piers–%	009				
Total Floor Area Incl. Bsmt •	010	2,494			
Window area–Sq Ft	011	220			
Partition Density Factor	012	.75			
Kitchens–No.	013	1			
Half Baths–No.	014				
Full Baths–No.	015	2			
Fireplaces–No.	016				
Outside Chimneys–No.	017				
Plumbing fixtures–No. ††	018				

• Must be filled in

(Continued)

PROFILE DATA *(Continued)*

Enter Section Descriptions ➡

† Do Not duplicate common walls
†† Do not duplicate fixtures included in Baths

		A	B	C	D
Fire escapes—No.	019				
Elevators—No.	020				
Dumbwaiters—No.	021				
Omit Interior Finish on Ext Wall-Indicate Area	022				

PERCENTAGE DATA

Excavation		SECTION A	B	C	D
Normal excavation	001	X			
Special excavation	write-in				

Foundation Walls		A	B	C	D
Masonry block— 8″	011	50			
— 12″	012				
Brick—12″	013				
Stone—12″	014				
Residential concrete	015				
Concrete— 8″	016				
— 12″	017				
— 16″	018				

Slab on Ground		A	B	C	D
4″	021	50			
2″ at crawl space	023				
6″	024				

Pre-Engineered Structures		A	B	C	D
Complete—up to 12′ high	045				
Complete—over 12′ high	046				
Without exterior wall	047				
Quonset Type	048				

Structural Framing (Except Roof) (omit for wall bearing construction)		SECTION A	B	C	D
Steel frame— 7#/sf	031				
— 10#/sf	032				
— 14#/sf	033				
Concrete frame— avg	036				
— hvy	037				
Conc. floor— 4″ 1#/sf	038				
— 6″ 2#/sf	039				
Conc. floor w/metal deck	040				

Floor Construction (Wall Bearing) (omit if structural framing selected)		A	B	C	D
Wood-joists & sub floors					
— residential & lt. com	050	X			
— medium commercial	051				
— heavy commercial	052				
Bar joists (4#/sf):					
— w/3½″ concrete	053				
— w/2″ wood plank	054				

Floor Construction (Wall Bearing) (omit if structural framing selected)		SECTION A	B	C	D
Ctr beam & cols (1#/sf)	055				
Precast hollow plank	056				
Precast T's	057				
Concrete topping	058				

Fireproofing		A	B	C	D
Concrete	034				
Spray-on	035				

Roof Structure (less deck)		A	B	C	D
Steel frame (7#/sf)	071				
Concrete frame	072				
Wood trusses	073				
Steel trusses cols. joists					
— 50 ft span (5#/sf)	074				
— 75 ft span (7#/sf)	075				
— 200 ft span (10#/sf)	076				

Roof Structure (less deck)		SECTION A	B	C	D
Bar joists & cols (5#/sf)	077				
Bar joists on wall (4#/sf)	078				
Long span & cols (7#/sf)	079				
Long span on wall (6#/sf)	080				
Laminated wood-arch'tl	081				
Laminated wood-comm'l	082				
Wood rafters (pitched)	083	X			
Wood joists (flat)	084				

Roof Deck		A	B	C	D
Composition deck	093				
Metal deck	094				
Lt wt concrete	095				
Poured conc 4″ (1#sf)	096				
Precast concrete	097				
Wood sheathing— flat	098				
— pitched	099	X			
— w/purlins	101				
Wood plank— flat	102				
— pitched	103				

Roof Insulation	SECTION A	B	C	D
Rigid— 2" 501				
— 3" 502				
Batt — 3½" 505				
— 6" 506	X			
— 9" 507				

Roof Cover	A	B	C	D
Shingles—Fiberglass 110				
— wood 111				
— asphalt 112	X			
— asbestos 113				
— tile 114				
— slate 115				
Built-up 116				
Sheet metal 117				
Roll Roofing 118				
Pitch & Gravel 119				
Wood shakes 120				

(11)

Windows	SECTION A	B	C	D
Wood sash 151	X			
Steel sash 152				
Aluminum sash 153				
Glass— D/S—A 154				
— Plate 155				
— Insulating 156				
Screens 157	X			
Storm windows 158	X			

Exterior Wall	A	B	C	D
Masonry block— 8" 121	30			
— 12" 122				
Brick & 8" block 123				
Stone veneer & 8" block 124				
Solid brick—12" 125				
Stone facing only 126				
Brick backup—8" 127				

Exterior Wall Studs & sheathing w/	SECTION A	B	C	D
—Wood siding 128				
—Wood shingles 129				
—Asbestos shingles 130				
—Stucco 131				
—Aluminum siding 132	70			
—Asphalt shingles 133				
—Brick veneer 134				
—Stone veneer 135				
—Wood shakes 147				
Store front contruction 136				
Curtain wall 137				
Insl metal panels 138				
Corrugated metal 139				
Corrugated asbestos 140				
Corrugated fiberglass 141				
Poured conc. — 8" (3#/sf) 142				
Precast conc.— plain 143				
— shaped 144				

Exterior Wall	SECTION A	B	C	D
Stucco (only) 145	30			
Paint exterior wall 146				
Wood framing 148				
Metal framing 149				
Tilt-up panels 150				
Vehicular doors 535				

Exterior Wall Insulation	A	B	C	D
Rigid 511	X			
Batt— 3½" 512				
— 6" 513				

(19) Fire Escapes	A	B	C	D
Elaborate 268				
Average 269				

(12) Partitions (*Perimeter Surface included)	SECTION A	B	C	D
* Stud & drywall 161	X			
* Stud & plaster 162				
Studs Only 163				
Masonry block— 4" 164				
— 6" 165				
— 8" 166				
— 12" 167				
* Plaster on masonry 168				
Brick— 8" 169				
— 12" 170				
Concrete— 8" (3#/sf) 171				
Furring—ext wall only 172				

Wall Finish (Perimeter Incl)	A	B	C	D
Paint 181	X			
Paper 182				
Paneling (use with line 163) 183				
Fitted paneling 184				
Bookcase 185				
Ceramic tile 186				

Wall Finish (Perimeter Incl)	SECTION A	B	C	D
Vitreous enamel 187				
Vinyl covering 188				
Fabric covering 189				
Marble 190				
Stone veneer 191				
Face brick 192				

Floor Finish	A	B	C	D
Paint only 201				
Hardwood 202				
Carpet 203	82			
Carpet over hardwood 204				
Wood block 205				
Ceramic tile 206	7			
Terrazzo 207				
Vinyl asbestos 208				
Vinyl tile 209	9			

Floor Finish	A	B	C	D
Asphalt tile 210				
Brick 211				
Marble 212				
Slate 213				
Flagstone 214	2			
Hardener 215				
Quarry tile 216				

Ceiling Finish	A	B	C	D
Paint 221				
Plaster & paint 222				
Gypsum board & paint 223	X			
Metal (stamped) 224				
Metal tile 225				
Wood & paint 226				
Acoustical – lay-in 227				
– splined 228				
– fibre tile 229				

(20) (21)

Elevators-Equipment (Do not duplicate shafts)	A	B	C	D
Hydraulic – psgr 241				
– freight 242				
Electric-psgr-low sp 243				
– psgr-med sp 244				
– psgr-high sp 245				
– freight 246				
– dumbwaiter 247				
– residential 248				

(20) Elevators	A	B	C	D
Doors 249				

(13) Kitchens (Incl. plg. conn) (omit if covered by write-ins)	A	B	C	D
Elaborate 251				
Average 252	X			
Minimal 253				

(16) Fireplaces	A	B	C	D
Custom 256				
Average 257				
Simple 258				

(17) Outside Chimneys-Residential	A	B	C	D
Custom 261				
Average 262				
Simple 263				

Outside Chimneys-Commercial	A	B	C	D
Masonry-on Bldg 265				
Masonry-round 266				
Steel 267				

Heating Only	A	B	C	D
Residential – Radiation 271				
– Forced air 272				
– Electric 273				
Commercial – Radiation 275				
– Unit heaters . . 276				

Heating-By Area Use (omit if covered above)	A	B	C	D
Apartments 277				
Manufacturing 278				
Warehouse 279				
Schools 280				

Heating-By Area Use (omit if covered above)	A	B	C	D
Supermarkets 281				
Residences 282				
* SF Cost 283				

Cooling Only	A	B	C	D
Window units 284				
Residential-Central AC				
Via heat ducts 285				
Independent ducts 286				

HVAC By Area Use (omit if covered above)	A	B	C	D
Apartments 295				
Laboratory 296				
Library, etc. 297				
Office – commercial 298				
– corporate 299				
Residential 307	X			
Schools 300				
Supermarkets, etc. 301				
* SF Cost 306				

* Enter SF Cost (In Cents – No Decimal)

PERCENTAGE DATA

Plumbing-By Area Use
(omit if covered above)
HVAC-Commercial

	SECTION A	B	C	D
Central Systems— Low 302				
— Med . . . 303				
— High . . . 304				

Plumbing-General

(18)

	A	B	C	D
Fixtures scattered 319				
Fixtures grouped 320				
Residential— custom 314				
— good 315	X			
— average 316				

(14–15)

Plumbing-By Area Use
(omit if covered above)

	A	B	C	D
Apartments 321				
Laboratory 322				
Library, etc 323				
Manufacturing 324				
Office 325				
School 326				
Supermarkets, etc 327				
Warehouse, etc 328				
* SF Cost 329				

* Enter SF Cost (In Cents — No Decimals)

Sprinklers

	SECTION A	B	C	D
% of Building Covered 318				

Electrical-General Comm'l

	A	B	C	D
Lighting Level — high 331				
— med 332				
— low 333				
Machine conns— hvy 336				
— med 337				
— light 338				

Electrical-Residential

	A	B	C	D
Custom 341				
Good 342	X			
Average 343				

Electrical By Area Use
(omit if covered above)

	A	B	C	D
Apartments— Custom 351				
— Average 352				
— Minimum 353				
Laboratory 354				
Library, etc. 355				

Electrical By Area Use
(omit if covered above)

	SECTION A	B	C	D
Mfg— heavy 356				
— medium 357				
— light 358				
Office— rental 359				
— corporate 360				
Schools 361				
Supermarkets, etc 362				
Warehouse, etc 363				
* SF Cost 364				

Fixed Equipment By Area Use

	A	B	C	D
Apartments 381				
Laboratory 382				
Library, etc 383				
Manufacturing 384				
Office 385				
Schools 386				
Supermarkets, etc 387				
Warehouse, etc 388				
* SF Cost 389				

* Enter SF Cost (In Cents — No Decimal)

NOTES

Gary A. Newhard
Residential Design Estimate
Masters Thesis Illustration

Split Level Residential House
Cranford

MAY 4, 1984 ESTIMATE NO.

DESCRIPTION	QUANTITY	UNIT	LABOR	MATERIAL	
FOUNDATIONS					
EXCAVATION-BULK	111	CU YD	206	218	
WALL FOOTING FORMS	79	SQ FT	174	49	
WALL FOOTING REINFORCING	79	LBS	18	48	
WALL FOOTING CONCRETE	3	CU YD	31	195	
BLOCK 8"	158	SQ FT	361	243	
ASPHALT DAMPFG	158	SQ FT	26	33	
			---	---	
			816	786	
FLOORS ON GRADE					
POROUS FILL	6	CU YD	75	90	
DAMPPROOFING	312	SQ FT	16	20	
S O G MESH	312	SQ FT	56	142	
S O G CONCRETE	4	CU YD	68	255	
STEEL TROWEL FLOOR FINISH	312	SQ FT	122	8	
			---	---	
			337	515	852
SUPERSTRUCTURES					
WOOD FRAMING	3118	SQ FT	3,177	4,591	7,768
WOOD SHEATHING	1871	SQ FT	817	1,536	2,353
WOOD RAFTERS	1559	SQ FT	1,191	1,138	2,329
PITCHED ROOF SHEATHING	1559	SQ FT	681	1,280	1,961
BATT INSULATION 6" THICK	1247	SQ FT	222	488	710
			-----	-----	------
			6,088	9,033	15,12!

Split Level Residential House
Cranford

MAY 4, 1984 PAGE

DESCRIPTION	QUANTITY	UNIT	LABOR	MATERIAL	TOTAL
ROOFING					
ASPHALT SHINGLES	1559	SQ FT	810	833	1,643
FLASHING	1	LP SM	203	307	510
GUTTERS & DOWNSPOUTS	1	LP SM	190	301	[illegible]
			-----	-----	--
			1,203	1,441	2[illegible]
EXTERIOR WALLS					
EXTERIOR BLOCK 8"	574	SQ FT	1,156	853	2[illegible]
STUCCO	574	SQ FT	504	157	
SHEATHING	1339	SQ FT	512	1,099	
INSULATION	1913	SQ FT	341	947	
ALUMINUM SIDING	1339	SQ FT	1,365	1,536	
WOOD WINDOWS	220	SQ FT	327	1,973	
SCREENS	220	SQ FT	196	550	
STORM WINDOWS	220	SQ FT	196	1,121	
STUDS	1339	SQ FT	607	1,099	
			-----	-----	
			5,204	9,335	
PARTITIONS					
STUDS 16" OC	1400	SQ FT	635	1,152	
GYPSUM BOARD	2810	SQ FT	833	1,792	
WOOD DOOR-FRAME & HARDWARE	1	LP SM	625	1,892	
GYPSUM BOARD	1910	SQ FT	568	1,222	
			-----	-----	-
			2,661	6,058	8,[illegible]
WALL FINISHES					
PAINTING	4720	SQ FT	1,560	676	2,236
			-----	---	-----
			1,560	676	2,236
FLOOR FINISHES					
CERAMIC TILE	131	SQ FT	238	560	798
VINYL TILE	168	SQ FT	86	314	400
CARPETING	170	SQ YD	759	3,309	4,068
FLAGSTONE	37	SQ FT	124	295	419
			-----	-----	-----
			1,207	4,478	5,685

Split Level Residential House
Cranford

MAY 4, 1984

DESCRIPTION	QUANTITY	UNIT	LABOR	MATERIAL	TOTAL
CEILING FINISHES					
GYPSUM BOARD	1871	SQ FT	833	1,048	1,881
PAINT CEILING	1871	SQ FT	928	268	1,196
			-----	-----	-----
			1,761	1,316	3,077
FIXED EQUIPMENT					
WALL OVEN	1	EACH	18	713	731
COOK TOP	1	EACH	15	261	276
DISHWASHER	1	EACH	80	593	673
EXHAUST FAN	1	EACH	11	159	170
COUNTERS	12	LN FT	143	1,735	1,878
WALL CABINETS	12	LN FT	143	993	1,136
			---	-----	-----
			410	4,454	4,864
HVAC					
HEATING AND AIR CONDITIONING	1871	SQ FT	4,086	4,900	8,986
			-----	-----	-----
			4,086	4,900	8,986
PLUMBING					
SINKS	1	EACH	235	473	708
FULL BATHROOMS	2	EACH	1,428	3,121	4,549
			-----	-----	-----
			1,663	3,594	5,257
ELECTRICAL					
LIGHTING AND WIRING	1871	SQ FT	1,489	1,780	3,269
			-----	-----	-----
			1,489	1,780	3,269
			------	------	------
CONSTRUCTION TOTAL			28,485	48,366	76,851

Gary A. Newhard
Residential Design Estimate
Masters Thesis Illustration

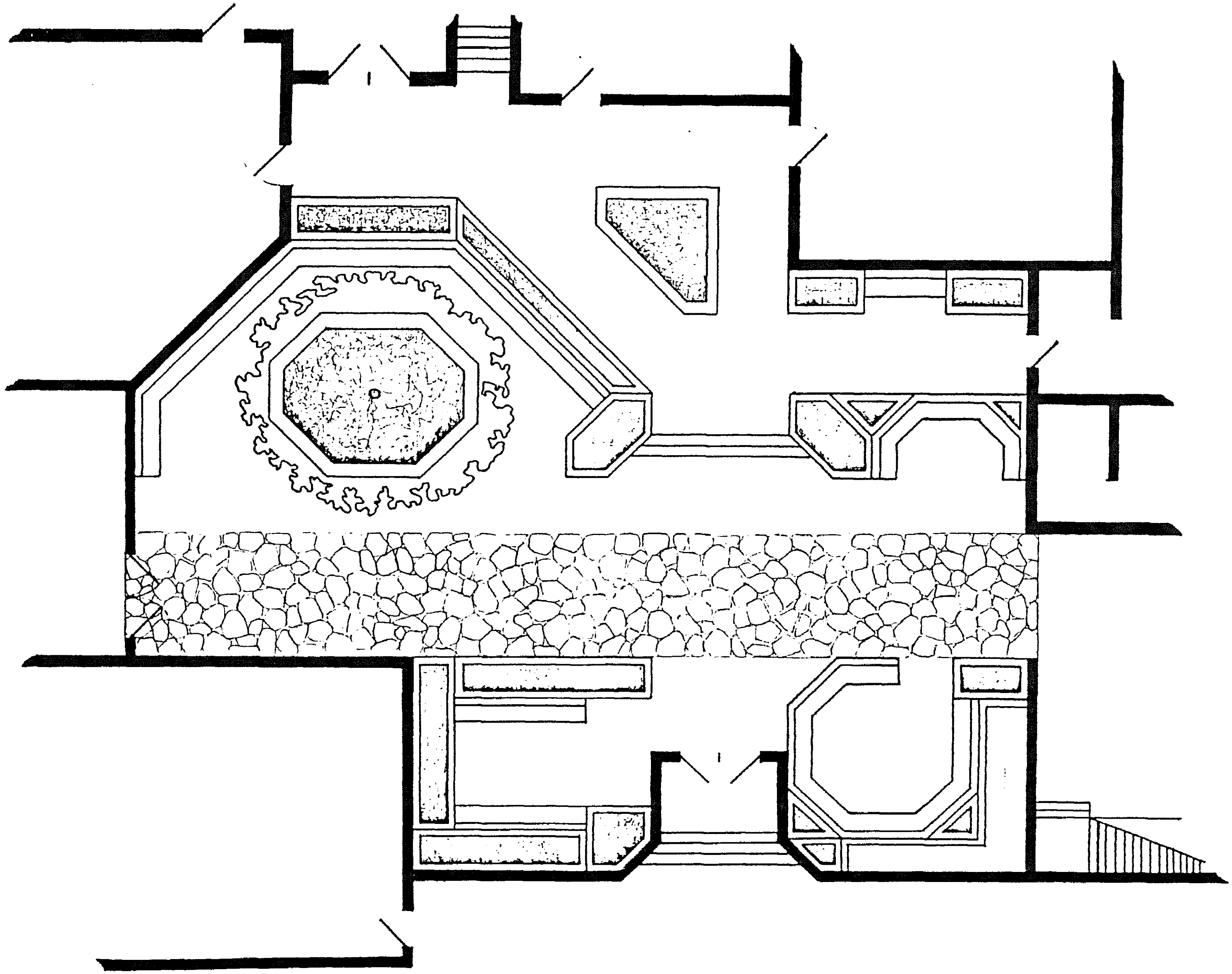
Split Level Residential House
Cranford

MAY 4, 1984 ESTIMATE NO. 701

DESCRIPTION	LABOR	MATERIAL	TOTAL	SQ FT
FOUNDATIONS	816	786	1,602	0.83
FLOORS ON GRADE	337	515	852	0.44
SUPERSTRUCTURES	6,088	9,033	15,121	7.87
ROOFING	1,203	1,441	2,644	1.37
EXTERIOR WALLS	5,204	9,335	14,539	7.57
PARTITIONS	2,661	6,058	8,719	4.54
WALL FINISHES	1,560	676	2,236	1.16
FLOOR FINISHES	1,207	4,478	5,685	2.96
CEILING FINISHES	1,761	1,316	3,077	1.60
FIXED EQUIPMENT	410	4,454	4,864	2.53
HVAC	4,086	4,900	8,986	4.68
PLUMBING	1,663	3,594	5,257	2.73
ELECTRICAL	1,489	1,780	3,269	1.70
CONSTRUCTION TOTAL	28,485	48,366	76,851	39.98

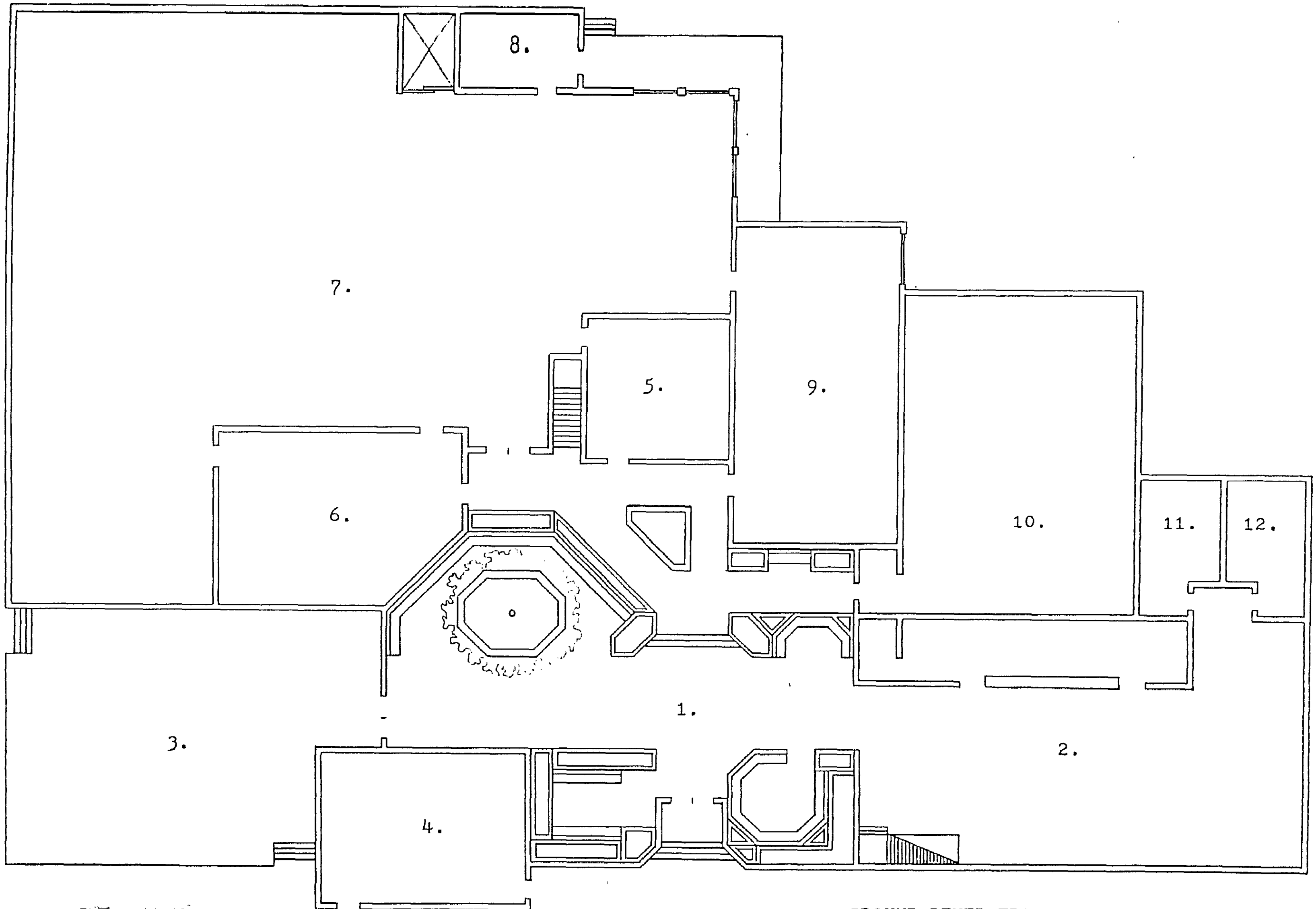
APPENDIX 4

COMMUNITY SPACE CONCEPT



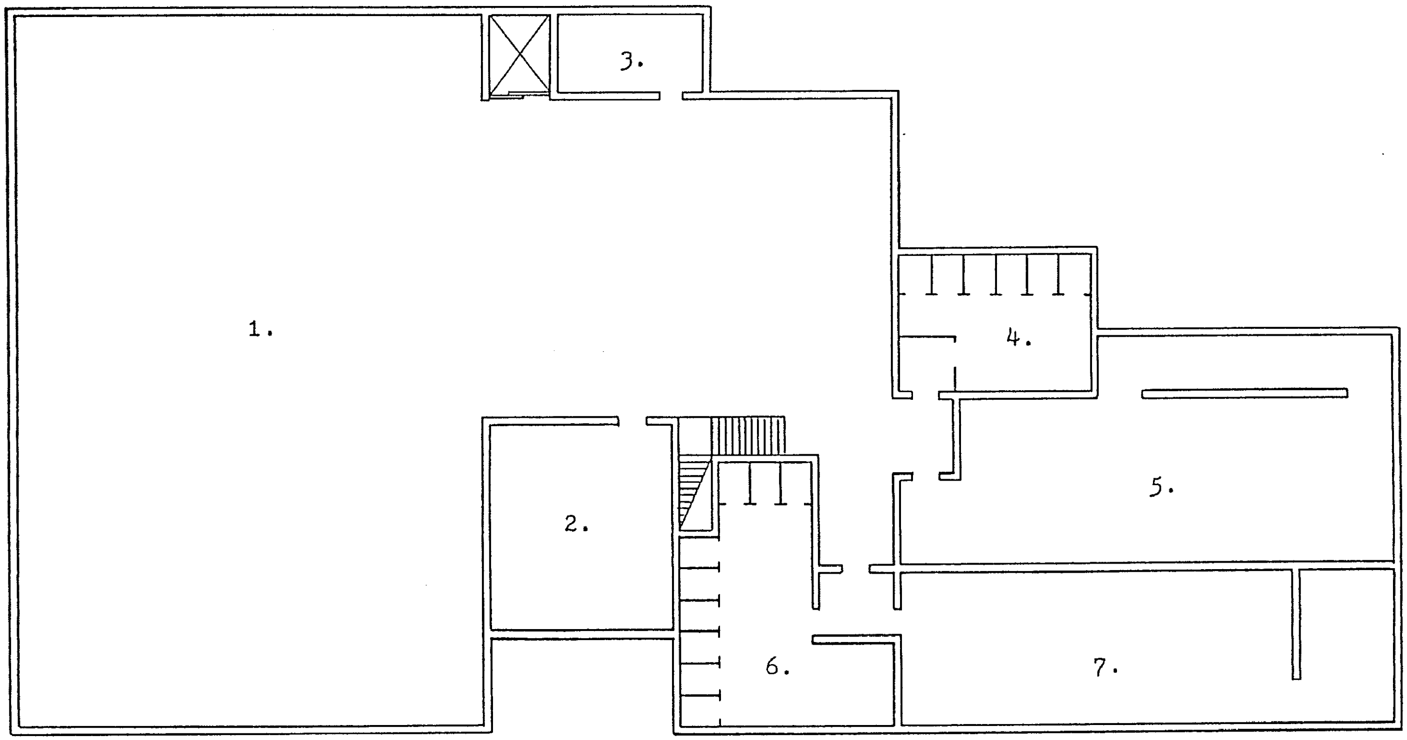
THE COMMUNITY SPACE

1. The community space interfaces all work departments
2. Sitting spaces tap off of main circulation
3. The space promotes tension release and constructive interaction

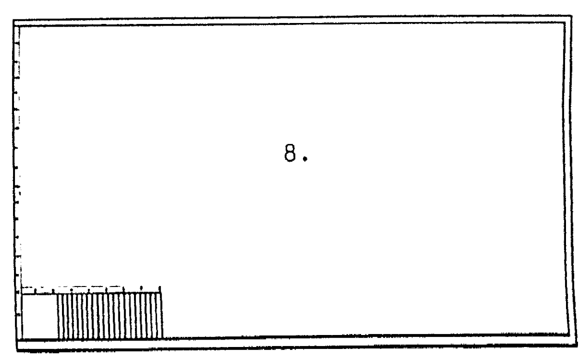


GROUND LEVEL FLOOR PLAN

1. Community Space
2. Cafeteria
3. Outdoor Sun Deck
4. Childrens Nursery
5. Doctors Office
6. Quality Control
7. Production Area
8. Shipping and Receiving Office
9. Maintenance and Engineering
10. Administrative Offices
11. Public Mens Room
12. Public Ladies Room



BASEMENT LEVEL FLOOR PLAN



UPPER CAFETERIA LEVEL

Spatial Program and Legend

1. Warehouse
2. Boiler Room
3. Warehouse Office
4. Mens Room
5. Mens Locker Room
6. Ladies Room
7. Ladies Locker Room
8. Balcony Eating Area

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