INDUSTRIALIZED HOUSING
IN BRITISH COLUMBIA

by

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This study, comprised of three major sections, reviews the concept of industrialization and its present application and future potential for the production of housing in the industrialized parts of the world, with a focus on the Province of British Columbia.

The discussion presented in the first two sections is based largely on the study of the available literature on the subject. The discussion in the third section is based on visits to selected factories, interviews and available references.

The first section describes the basic characteristics of industrialization, that is, (a) mass production, (b) assembly line and centralized work and (c) organization and planning of production. It is noted that standar-dization, co-ordination of work and dynamic approach to marketing are essential elements of industrialization.

The second section examines the relationship between the basic characteristics of industrialization and those of housing. The characteristics of housing, (such as demand for individualization, its complexity
and bulkiness, cost of its production and purchase and its fluctuating market) make organization and comprehensive planning imperative for its mass production and efficient distribution. In addition to the characteristics of housing, local factors such as geography, market distribution and capital availability need to be considered in a comprehensive planning for industrialized housing. Housing, being a complex, a bulky and an expensive product, the efficiency of its factory production (off-site production) must be extended to its on-site assembly through a co-ordinated approach to both off-site and on-site works.

The third section is a review of industrialized housing in British Columbia. The local geography, market distribution, availability of capital and government's role in housing are examined. The production method and the organizational approach of the "modular" and "package" housing industry are analysed. Four manufacturing firms are chosen for the analysis. It is concluded that at present the industry of factory-produced housing does not compare favourably with the site-built housing industry. The current trends of industrialization of housing are likely to remain unchanged unless an initiative is taken for a comprehensive planning of industrialized housing.
This planning must consider: the need for standardization and co-ordinated off-site and on-site works; the unevenly distributed and fluctuating market; the economics of large-distance transportation on a mountainous terrain; the task of providing environmentally appropriate housing; and the characteristics of housing. Individual manufacturers are less likely to take such an initiative because of their commercial motives. Therefore, the initiative should come from the government through their housing policies, guidelines and, perhaps, financial incentives. In the absence of this initiative, the desirable development of industrialized housing benefitting the ultimate users of these housing—the dwellers, would continue to be a difficult task.
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INTRODUCTION

Industrialization is a dominating factor of our times. Its role in the field of housing production has greatly expanded, as demonstrated by the increasing use of industrially produced products for the construction of houses—from doors and windows to larger, three-dimensional modules such as bathrooms and kitchen units, and mobile homes. The history of industrialized housing shows that over the past years this has, on the one hand, resulted in situations such as the rapid provision of houses of acceptable standards while on the other hand the production of highly standardized houses based on preconceived design notions has sometimes created stereotyped residential environments.

Such desirable and undesirable situations have given rise to a number of arguments for and against industrialization in housing production. The following study is based

* In parts of Europe and Russia. A review of Danish industrialized housing notes: "The enormous demand for housing, combined with the need for rational planning of the building process too often results in big, uniform projects, the very size of which has a depressing effect on the people who live in them - giving them a feeling of alienation and of not really "belonging"... There has been a tendency to equate efficient industrialized production methods... with dehumanized and barren housing environments." M. Kjeldsen and W. Simonsen, Industrialized Building in Denmark. (Copenhagen: Skandinavisk Bogtryk, 1976), p. 9.
on the premise that the motivating forces behind this industrialization provide some of the major reasons for these situations. For example, the motive to create rapid and large profits may result in large scale commercialism and indifference towards the actual requirements of the ultimate users - the residents.

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Industrialization in housing production had been adopted on a large scale during and immediately after the two World Wars, especially in Europe and, to an extent, in North America. Such large scale adoption was a result of many overlapping factors, such as: (a) the mass destruction of buildings during the wars, (b) an acute shortage of materials, finances and skilled construction labour, and (c) a need for temporary or emergency housing and dormitories.

This situation was further aggravated by the massive migrations of rural people to industrial settlements and urban areas, and by the rapidly growing populations of some nations, particularly that of Britain*. Consequently,

* "The Industrial Revolution began in Britain with a sudden and dramatic increase in population... the 9 million population of 1801 represented an increase of about 50 per cent over that of 1750. By 1811 an increase of a further 14 per cent ... by 1901 the population of Britain was over 40 million ... This increase was further dramatized by massive migrations within the country..." Martin Pawley, Architecture vs. Housing (London, Eng.: Studio Vista, 1971), p. 10.
In many countries, careful planning and construction became secondary to the rapid provision of housing.

Prefabration and production of houses in factories was advocated as an answer to such a situation. This development was largely encouraged by: (a) the assistance of governments and influential people motivated by idealistic notions; (b) the profit motive present in our society; and (c) the radical thinking that was emerging in the fields of architecture and planning.

In recent times, crisis situations similar to the ones created by the World Wars have not existed, except in times of natural disasters. In the absence of such crises the rapid growth of population is sometimes put forward

* For example: In 1933, the Mayor of Frankfurt, Landmann - a planning enthusiast and inheritor of considerable powers, had wholeheartedly supported the construction of a series of satellite suburbs ringing the city to provide people with low cost housing in short time. He and the chief architect, Ernst May, agreed that slum clearance should be subordinated to such development. For rapid construction an extensive use was made of a pre-cast concrete prefabrication system called "massivblock". Martin, Pawley, *Architecture vs. Housing* (London, Eng.: Studio Vista, 1971) pp. 28, 29.

** Some examples are Walter Gropius' enthusiasm for mass produced housing systems and his teachings at "Bauhaus", German architect Bruno Taut's experiments with prefabricated housing techniques when he was the chief architect for one of the prestigious Berlin building societies -- "Gehag", and Le Corbusier's thoughts on "new" architecture, mass production and prefabrication.
as an argument in favour of industrialized housing. More appropriate reasons, however, for the continuing interest in the subject are demands for the maximum possible savings in the amount of money, labour and effort spent in providing people with basic housing.*

For example, in North America traditionally the construction phase of a site-built house involves the coordination of a number of trades, subtrades, and their requirements. The array of inspection procedures, permits and approvals, labour fluctuations and possibilities of disputes, and unexpected weather changes may all contribute to the inefficiencies of the house building process. The increasing costs of traditional labour and materials may add to the total cost of this process. Mass purchase of materials, mass production, and the building up of an inventory of labour are uncommon for small builders because of the small size of many projects and the fragmentation of the market.

The reaction to this situation is, in part, a moti-

* The interest in this subject continues also because of the possibility of providing houses of acceptable standards with minimum wastage of materials in those areas where traditional construction methods may prove to be inadequate for house building, for example in colder climates such as those prevalent in parts of Scandinavia and Canada.
vating force behind the current ventures for industrialized housing. Other motivating forces are the continuing assistance of governments in the socialistic countries of Europe for such ventures and the desire for profit maximization by industrialists in the capitalistic countries of the West.

In general, industrialization aims at the following:

(1) To lower the costs of production.

(2) To increase the speed of production and save in labour.

(3) To maximize consumption of products and thereby to increase profits.

Industrialization is normally considered to increase efficiency by control over the product and by maximum co-ordination within production and distribution. Planning and organization are the key factors in industrialization.

The following thesis reviews the characteristics, implications and requirements of industrialization and their application to housing production. It culminates in general recommendations for the industrialized housing
sector of British Columbia. It should be noted that this thesis does not deal with the specifics of house designs. Rather, it deals with the overall planning and organization of industrialized housing.

The thesis is divided into three major sections. The first section deals with the concept of industrialization and the second section explains the relationship of industrialization to housing. The discussion contained in these two sections is mainly based on the references from the available literature pertaining to the subject.

In the remaining section, the situation of industrialized housing within the province of British Columbia is examined in light of the conclusions from the previous two sections. This examination attempts to determine the degree and direction of industrialization in housing within the province.

Personal interviews were conducted with the representatives of selected home manufacturers operating within the province, the construction unions, the Department of Housing and the Department of Economic Development.

The data contained in the third section is mainly based on these interviews and on personal observations made during visits to factories. Some data is also drawn from various sources such as brochures supplied by the
manufacturers, government reports, and articles published in journals and local newspapers.

Four manufacturers were selected for detailed analysis. Limitations of time, distance and finance, and the difficulties of determining the current situation in other firms prevented visits to all manufacturers operating within the province. For example, approximately 12 firms were approached by mail. However, only two of them responded to the questionnaire* sent to them; others had either gone out of business or had changed their locations; some did not reply at all.

It is unlikely that the firms not included in the study will have a totally different approach than the one being followed by the firms visited.

* A sample questionnaire is included in the Appendix.
SECTION - 1

INDUSTRIALIZATION
1.1

TOWARDS INDUSTRIALIZATION

The charts on the following pages (pp.10-12) are an attempt to explain the process and consequence of industrialization. The changes in the methods of production of goods—-from handicraft to machine production—-are examined in these charts.

These charts are not intended to be read as a list of events in a chronological order. Therefore, no specific dates are provided. They are, rather, arranged so as to provide the reader with a quick review of the changes and events which led to industrialization.

The three charts are entitled as follows:

(1) Phase of Self-dependence.

(2) Phase of Interdependence.

(3) Phase of Industrial production.
PHASE OF SELF-DEPENDENCE

- Referred to as the "Eotechnic" phase by Lewis Mumford and as the "Usufacture" phase by N.S.B. Gras.

- Products manufactured for personal use and not for sale, that is, the PRODUCER WAS HIMSELF THE CONSUMER OF HIS PRODUCTS. The products were manufactured in accordance with his choice, needs, available materials and techniques.

- Mass production was not necessary as there was never an intention of selling.

- No power machinery was used; products were hand-made and the process was time-consuming and labour intensive; workmanship and quality were not uniformly maintained; products were manufactured with personal care and had an identity.

- "A predominant kind of manufacture among peoples in the collectional cultural nomadic and settled village economy, e.g., Eskimos making thongs out of seal skins for personal use or Greek women who used to weave cloths at home for their families." N.S.B. Gras.

- For example, a man bringing wood from the forest, cutting it to the required sizes and shapes and building a cabin with the help of his family or tribe. This is found among some tribes today, e.g., bamboo and cane structures in some African settlements, mud huts in the villages of India, or tents and teepees of North American Indians.

- "The goose quill pen, sharpened by the user himself is a typical product of this phase. ... (they are) economically cheap, technically crude but easily adaptive to the style of the user". Lewis Mumford.

- Self-sufficiency and satisfaction in doing creative work through unconscious but direct participation and contribution.
- Referred to as the "Paleotechnic" phase by Lewis Mumford and as the "Handicraft phase by N.S.B. Gras.

- People with fewer skills and less time became dependent on other people who had more knowledge, training and time to spare for manufacturing the required products in exchange for other products (latter system).

- Special skills and trades were developed; simple tools were invented to aid hands, wind and water were the main sources of energy, population growth and development of trades multiplied the demands for goods.

- The mercantile system emerged; producers and users drifted apart. This type of relationship and an increasing pressure from the merchant-employers to produce more goods in a given time discouraged some producers and they lost personal interest in the products.

- For more control and direct supervision the "central workshop" system was started by merchants. Thus, concepts of mass production and centralization of manufacturing appeared. Large power machinery was absent as yet. All products were still largely hand-manufactured with the help of simple tools. ("The tool lends itself to manipulation and the machine to automatic action". Lewis Mumford).

- The idea of "division of labour" was introduced to reduce duplication of work and to allow individual workers to concentrate on learning and developing special skills.

- The end of this phase is marked by the discovery of materials such as iron and glass. Iron and glass were the chief materials used in the mass production of parts for the Crystal Palace (1851) - the turning point in the history of prefabricated structures.
PHASE OF INDUSTRIAL PRODUCTION

- Referred to as the "Neotechnic" phase by Lewis Mumford,* or the phase when industrial methods began to be applied for mass production of standardized products, or the period known popularly as the Industrial Revolution.

- "A typical example of the products of this phase is a fountain pen with its barrel of rubber, its gold pen, its automatic action pointing to the finer neotechnic economy. Its use of the durable iridium top lengthens the service of the point and reduces the need for replacement." Lewis Mumford.

- The later development in writing pens - the ball-point pen, with its economical, durable and easily replaceable carbon cartridge, is also a good example.

- War destruction on a large scale, shortage of skilled labour, and growing demands for goods encouraged the development of industrial mass production. The concepts of assembly-line and division of labour which were already in existence, but limited in application, became stronger and began to be used on a larger scale.

- Mass production required dimensional co-ordination and standardization for ease and speed in manufacturing. The production of standard products in quantity was a highly mechanical process.

- The use of mechanically powered motion was introduced for production. Hence, the use of machines - apparatus for applying mechanical power.

- The discovery of steam power, internal combustion power and subsequently electric power replaces the traditional power sources such as wind and water.

- The development of higher technology, computers and sophisticated machinery have slowly replaced human labour for the rapid mechanical production of goods in large quantities. The increasing use of technology for mass production was also a result of the increasing costs of skilled labour and the desire of manufacturers for large profits.

- As industrial production methods have become more advanced, and, as continuous mass production of goods has become a paramount factor, particularly in order to lessen risks of capital investment, disposable/throw-away goods have begun to be introduced. The cycle of more production - more consumption - more production is perpetuated.

* N.S.B. Gras, however, does not give a title to this phase.
Mass demands for economical goods of uniform quality called for more efficiency and accuracy in production and for reduction in the wastage of materials. This resulted in the gradual elimination of home-manufacturing and in the introduction of centrally managed and organized factories based on the principle of mass production for mass consumption.

On the one hand, this provided relatively low-priced and durable goods of uniform quality to almost all income groups. On the other hand, the use of this technique as a tool for larger profit resulted in situations such as the following:

1. Uneven distribution and concentration of wealth.
2. Exploitation of workers.
3. High rate of unemployment due to the use of highly mechanized or automated equipment.
4. Exploitation of consumers through the use of sophisticated advertising techniques.
5. Creation of a sense of alienation in relatively traditional and conservative societies by large scale introduction of non-traditional
materials, forms and machine-made objects.

If relatively low-priced and uniform quality goods are provided through the process of industrialization, it is also assumed that they are rapidly bought, used and replaced. In other words, in most cases, the goods are not manufactured to last. The reasons for this are that the machines have to be kept running, the employees have to be paid, and the risks of loss have to be lessened. This situation has been mentioned by Alvin Toffler in his book: "Future Shock". He talks about the "built-in obsolescence" and "throw-away" goods which are rapidly becoming commonplace in the industrialized nations.

As much as industrialization is likely to expand its role in the development and production of various products, its consequence must be taken into account. Its introduction and large scale adoption must be based on social, cultural, political, economic and physical factors.
1.2

CHARACTERISTICS OF INDUSTRIALIZATION

Normally, when the concept of industrialization is applied to housing production, the trend is to immediately propose "innovative" housing systems. As a result, the essential aspects of industrialization and their implications are often neglected. It is well known by now that many of these "innovative" systems have either failed to materialize or have had a limited success, especially in North America.

The process of industrialization is characterized by mass production, mass distribution, organization and planning. Its application presupposes the following:

(1) the development of a transportation and communication infrastructure. *

(2) the availability of capital resources—both renewable and non-renewable—such as money, raw materials and energy.

* This development may be affected by the local topography and climate. However, it is not always affected by these factors. Although Switzerland, for example, is more hilly compared to India, its transportation system is one of the most advanced in the world.
(3) the availability of workers.

(4) the market.

(5) the development of science and technology.

(6) the government policies conducive to industrial development.

These are the prerequisites of industrialization. In other words, industrialization is directly dependent on the development and availability of these prerequisites. The history of industrialization shows that where these were readily available and highly developed, industrialization was adopted rapidly and easily. One of the reasons that England pioneered the Industrial Revolution was the existence of favourable conditions in terms of good roads, availability of capital for investment in industrial production, migrant workers willing to work in factories, and availability of a large market within and outside England.

Mass production:

Industrialization requires capital investment in materials, equipment, personnel and factory buildings. In order to justify this investment and avoid any loss, a certain degree of quantity production or mass production
of goods is essential. This degree may be determined depending on the capital invested, the market available and the profit desired.

Various theories and concepts exist about the meaning of mass production. The simplest definition is provided by Charles Walker. He defines it as the "volume production of a standardized product for mass consumption". 4

Henry Ford had this to say about mass production:

... The term mass production is used to describe the modern method by which great quantities of a single standardized commodity are manufactured... Mass production is not merely quantity production... nor is it merely machine production... mass production is the focussing upon a manufacturing project of the principles of power, accuracy, economy, system, continuity, speed and repetition. The normal result is a useful commodity of standard material, workmanship and design at minimum cost. The necessary precedent condition of mass production is capacity, latent or developed, of mass consumption... 5

Mass production involves the following:

(1) Standardization of products and their parts. Such products should be light in weight for fast handling.

(2) Predetermination of final sizes and shapes of products.

(3) Mass procurement of materials, equipment and
labour.

(4) Mass distribution and mass consumption which involves a thorough analysis of market factors.

(5) Management which, through studies of operation and co-ordination of labour, materials and equipment, makes continuous mass production possible.

(6) Large scale use of capital.

The implications of mass production are as follows:

(1) System and accuracy in production.

(2) Elimination of waste and guesswork in production.

(3) Increase in the speed of production as extra work is either eliminated or reduced due to standardization.

(4) Uniformity in the quality of products.

(5) Mass procurement of materials, equipment and labour in order to produce savings in the total cost.

(6) High input of energy resources.
It is self-evident that when such mass production is supported by an increased mass consumption of goods* the normal result would be an increase in the speed of the perpetual cycle of "mass production-mass consumption-mass production". As discussed earlier in the charts (pp. 10-12) this is likely to bring about more consumerism, commercialism and uneven distribution of wealth within the society whose undesirable side effects are well known.

The mass production of standardized products at increased speed requires mechanization. Such mechanized mass production usually leads to assembly line production. The words "assembly line** production" imply that the resulting product is an assemblage of parts/materials. This means that assembly line production is normally suitable for a complex product,*** that is, the product is

* This, that is, an increase in the mass consumption of goods is the basic aim of all industrial ventures in order to gain maximum return. This increase is achieved by various means, one of which is the large scale and consistent use of the mass media for advertisements.

** The Oxford dictionary defines an "assembly line" as a group of workers and machines progressively assembling a product.

*** An assembly line is also suitable for a complex task which can be divided into a series of component tasks, for example, the job of slaughtering, cleaning, cutting and packaging a chicken and its parts.
divisible into smaller components, each of which may be individually manufactured. These components are designed for easy and fast handling in a continuous series of operations. The production of automobiles is a well known example of this type of production.

In assembly line production the total job is broken down into a series of relatively simple and repetitive tasks which are performed by individual workers and machines over and over as the line moves by. In other words, a worker (and a machine) stays in one place performing an assigned job. Materials are brought to him and the finished work is taken away to another worker on a "moving line".

Standardized, preplanned, co-ordinated and centralized works are the necessary features of assembly line production.

* Although a large number of automobiles are still manufactured by workers and machines performing assigned tasks on moving assembly lines, this type of rhythmic/repetitious work is no longer considered to be highly essential by some automobile manufacturers. In Sweden it has been reported that in an automobile plant the management is successfully experimenting with a group of workers being responsible for a complete automobile instead of individual workers being responsible for specific assigned tasks. Notably, the success here is the result of efficient planning of a task and organization of workers assigned to finish the task as a team work.
Some consequences of such planned and co-ordinated assembly lines are: (a) orderly movement of materials and products; (b) this efficient movement of materials usually resulting in the reduction of waste in time and labour; (c) specialized assignments to workers resulting in the increased specialization and division of labour; (d) strict control over the quality of work and products; and (e) repetitious work that could create an indifference to the product among workers.

Organization/Planning:

Industrial production which brings about an increase in standardization, specialization, distribution and consumption requires planned and organized work. This is illustrated by the complex organization of the more advanced industries, such as those concerned with automobiles, electronics and textiles. These mass production industries, with their large scale requirements of capital, would not be successful without organization and planning. One of the important consequences of advanced industrialization is the increased use of specialization. An organization brings the work of various specialists together to produce the required result.

One of the more accepted definitions of an organization
is provided by John Kenneth Galbraith: "a system of consciously co-ordinated activities or forces of two or more persons". The Oxford dictionary defines it as "an undertaking which involves co-operation". The co-operation between individuals and the co-ordination of their activities are implicit in these definitions.

Management is a vital part of such organizations. Its job is to co-ordinate various activities such as research, development, financing, production, marketing and post-sales servicing. It involves decision making for the efficient use of capital, materials, labour and equipment in order to achieve maximum possible efficiency in production and distribution.

Planning is an inevitable counterpart of organization. The task of organizing for mass production, mass distribution and mass consumption invariably involves efficient management, inflexible commitments of time and capital, and profitable marketing of products. In order to off-set or neutralize the effect of any problem that may arise due to this as well as the effect of all adverse developments which may take place in the market and industry, planning is considered to be an essential criterion of industrialization. This is particularly evident in the case of products which are complex, which require large investments in highly spezia-
lized labour and machinery, and which are produced by highly refined processes.

Galbraith explains this in the following manner:

In the early days of Ford (automobile), the future was very near at hand. Only days elapsed between the commitment of machinery and materials to production and their appearance as a car ... If the car did not meet the approval of the customers, it could quickly be changed. The briefness of the time in process allowed this; so did the un-specialized character of manpower, materials and machinery. Changes were needed (in the earliest cars) ... Such shortcomings in the Mustang would have been unpleasant ... The machinery, materials, manpower and components of the original Ford, being all unspecialized, could be quickly procured on the open market ... For the more highly specialized requirements of the Mustang, foresight and associated action were indispensable ... Thus the need for planning. 

Planning involves investigation, comparative analysis, and decision making for all tasks of production and distribution -- from the types of products to be produced to the methods of promotion and sale of these products. The importance of planning is such that, according to Galbraith, advanced industries tend to reduce their dependence on the uncertain market with intricate planning. This, however, mostly depends on the product itself. The market for eggs and milk, for example, is highly reliable,
constant and predictable. In comparison to this, no similar reliability and continuity of the market for automobiles of a particular colour or design exist. Planning in the latter case is difficult but highly essential. The industry must not only foresee the consumer demands but it should also ensure that its products are bought by customers at a price which will ensure maximum profits for the industry.

Some implications of such intricate planning and complex organization are that: (a) mass distribution and mass consumption is often ensured; (b) profits are, more or less, guaranteed; (c) risks of capital commitments are lessened, and (d) adverse effects of unpredictable future developments can be neutralized. The other significant implication is that decision making is likely to be highly centralized. Centralization brings order, clarity and efficiency but does not allow for flexibility which is needed when dealing with localized situations. Therefore, for an industry to be more successful, innovative and responsive to market fluctuations, both centralization and decentralization are essential.* In other words, it

* "Once a large organization has come into being, it normally goes through alternating phases of centralising and decentralising ... In any organization, large or small, there must be a certain clarity and orderliness; if things fall into disorder, nothing can be accomplished. Yet, orderliness, as such, is static and lifeless ... Centralization is mainly an idea of order; decentralization, one of freedom." E.F. Schumacher, Small is Beautiful: A study of economics as if people mattered (London, Eng.: ABACUS, 1974), pp. 202-3.
is the degree of centralization which needs thorough planning.

The decision on the degree of centralization is an important part of planning and organization. For reasons of economy and ease in marketing of the product, as well as to allow for a quick response to local situations, an industry may choose to decentralize the production by establishing smaller plants and sub-assemblies in different areas. Many accessories and parts for automobiles are manufactured at plants in various locations. Their final assembly is also done at different places.

The degree of such "centrally organized, decentralized production" depends on the complexity of the product and on local situations such as the distribution and requirements of the market as well as the availability of transportation, materials, labour and equipment. Good planning and organization ensures the efficient co-ordination of tasks performed at the decentralized plants by encouraging the co-operation of the various participants involved in these tasks.

The significance of the degree of centralization, and therefore of planning, increases in proportion to the
increase in capital investment, sophistication in the methods of production and complexity of the product.

Conclusion

Industrialization is not feasible without certain prerequisites such as the existence of transportation and communication infrastructures, labour, capital, market and government policies favourable to industrial development. It is normally characterized by mass production and mass distribution as well as intricate planning and organization.

Mass production is suitable for products which are light in weight and which can be predetermined, standardized and distributed with ease in large quantities. The market factors for such products should be highly predictable and reliable in order to procure maximum return from the sales. Production of standardized articles in a quantity usually means reduced wastage, efficient work, low production costs, greater speed of production and uniform quality of products. As a result of this type of production low priced products may be provided to potential customers in order to attract a large market.

Organization and planning, the key factors in mass production and distribution, achieve co-ordination of various tasks necessary for production and marketing. These two
factors are both essential and difficult in the case of products whose market is unpredictable and fluctuating. The risks of capital investment are high in such a situation, which calls for more planning on the part of management. The degree of centralization, which is an important part of organization and planning, is usually determined by the complexity of the product, by the localization and distribution of the market, and by the availability of transportation and labour.

Such considerations must be taken into account for the purpose of determining the relationship of industrialization and housing. These and other such considerations of a technical nature however, would be inadequate for the purpose of housing production, because the considerations of a social and psychological nature would be equally important for this purpose.
FOOTNOTES:


SECTION - 2

INDUSTRIALIZATION AND HOUSING
2.1

CHARACTERISTICS OF HOUSING*

In order to determine the efficient ways and means of industrializing housing production the following characteristics of housing **--considered as physical product--are identified:

(1) **Physically complex and bulky product**

A majority of housing can be said to comprise of several physical elements known as walls, floors, roofs, stairs, etc. (from now on referred to as dwelling elements). Various combinations of such elements form definable areas for various functions such as sitting, entertaining, cooking, sleeping and storing. These dwelling elements together impart bulkiness to housing.

(2) **Unreliability and localization of its market**

General demand for housing--particularly new units--

* This discussion applies primarily to situations in the industrialized nations, especially in North America, as situations are likely to vary in different nations depending on local conditions.

** Here, housing is considered synonymous to house/houses.
is mostly fluctuating. The fluctuations in demand make the housing market unsteady and unreliable. The reason for the fluctuating demand for housing is that this demand is usually generated by such variable factors as population growth and mobility rates, the distribution of wealth and income in the society, the overall costs of housing and land, the stock of existing housing, and the frequency of calamities* in the area. Also, a major portion of the market is localized due to factors such as geographic variations, labour and construction codes, and availability of materials.

(3) **Product for living**

Housing is the only physical product wherein a majority of people carry out day-to-day living functions. The priority of various functions and their relationship may vary from people to people depending on their culture and other factors. In heterogeneous societies people are likely to have diverse lifestyles and a large range of requirements. Housing, in a sense, is a socially complex product as well. The reason for this is that housing production and distri-

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* Either natural such as earthquakes and floods or man-made such as wars.
bution is influenced in varying degrees by many factors other than those simply of a technical nature.

(4) **Design and production**

A majority of housing is built on site with several materials and components involving the employment and coordination of various trades and subtrades. Inefficiencies in work and wastage of materials are likely to occur.

The availability of materials and their characteristics may impose certain restrictions, for example, only certain types of construction and design are possible and economical with wood products.

(5) **An expensive product**

For a majority of people housing is perhaps the largest and most important expense in their lifetime. They therefore demand affordable housing built of durable materials and designed to meet their own requirements.

From these characteristics of housing and from the conclusions of the previous chapter the following is inferred:
Housing as a "complete" unit is inappropriate for
mass production and distribution—from now on referred
to as mass industrialization. The ease and speed in
handling the product within and outside the factory,
which is a characteristic of mass produced articles,
is difficult to achieve and maintain. Mass indus­
trialization is relatively easy and efficient when
housing is considered as a complex/composite product
comprised of several dwelling elements.

Albert Bemis, who advocated rationalized mass
production of housing, explained this in the following
manner:

What, then, do we mean by mass production in the
housing industry? Not mass-produced raw materials;
we have them now. Not mass-produced houses,
fabricated entirely in factories, for the house as
an entity is not adopted in bulk or weight to
manufacture in a shop or to transportation and
errection at a distance. Nor does a room unit
answer the requirements. A smaller unit, both
in design and structure, must be found in further
subdivision of the composite house.1

The dwelling elements described earlier which together are
used to form housing are small in size and light in
weight in comparison to larger modules such as com­
plete rooms or complete houses. Their functions are
more or less limited and virtually predictable.
They are, therefore, more suitable for standardi-
zation, storage and efficient handling within and outside the factory than complete housing units or modules. They are suitable also for providing a larger range of possible combinations.

(2) The unreliability of housing market makes complete units unsuitable for mass industrialization, as a steady and reliable market is essential for mass produced articles. Accurate predictions as to whether a certain style, shape or type of housing will attract a large and continuous market are difficult to make. In comparison to this, the dwelling elements by virtue of all the possibilities for their use in varied projects, are likely to have a more reliable and larger market.

(3) Because heterogeneous populations usually generate demands for non-standardized, non-uniform and differentiated housing to suit the various personal requirements, the mass production of complete units based on preconceived notions does not seem appropriate.

* For example, a standardized wall unit can be used in buildings other than housing.
The idea of standard dwelling elements or components versus complete units is favourable also because of:
(a) the fewer restrictions that their size may impose on design and assembly; (b) the possibility that they can be purchased singly or in bulk by users; and (c) the greater degree of ease, efficiency and economy in their transportation to the site that can be achieved.

It is concluded from this discussion that the production of dwelling elements based on certain uniform standards is more appropriate for housing industrialization than the production of complete units, except in certain situations. In emergency situations, adverse climate conditions, or in areas with an acute shortage of skilled construction labour, for example, the production and supply of complete units may provide a better alternative. To take one example, in the U.S.A. during the war in the early forties there was an urgent need to find emergency accommodation for thousands of conscripts. This situation resulted in the production of "instant" dwellings, entirely prefabricated in factories and trucked to the site intact. Entire townships were constructed with the use of these "instant" dwellings, such as the Willowcourt township near Washington D.C. which comprised 5,000 units and another township near Portland which comprised 10,000 units. Another example is
a twin-drum dwelling which was devised by Buckminster Fuller from standard steel grain bins to serve as house units for air crews. The production of these "dwellings" had reached 1000 units per year.\(^2\)

The discussion of industrialization for housing, however, has to go beyond the discussion of "hardware", that is, mass production of dwelling elements versus complete units. The task of co-ordination between various activities essential for production and distribution of goods is a primary concern in the organization of many advanced industries. In these industries, co-ordination is essential from the delivery stage of raw materials to the supply stage of goods to distributors and dealers. In the area of industrialized housing the task of co-ordination should encompass the work involved beyond the final phase of supply. The reason for this is that the efficiency of both off-site and on-site work phases contribute to the overall efficiency of the complete process of housing production. The on-site management and efficiency is as important as the off-site or factory management
and efficiency.* In other words, the task of co-ordination in the organization of industrialized housing should ideally cover all or most of the following activities depending on the local situations: (a) research and development, (b) design, (c) financing, (d) production and marketing, (e) delivery, (f) assembly, (g) work other than assembly of products on site such as foundations, service installations and utility connections, (i) securing permits and approvals.

In those European countries where socialistic governments provide active support for industrialized housing** some organizers of industrialized housing have been able to achieve the co-ordination through controls over land development, design, production and supply.

A National Research Council of Canada -- from now on referred to as NRC -- study noted:

* DOFASCO (Dominion Foundries and Steel, Limited) of Canada developed and constructed a housing project in Ontario in 1971. According to the Director of the project the co-ordination of production, storage, transportation and erection activities was considered highly important in order to achieve efficiency and avoid bad weather slowdowns. The project was constructed with the IBIS (Industrial Building in Steel) system of the British Steel Corporation. 3

** See "Introduction". Also see "Architecture versus Housing" by Martin Pawley.4
... These ventures reflect a philosophy that may still be surprising in the building business but it is a first principle in any serious mass production industry: one part -- the producer -- must control all inputs required to create the desired finished product ...
The producer assembles and develops the land, and produces the housing complexes offering the client desirable design, place, quality and price within the desired time. 5

The high degree of government involvement in industrialized housing systems and the necessity to establish controls over as many phases of a project as possible have resulted in centralization of industrialized housing in some European countries. This trend of centralization to achieve more productivity, faster growth and greater efficiency is comparable to that of large and productive industries of North America.

The NRC study noted that "totalkontrakt" schemes akin to package deals have become quite common in Scandinavia where government, semi-government and non-profit institutions are major clients for a number of housing complexes. Centralization is considered essential in such cases to achieve economy and efficiency. From start to finish a majority of decisions affecting the design, production and distribution of industrialized housing are centrally made. This has been largely the case in multiple housing

* North European industrialized housing systems.
systems.*

Various examples from the European housing systems show that some of these "totalkontrakt" and centralized systems based on the principles of mass production and mass marketing of housing have achieved substantial success (in terms of productivity and efficiency) in the market. The degree of this success, however, in terms of architecture and planning has been questioned by various urban designers and social planners. They suggest that those trends in industrialized housing which stem mainly from the mass production concepts of other industries, such as automobile manufacturing, are not always desirable from the point of view of the ultimate users, that is, the dwellers as well as from the point of view of the environment that is created. The mass produced and centralized systems of Russian housing is one example. An increasing demand and awareness for participation by users** is perhaps indicative that dissatisfaction does exist to one degree or another for all centrally designed and mass produced housing.

* For example, Larsen and Nielsen (Denmark), and Elementhus (Sweden).

** Assuming for the time being that participation is always desirable and workable, as argued in such diverse works as: Advocacy Planning, Supports by N.J. Habraken, Pattern language by C. Alexander, John Turner's Housing by People, the Take Part approach of Lawrence Halprin and the Habitat 1976 proceedings.
N. J. Habraken, a Dutch architect, has established a research group in Holland in order to provide an alternative to the present mass housing systems and strategy.⁷

In addition to the view that centralized organizations of mass produced housing may create stereotyped environments by not allowing for the diversity of needs of the potential occupants, such centralized organizations do not seem favourable from the following points of view: (a) the localization of housing markets which depend on the availability of materials, labour and equipment, local building requirements and local community needs; (b) the availability and economy of transportation, for example, in Western Europe, a British study concluded, because of the highly developed rail and road system some manufacturers of industrialized housing have found it economical to concentrate their plants in few areas and transport components to sites;⁸ and (c) the local geographic conditions, for example, in parts of Scandinavia, the rugged topography and cold climate have influenced the population distribution. The population is grouped in relatively isolated, mushrooming pockets meaning the housing market is concentrated in these isolated pockets. This creates localized situations in the market.⁹

The following points emerge from this discussion:
(1) Some form of control and co-ordination over various phases of housing industrialization—from production to final assembly on site—is desirable.

(2) Centralization brings efficiency and control which is desirable from the point of view of industrial production.

(3) Centralization may not allow for various local factors which may generate a diversity of market conditions and user requirements.

Considering these points, a conclusion is drawn that any strategy for housing industrialization, that is, organization and planning, should plan for controls, co-ordination, and centralization within local contexts. For example, total or maximum control over land development, production and assembly is possible only within certain sociopolitical situations such as those of Northern Europe where, as the NRC study mentioned earlier noted, governments provide large financial and political support to industrialized housing; labour/management disputes are not frequent; a major percentage of housing projects is multifamily housing complexes.10

In North America the situation is somewhat different. Here, there are many large and small competitive builders
operating individually; governments and local authorities maintain a low profile in the traditional "free" market system; the land development, financial and labour institutions are essentially autonomous; a large percentage of the population traditionally prefers single houses with private yards which means that the market comprises many individuals and families acting as independent customers.

Such existing traditions of the local building business have been recognized by one of the more commercially successful home manufacturing firms in the U.S.A.—National Homes Corporation. As a result the company, instead of imposing complete controls in different phases of house productions, chooses to provide a full range of optional services including financing,* occasional land development and improvement, and on-site work management through franchised builders operating in as many as 38 states.¹¹

The co-ordination of both off-site and on-site works is essential for efficiency. The present North American situation means that most of the off-site factory work can be fully controlled by management whereas the on-site work or post-delivery work should be co-ordinated to the maximum extent possible by management.

* For customers and builders alike.
The earlier inference that centralization is both essential and non-desirable from various viewpoints raises the question about the degree of centralization necessary in a given context.* For example, due to the localized markets of the isolated community pockets which exist in Scandinavia, some of the local producers of industrialized housing have chosen to decentralize production by introducing on-site or local factories** along with regional factories. For instance, one Finnish manufacturer (A. Puolimatka OY) has developed an example of central/regional factory balance. The central factory produces pre-cast components such as exterior walls, bathrooms, ducts etc. The regional factory is responsible for the supply of lower cost and bulky cross-walls and floor panels, all phased and planned for site co-ordination.\textsuperscript{13}

\* E.F. Schumacher, the author of Small is Beautiful, notes in the book that many industries, e.g. automobile manufacturing, are to one degree or another centralized and decentralized at the same time. Total centralization, for various reasons, is rarely possible and feasible. \textsuperscript{12}

\** At present, however, the site factories can be used economically only for large projects because of the time and money entailed in moving them. The NRC study mentioned earlier notes that because of its compactness, ease of sheltering and heating, and freedom from requirements for massive base rigidity, there appear to be no severe drawbacks inherent in this approach for small projects.
Mobile production plants are also becoming common, for example, the Wates system in England. In northern Manitoba, with provincial government assistance, a program called "Ready-To-Move" (R.T.M.) was started in 1970-71. Under this program mobile units with small scale machines and tools go to northern communities once or twice a year. With the help of local people these units manufacture a number of small and simple wood components for houses. Once a certain number of houses are completed and local requirements are fulfilled, the units move to another community. Cold climate, shortage of skilled labour, availability of light weight material such as wood for construction, resentment of native northerners for southern designs and construction as well as the unwillingness of manufacturers to establish factories because of an unattractive and non-continuous market in the area were some of the reasons for the introduction of the R.T.M. program.

This type of approach, or the central/regional factory

* "Programs are the life-style of officials. We want to talk about how a family in any community can decide what is best for itself. We think it is wrong that a house in the north must be made of expensive, southern materials, simply because this is what a program provides." This was stated by a native during a conference on Northern Housing.
approach to the planning and production of industrialized housing usually means lower capital investment,* efficient work and the possibility of community involvement.

Such decentralized production facilities can have central management or be centrally organized in order to benefit from the efficient planning and co-ordination which centralized systems seem to provide. Depending on the local sociopolitical situation the central management/organization may be provided by either governments, or by one or more large manufacturers with incentives from governments, or jointly by both government and manufacturers.

Such "centrally organized, decentralization" can benefit from: the use of local labour and materials, the reduction in the costs and inconveniences of long distance trans-

* A study carried out by the School of Architecture, Halifax, Nova Scotia (sponsored by the Atlantic Industrial Research Institute) on similar programs in 1971 reported that for portable units using wood for production with a capacity for 300 houses/year production in Nova Scotia, the capital investment required will be approximately $156,000. Depending on local factors, this may vary from one region to another. Therefore regional analysis in detail should be carried out prior to introduction of such methods. The materials used for production of components should be also analyzed. Concrete, because of its requirement for special skills and equipment may add to the capital cost of such plants.
portation, the expansion of the market as a result of local community involvement as well as from the side effects of economic development of the area that such an approach may generate.

It is inferred from the foregoing discussion that maximum possible co-ordination, efficient marketing and fulfillment of localized requirements can result from the comprehensive planning and organization of industrialized housing which has taken into account the local situation. The comprehensive planning should encompass all processes (both off-site and on-site work processes) necessary for efficient industrialization of housing. Such processes would include particularly design, production and assembly.

Conclusion

The characteristics of housing, considered as a physical product, distinguish it from any other comparable product. Therefore, to produce and market housing like these products

* Various studies on industrialized housing come to a general conclusion that 300 miles is the maximum limit for the economical and efficient transportation of housing assemblies to the site from the factory. The limit may vary by few miles depending on the local situations. See "Prefabrication of Houses" by Burnham Kelly and "The Case for Industrialized Housing Re-examined" by Hodes Daniel and Jensen Gordon. Refer to Bibliography, pp.155.
is inappropriate. To limit its industrialization to the aspects of "hardware" production (components, modules etc.) alone is also inappropriate. Comprehensive planning and organization based upon the characteristics of housing, localized requirements and other local factors such as geography and population distribution should form an essential part of housing industrialization. Efficient planning, production and assembly of products both within and outside the factory is a vital part of such organization. Affordable and satisfying housing produced efficiently with minimum wastage should be offered by the planners and the suppliers of industrialized housing in order to make it more attractive in comparison to conventionally planned and produced housing.
FOOTNOTES:


4. Pawley, Architecture, passim.


6. Platts, System Production, passim.


10. Ibid., passim.


15. Ibid.
Industrialization is normally characterized by mass production, mass distribution, organization and planning. Mass production of standardized articles has the potential of resulting in reduced wastage of materials and increased speed of production.

The two essential considerations in organization and planning for any industry are: (a) maximum control/coordination of production and distribution phases, and (b) the degree of centralization within the industry.

In the case of industrialized housing industry these are influenced by the regional conditions such as localization of the housing market, traditions of the building business, geography, transportation, and availability of capital investment.

A complete control of all phases of housing industrialization and total centralization which go together, will likely bring efficiency and control over the quality of the product but complete control and total centralization is not always feasible and desirable from various viewpoints such as housing characteristics, government
policies, and other conditions described above.

The prerequisites of the availability of transportation, a continuous and stable market, the availability of capital and labour as well as the government policies conducive to industrial development must exist for the long term development of industrialized housing.

Providing such prerequisites exist, industrialized housing could have the following potentials:

(1) Reduced production costs because of reduced wastage.

(2) Increased control over quality of products.

(3) Increased speed of production.

(4) Decreased amount of time and labour in the provision of affordable and standard houses in areas where building is difficult because of adverse climate conditions and shortage of skilled labour as well as building materials.

Despite such benefits however, industrialized housing would not be desirable if: (a) housing, which is a product different from any other in many aspects, is produced and marketed in the same manner as products such as cars are
produced and marketed; (b) the environments created are stereotyped; and (c) its production and distribution is used for the sole purpose of profit making.

Whether a particular strategy or form of industrialized housing is desirable or undesirable is largely dependent on factors such as the motives of its producers and suppliers, the prevalent political systems -- whether socialistic or capitalistic, the methods adopted for design and production of houses, and the prevalent social traditions.

Since industrialization is a dominating factor of our times and since its role in the field of housing production is likely to expand, our aim should be to analyze the local situation and the prevailing methods of industrialized housing in order to determine the desirability of these methods in the local context.
SECTION: 3

CONTEXT OF BRITISH COLUMBIA
Illustration: 4 British Columbia
3.1

PROVINCIAL CONDITIONS

Local geography, market distribution and transportation:

British Columbia is essentially mountainous. Its vast and rugged topography is the main feature of its geography. The presence of the Pacific Ocean in the west and the mountainous terrain in the west and east has resulted in a varying climate.* Because of plentiful precipitation a large part of the mountainous terrain is covered with forests which supply the chief building material used in the province -- wood. Since it is abundant in supply, the wood and its products are not as expensive as any other building material.

To large extent, the mountainous terrain and the climate have combined to influence the distribution of population (Illustration: 5) and the transportation infrastructure (Illustration: 6) within the province of British Columbia. These two factors -- population distribution and transportation infrastructure are the

* The climate varies from temperate-like in parts of southwestern British Columbia to sub-arctic in northeastern British Columbia.
Illustration: Population Distribution

Illustration 6 Transportation Infrastructure of British Columbia

1. Vancouver
2. Victoria
3. Nanaimo
4. Port Alberni
5. Penticton
6. Kelowna
7. Vernon
8. Kamloops
9. Cranbrook
10. Prince George
11. Dawson Creek
12. Prince Rupert
basic indicators of the market availability which is an essential prerequisite of industrialized housing. Therefore, these two factors are briefly examined in the context of seven geographic subdivisions of the province (Illustration: 6) which are as follows:

1. Georgia Strait.
2. Coastal.
3. Okanagan-Thompson
5. Central Interior.
7. Northern Interior.

Each of these regions has developed a character of its own through the differences in its physical geography, land use and population concentration.

1. The Georgia Strait is the most densely populated and highly developed area of the province. More than 75% of the total provincial population reside in this area. Most communities are well connected to one another by roads and railways (Illustration: 7). Two of the largest cities of the province -- Vancouver (410,000 population)*

* Population figures for various places in British Columbia are shown in (Table: 1), pp. 187
GEOGRAPHIC SUBDIVISIONS:

A - Georgia Strait
B - Coastal
C - Thompson - Okanagan
D - Columbia - Kootenay
E - Central Interior
F - Peace-Liard
G - Northern Interior

* See the following page for reference to numbers on the map.
### ILLUSTRATION: 7. (cont'd...)

#### Cities (over 10,000 Population):

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<th>Rank</th>
<th>City</th>
<th>1976</th>
<th>1971</th>
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<td>1</td>
<td>Vancouver</td>
<td>410,188</td>
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<td>Victoria</td>
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<td>3</td>
<td>Prince George</td>
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<td>4</td>
<td>Kamloops</td>
<td>58,311</td>
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<td>5</td>
<td>Kelowna</td>
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<td>6</td>
<td>Nanaimo</td>
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<td>7</td>
<td>Penticton</td>
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<td>Port Alberni</td>
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<td>9</td>
<td>Vernon</td>
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<td>10</td>
<td>Prince Rupert</td>
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<td>Cranbrook</td>
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#### Towns (over 5,000 Population):

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<td>Sidney</td>
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</tbody>
</table>
and Victoria (62,500 population) -- are located in this area. Port Alberni (19,500 population) and Nanaimo (40,300 population) are other large cities located here. (Illustration: 7)

(2) The Coastal region is sparsely populated. The population is scattered along the Pacific coast and is concentrated in few locations. The rough terrain of the Coastal mountains and the sparse population have not encouraged road building in this area. The communities are served largely by sea transportation. The major towns located in this area are Prince Rupert (14,700 population), Kitimat (11,900 population) and Terrace (10,200 population).

(3) The Okanagan - Thompson region is populated mostly in the area between and along the Okanagan and the Thompson Rivers. An infrastructure of roads and railways in this area links most communities to each other. Kamloops, with a population of about 58,000 is the largest community in this area followed by Kelowna (51,900 population), Penticton (21,300 population) and Vernon (17,500 population).

(4) The Columbia - Kootenay region contains a major part of the Columbia and Rocky Mountains. Its geographic features such as rough terrain, deep valleys
and plentiful precipitation do not attract large populations and extensive developments. Trail (9,900 population), Nelson (9,200 population), Cranbrook (13,500 population) and Kimberley (7,100 population) are the largest communities in this area.

(5) The Central Interior region, like the Okanagan-Thompson region, is rapidly developing and is served by a network of railways and roads. A large percentage of the regional population is located in the vicinity of the Fraser River. Prince George (59,900 population), Quesnel (7,600 population) and Williams Lake (6,200 population) are the three growing, sizeable communities* located in this region.

(6) In the Peace-Liard region the only populated areas are in the southeast corner on the Peace River and a small area in the vicinity of the Fort Nelson River in the north. The regional population is sparse and largely concentrated in few sizeable communities which are Fort St. John (8,900 population), Fort Nelson (2,900 population) and Dawson Creek (10,500 population). The rest of the

* The population figures of these communities in 1971, compared to 1976 figures as given above were respectively 49,800, 6,300 and 4,100.
communities are small isolated groups of 10 to 250 people each.

(7) The Northern Interior region constitutes a large area with relatively small population. This region has remained virtually undeveloped as it lacks resources for economic development. Cassiar, the largest community, has a population of less than 500 people, located in isolated groups.

This description and the accompanying illustrations show the following points which could have a bearing on the existing and future situation in the industrialized housing of the province of British Columbia:

(1) The population of British Columbia is unevenly distributed. A large percentage of the total population is concentrated in relatively few locations of the southern half of British Columbia, notably in the Georgia Strait region, parts of the Okanagan-Thompson Valleys, the Kootenay region and the Fraser uplands of the Central Interior.* The rest of the province is sparsely populated

* Approximately 75% of the total provincial population lives in the Lower Fraser Valley and the eastern lowlands of the Vancouver Island; 15% of the population lives in the Okanagan Valley area; the rest (10%) lives in the vast region of central and northern British Columbia.
in isolated places. Population of the northern half of British Columbia is concentrated mainly in a few locations such as Prince George, Dawson Creek, Prince Rupert and Kitimat. The metropolitan areas of the Georgia Strait region are large conurbations (Greater Vancouver and Greater Victoria) in contrast to the small, scattered urban nuclei (Kamloops, Kelowna, Cranbrook etc.) and the isolated concentrations of rural population in the rest of the province. The Okanagan-Thompson and the Central Interior regions are the two steadily growing areas of the province.*

Although the population of Fort Nelson and Fort St. John in the Peace-Liard region have increased over the last few years, the increases are small and they remain isolated examples of population growth in the northeast corner of the province.**

Based on the population distribution a general pattern of potential housing market distribution can be

* The populations of each of these two areas have increased by approximately 20 to 25% from 1971 to 1976. Approximately 50% of this increase took place in the urban centres such as Prince George, Kamloops, Kelowna and Penticton. The rest of the increase was in small towns of Quesnel, Merritt and Williams Lake as well as in villages such as Princeton, Fort St. James and Vanderhoof.

** The populations of these two places, respectively, increased from 2,289 and 8,303 in 1971 to 2,916 and 8,947 in 1976.
determined. From this consideration, a conclusion is drawn that the market is fragmented and unevenly concentrated. Most of the market is in the Lower Fraser Valley, southern Vancouver Island and in parts of the Okanagan Valley and the Central Interior. In the northern parts of the province — such as in the Peace-Liard region — there is a relatively small market, particularly for permanent dwellings. The large urbanized areas of the lower Fraser Valley and southern Vancouver Island generally seem to provide prospects for stable urban markets in contrast to the relatively non-continuous and fragmented markets of the scattered urban and rural concentrations of the rest of the province.

(2) Although the large communities are served by a close network of roads and railways, the rugged terrain and the small size of several communities in most of the

* It is noted, however, that population distribution alone is not an exact indicator of housing-demand distribution. Housing-demand is influenced also by factors other than population distribution — such as household formation, age group distribution, income distribution, employment and mortgage availability. Since this thesis is limited in scope and since such detailed investigation would be time-consuming, the readily available data of population distribution is considered to arrive at a broad overview of potential market distribution.
province have deterred the expansion of this network over a large area of the province. The coastal communities, for example, have to rely largely upon water transportation and air service. In the northern part of the province the transportation is difficult and slow, particularly in winters. Also, large distances between the few sizeable communities located here make transportation uneconomical. For example, between Prince George and Dawson Creek, for a distance of about 260 miles, there is only one community of more than 1200 people - Chetnwyd. Rest of the communities have less than 250 people. Between Dawson Creek and Fort Nelson, for a distance of 300 miles, Fort St. John is the only community with a sizeable population of about 9,000 people. The rough mountainous terrain of British Columbia also means the existence of mountain passes and tunnels in several parts of the province. Such passes and tunnels normally impose restrictions on the dimensions of goods to be transported and on the mode of transportation.* Since the ease and efficiency of transportation is an important criterion for industrialized housing, such restrictions limit the design and construction aspects of these housing. The limitations

* This is discussed in detail later in this thesis. See pp. 73, 131
affecting mobile homes is a well known example.  

(3) The varying climatic conditions of the province could give rise to differences in housing design and construction requirements in some regions. The colder climate of the northern regions of the province such as that of the Peace-Liard region entails maximum retention of heat within a house, maximum exposure to the Sun in winters and protection from the sub-arctic winds. In order to provide for environmentally appropriate housing, all housing design and construction solutions must evolve out of a direct response to the local climate.*

Capital investment and Government policies

The availability of capital for investment purposes is an important prerequisite of industrialization. British Columbia, like the rest of Canada, has been experiencing a slow economic growth over the last few years. Capital investment in industrial development is low. As recently as in September 1976 the British Columbia Chamber of Commerce, at its annual conference, expressed

* For example, smaller windows to reduce heat loss; thicker walls or the use of material with high insulation value; compact forms of houses (△ or □, for instance) in order to minimize exterior surface area; and minimum obstruction on the exterior surface to avoid heat loss through minimum resistance to cold winds. 4
concern over this situation and called on the provincial government to take steps to regain investors confidence in the provincial economy. Large-scale industrialization based on centralized mass production inevitably requires large-scale capital investment and a guaranteed, continuous market. The fluctuating market for new, detached housing (which is dominated by variously competitive builders of site-built houses) does not appear to attract large capital investment. This is evident especially during the current period of slow economic growth and economic restraint. In addition to this situation, the view that a greater degree of capital investment result in a greater degree of centralization, commercialism and indifference to localized market needs suggests that the methods of industrialized housing utilizing relatively lower amounts of capital should be investigated. Such methods could be adopted until the market conditions and investment situation would warrant otherwise.

To certain extent, in addition to the motives of the

* The market for such houses is low at present because of various reasons such as: (a) slow rate of population growth; (b) reluctance of people to buy houses due to rising unemployment; (c) continuing inflation and slow economic recovery; (d) decrease in population of some areas; (e) surplus of houses in some areas; (f) rising land costs; and (g) growth of interest in housing rehabilitation.
investors and manufacturers of industrialized housing, the compatibility of industrialized housing methods with local conditions depend also on government policies concerning housing. Traditionally, governments of this province have maintained a relatively low profile (until recently) in this field. This is largely due to the traditional system of "free" market. Long-term, comprehensive policies dealing with various aspects of housing, besides the provision of financial aids, have been mostly absent. Except for a report on mobile homes and a small report on the package and modular housing industry of British Columbia (1975), no major studies have been done on current methods, consequences and problems of industrialized housing in the province. An Interdepartmental Study Team in 1975 noted that, until 1973, the province of British Columbia did not even have a separate ministry of housing. Particularly now when the use of industrially made parts and modules is increasing in the field of housing, long-range comprehensive planning for industrialized housing should form an essential part of the provincial housing policy.

* Examples of the importance of long-range policies are found in some European countries. In Denmark, for example, until 1960 there was no long-term government planning for housing. The first steps which enabled this were taken in 1960 by the Danish government. From the Danish viewpoint this planning was of the greatest importance to the development of industrialized housing in that country.
Conclusion

The local geographic conditions and the pattern of population distribution have together resulted in the existence of localized housing markets situated mostly in the southern half of British Columbia. A large percentage of the fluctuating market of the traditionally preferred detached houses is concentrated in relatively few locations of this province. This market is particularly located in the metropolitan areas of the Georgia Strait region and in the small urban nuclei of the Central Interior, the Okanagan-Thompson and the Columbia-Kootenay regions. Compared to this, only a small market exists at present for permanent, detached houses in the Peace-Liard region in the northeast corner of the province.

A low level of provincial government incentives in the traditional "free" market system, a lack of long-range comprehensive planning and the relatively small size of projects offered by the fluctuating market of detached houses deter large-scale and continuous capital investment in housing production.

Large-distance transportation in much of the province is difficult and restricted due to the existence of tunnels and mountain passes in the essentially rugged
terrain. Such transportation is also expensive in parts of the northern province because of large distances between sizeable communities.

Most communities in British Columbia are small and they do not have the potential for a continuous demand for new housing.

In order to determine the compatibility of the existing methods of industrialized housing within the province, considerations of the local situation -- such as the above -- are essential. As industrialization deals with continuous, quantity production and depends on a guaranteed market to justify investment, thorough consideration of local situation provides a firm economic basis. This consideration should form an important part of organization and planning of industrialized housing in British Columbia.
3.2

REVIEW OF EXISTING INDUSTRIALIZED HOUSING OF BRITISH COLUMBIA

At present a number of industrialized products, including prefabricated and pre-cut products, for housing are offered on the local market. Such products are:
(1) components  (2) mobile homes,  (3) package housing,  
(4) modulares and sectionals.

(1) Components:

Components -- such as doors, windows, cabinets, furniture, sanitary units, trusses and panels -- are manufactured by several independent secondary industries in a wide range of finishes, prices, sizes and standards.

(2) Mobile Homes:

A mobile home is a portable, vehicular unit, intended for use as a single detached dwelling. It is built on its own chassis and transported on wheels, as a vehicle, to a piece of land which is specifically designated for mobile homes. The unit may be supported with a permanent foundation. It may have been manufactured in accordance with approved construction standards
and codes. Most manufacturers of mobile homes follow a standard established or accepted by the mobile home industry itself. In this province, all new mobile homes are required to conform to the Canadian Standard Association's standard no. Z 240.

The provincial highway regulations limit maximum body dimensions of a mobile home to 12'-1" for width and 68'-0" for length, including the hitch. Projections may extend 0'-5" beyond the 12'-1" allowed width. Sometimes even 12' wide mobile homes are not permitted on certain roads within the province owing to the narrowness of tunnels and bridges. The maximum height of a load to be transported (or of a vehicle) may not exceed 13'-6" which is measured from the ground to the top of the load. 10

Although there has been an interest and a suggestion for developing mobile home units which can be combined with other units, can be expanded by "folding-out", or can be stacked upon one another, there is no doubt that the highway limitations have considerably minimized design and distribution possibilities for mobile homes. This will hold true in spite of the future possibility that 14' wide units will be allowed on the highways.
(3) "Package" Housing:

A kit of prefabricated or pre-cut components such as exterior/interior walls and roof sections are manufactured in a factory for assembly on site. A permanent foundation is constructed prior to assembly. The components are assembled in a particular manner following a predetermined design. The ultimate product—a house—conforms to building codes and qualifies for long-term mortgages.

(4) Modulars or Sectionals:

These units are similar in some respects to mobile homes. For example, they are factory-manufactured, portable units intended for use as dwellings after being transported to a site and placed on a foundation. Since they are transported as complete units, as are mobile homes, the same highway restrictions that apply to mobile homes also apply to their transportation. They differ from mobile homes in following respects:

(a) A modular or a sectional is not a vehicular unit. It does not have its own chassis and wheels. It has to be transported on a
specially built truck.

(b) It is permanently attached or placed on a foundation. It cannot be moved again once it is attached to the foundation.

(c) It meets approved construction standards and qualifies for long-term mortgages like conventionally built houses.

In the case of a "sectional", instead of only one modular unit, either two or more units are combined on site to obtain a desired and predetermined house design.

At present the industry primarily concentrates on the production and supply of single detached houses with both the "package" and the "modular" concepts. These houses are essentially "stud-wall" structures.

The following discussion deals mainly with the "package" and "modular" housing industry. The mobile homes are not studied in detail because of the following reasons:

(a) In this author's view, the changing requirements of the housing market as, for example
a rise in multi-family, high density dwellings and pressures to limit suburban growth will make mobile homes either less viable in the rapidly urbanizing areas of the province,* or they will change in their design, construction, and distribution approaches by a considerable degree.

(b) "Mobile homes", by virtue of their definition as predetermined three-dimensional volumes, have a limited scope for design, space utilization and construction method improvements. The size and shape of a mobile home is likely to remain restricted because of the limits placed by factory size and highway regulations. Even if 14' or 16' wide units are permitted on highways, always there will be some roads, tunnels, mountain passes and bridges within the province narrower than the allowed width for mobile homes. This situation will limit their wider distribution.

* A similar opinion has been expressed by the Provincial Inquiry Commission appointed in 1975 to carry out studies on the problems and prospects of the provincial mobile home industry.\[^{11}\]
(c) A number of studies pertaining to mobile homes in Canada as well as in this province have been prepared by university students, mobile home manufacturers, CMHC, city planning departments, governments and other agencies. The mobile home industry is highly organized, committed to a certain approach, well developed and aware of what is expected from it and what is it capable of offering. In addition, more than 50% of mobile homes sold in this province are manufactured in and imported from the U.S.A.

Some reference will be made to mobile homes; however, the discussion will deal basically with that segment of the industrialized housing sector which is concerned with "package" and "modular" housing.

In this Province there are several firms involved in the production of package and modular housing, but only a few of them are involved on a year-round basis. They offer a range of types and sizes of houses ** which are based

* Mobile home development, however, is an important phenomenon in housing. Mobile homes are an attractive alternative to conventional forms of housing. This is evident particularly in those areas of the province where on-site house building may be difficult either due to high labour cost or adverse climatic conditions.

** Largely detached houses.
on a certain number of predetermined designs. Some firms also offer to manufacture for "custom designed" plans.

The following discussion is based mainly on data gathered during visits to the manufacturing plants of some firms. (Illustration: 8) The data on other firms is obtained from available literature. A majority of the firms included in the following study have been in steady business over a number of years ranging from approximately 7 to 25 years. These firms occasionally engage in the promotion of their products through newspaper advertisements, magazines, press meetings and exhibitions.

It is not unrealistic to assume that these firms present a more or less true picture of the industry, especially in view of the uncertainty and instability of many other firms. It appears unlikely that such firms (the ones not studied) would have an approach different from the one discussed in the following pages, even if they were in steady operation. The names of the firms visited or referred to in the discussion are as follows:


4. Mariner Homes, Penticton.

All of the above firms were visited by this author. Information on the following firms is obtained from the available references.

5. Elba Homes, Prince George.

6. Beaver Homes, Surrey.
1 - Pan-Abode Buildings Ltd., Richmond
2 - Westwood Building Systems, New Westminster
3 - F.G. Fowler & Associates, Surrey
4 - Mariner Homes, Penticton
5 - Elba Homes, Prince George
6 - Beaver Homes, Surrey

Illustration 8 Location of Firms Studied
Description of the Products and Production:

1. Company: PAN-ABODE BUILDINGS LTD.
   2090, Westminster Highway, Richmond.
   In operation since 1948.

Off-Site work:

Packages of pre-cut wood parts for the following items are made available by the manufacturer:

- Floor framing.
- Interior and exterior wall parts in 3" or 4" cedar.
- Roof purlins and roof sections.
- Preassembled door and window framing.

Prehung doors and glazing are also available.

The packages are for the assembly of bare minimum "shells" based on 14 different predetermined house designs. Packages for custom made designs are also available at higher costs.

Generally, no insulation is incorporated in the package parts. Insulation materials, however, are supplied.

* This description and the accompanying illustrations are actual data only as supplied by the manufacturers. No attempt is made at this point to analyse these data.
upon request.

The parts are supplied with precise machine-cut notches for joints at predetermined points of connection.

**On-site work:**

The manufacturer limits his services to on-site delivery of the packages. The delivery costs, however, are extra.

All site work is the responsibility of the customer who may choose to do the work himself or may hire a contractor for this work. The site work includes the following:

- Foundations.
- Basement work (no parts are supplied for this work by the factory).
- Finishing and furnishing work.
- Insulation work that may be required (If requested, the insulation materials are included in the package).
- Assembly work for the package parts.
- Service installation and utility connections.

**Ultimate product:**

Usually this is a single storey detached house for use either as a year-round residence or as a vacation
house. The construction conforms to the National Building Code of Canada (N.B.C.) and local building codes.

The predetermined designs range from 831 sq. ft. for a 2 bedroom house to 2006 sq. ft. for a 5 bedroom house, all without basements.

The factory price for one of the average 3 bedroom package houses of 1262 sq. ft. area is quoted as $17,664.00* (with 4" thick cedar parts).

This price does not include delivery costs, provincial sales taxes, on-site work costs, service installation costs and land purchase price.

* 1977 prices.
1. The Pan-Abode logs are pre-cut to length and coded to identify their location.
2. Door and window openings are formed during assembly of the walls.
3. The roof system is Western Red Cedar boards supported by purlins.
4. The Pan-Abode package includes all the interior and exterior trim needed to finish the building in an attractive fashion.

Illustration: Assembly of a typical Pan-Abode house.
2. Company: WESTWOOD BUILDING SYSTEMS

2, Ewen Avenue, New Westminster

In operation since 1960.

Off-site work:

Three basic alternative systems are offered:

(A) Package housing:

packages contain components such as the following:

- Roof trusses and roof ends.
- Interior and exterior walls.
- Floor sections.
- Door and window units.
- Kitchen cabinets.

Materials necessary for basements, and other materials such as bathroom tiles and wall papers are included in the packages, depending on the order.

The packages are based on 40 predetermined designs. Custom made designs are handled at extra costs.

Wall components are typical stud-walls. The chief material used is kilndried timber for framing work and plywood for sheathing.
(B) "Service-Core" houses:

In this alternative, called the "Westcore" system, a module comprising of a kitchen counter with cooking range, and a bathroom unit with "all plumbing, electrical wiring and heating units preinstalled", is supplied as the "core" of a house. Along with this service-core, prefinished, insulated and serviced wall and roof components are supplied.

(C) Modular or "Pre-built" module system:

Modules ranging from 12' x 38' to 12' x 60' are prefinished with services incorporated, that is, electrical wiring, plumbing and heating. The maximum height of a module normally does not exceed 10'-0" (including roof) due to highway restrictions. The modules are furnished with carpets, wall papers, cabinets etc.

The modules may be used singly or in combination with other modules. 9 predetermined configurations are offered by the manufacturer which are based on the use of two uniformly dimensioned modules. Custom made designs are handled at extra costs.

* See pp. 73
On-site work:

The manufacturer limits his responsibility up to the stage of on-site delivery of modules.

All site work is the responsibility of the customer who may choose a contractor to do the job or he may do it himself, particularly in the case of a "package" house. Either way, a manual for carrying out the work is provided by the manufacturer upon request.

In the case of "package" housing, the site work includes the following:

- Foundations.
- Basement when it is included in the order.
- Finishing and furnishing work.
- Assembly work for the package components.
- Service installation and utility connections.

In the case of the "Westcore" system, the site work includes all of the above operations except the service installation and finishing work. In addition to this, the on-site work includes the "setting-in" of the "core" units on foundations.

In the case of the "Modular" system, the site work includes all of the above operations with the exception of
the finishing, the "setting-in" of the modules on foundations and the joining of the modules to each other.

Ultimate product:

Usually this is a single storey or a double storey detached house for use either as a year-round residence or as a vacation house. The construction conforms to the N.B.C. and local building codes.

In the case of "package" housing, the houses range from 815 sq. ft. for a 2 bedroom house to 1240 sq. ft. for a 3 bedroom house. The factory price for a standard 3 bedroom house of single storey (without basement) is in the average of approximately $10,000 to $12,000 with sizes ranging from 1066 sq. ft. to 1240 sq. ft.

The price does not include delivery costs, provincial sales taxes, on-site work costs, service installation and land purchasing costs.

No prices or sizes for the "Westcore" system are available at this time.

In the case of the "Modular" system, the designs range from a 2 bedroom house of 864 sq. ft. to a 3 bedroom house of 1200 sq. ft. No price lists are available at this time.
THE CASABELLA

Total floor area: 1668 square feet.
Three bedrooms, 1½ bathrooms, powder room, family room, double garage.

With its tiled inner courtyard, graceful archways and merging, terra cotta roofs, here is a beautiful family home carried out in the true Spanish tradition. Yet it lacks none of the essentials to modern living. From the foyer, through double doors one enters the finely-appointed living room, with its handsome fireplace, graceful arched windows and sliding doors leading to a patio. A folding screen closes off the dining room from the foyer. The family room is located at the rear, permitting a second centre of activity for groups such as children or teen-agers. The upstairs sleeping area consists of three bedrooms, with the master bedroom en suite. A walk-in closet in two bedrooms is an added feature. Apart from its rational floor plan, this home is notable for its individual character carried out to the last detail.
3. Company: F.G. FOWLER AND ASSOCIATES,
   6630, 144th Street, Surrey.
   In operation for approximately 20 years.

Off-site work:

   (A) "Package" housing:

   Packages of pre-cut parts and preassembled components
   containing the following items are supplied, based on 22
   predetermined house designs. The packages include:

   - Preassembled and insulated exterior and
     interior walls.
   - Floor framing parts.
   - Roof sections.
   - Door and window units.
   - Plumbing wall units.

   (B) "Modular" housing:

   Modules ranging in size from 12' x 38' to 12' x 60'
   are prefinished and prefurnished including service
   installation, carpets, wall papers, sanitary fixtures etc.
   The maximum height for the modules are generally 10'-0"
   (including roof).*

   * Roof, however, may be manufactured separately from
     modules. In this case the maximum height of a
     module may be increased up to 10'-0".
For two-module combinations, 29 predetermined house designs are available. In this case, both of the modules in any one design are of the same size.

The chief building material used is kilndried timber. Plywood is used for sheathing in both the "package" and "modular" housing production.

On-site work:

All site work is the responsibility of the customer.

In both the "package" and the "modular" housing, this work would include the following:

- Foundations.
- Basement, when it is included in the order.
- Service installation and utility connections.

The assembly work, the finishing work and the furnishing work are additional in the case of a "package" house, whereas in the case of a "modular" house, the additional work includes the placing of the modules on the foundations, and the joining of the modules to each other.

Ultimate product:

This is usually a single storey or a one-and-a half storey detached house for use either as a year-round house
or as a vacation house. The construction conforms to the N.B.C. and local building codes.

The "package" housing are available in the ranges of 864 sq. ft. (2 bedrooms) to 1352 sq. ft. (3 bedrooms).

The factory price for a standard 3 bedroom house is in the average of $10,000 to $12,000.

The "modular" houses range from 912 sq. ft. (2 bedrooms and a basement) to 1296 sq. ft. (3 bedroom and a basement). The factory price for an average 3 bedroom house (without basement) is in the average of $22,000 to $24,000.

None of these prices include delivery costs, provincial sales tax, on-site work costs and land purchase prices.
4. Company: MARINER HOMES,
568, Dawson Avenue, Penticton.
In operation since 1969.

Off-site work:

(A) "Package" housing:

Packages for 22 predetermined designs are supplied which contain the following items:

- Roof trusses and roof ends.
- Door and window framing.
- Floor sections.
- Interior and exterior walls with insulation.

Custom made plans are handled at extra costs.

(B) "Modular" housing:

Modules range in sizes from approximately 10' x 38' to 12' x 60'. There is also a module of 12' x 15'. Out of 11 predetermined configurations, 10 are two-module combinations whereas the remaining one is a three-module combination. The maximum height of a module does not ordinarily exceed 10'-0" (including roof).

All modules are prefinished and prefurnished with necessary service installation and insulation.
On-site work:

All on-site work is the responsibility of customers, with the exception of placing and joining of the modules on already constructed foundations.

(A) Package housing:

The site work includes the following:

- Foundations.
- Basement, when it is included in the order.
- Assembly of the package.
- Finishing and furnishing.
- Service installation and utility connections.

(B) Modular housing:

In this case, the site work includes all of the above operations except service installation, assembly, finishing and furnishing.

The placing and joining of the modules on foundations is additional site work.

Ultimate product:

With the exception of a recently introduced plan for a multi-family walk-up block, a major percentage of
production is for single family detached houses of either one or two storeys. The construction conforms to the N.B.C. and local building codes.

Designs for "package" housing range from 832 sq. ft. (2 bedrooms) to 1381 sq. ft. (3 bedrooms). The factory price is quoted as about $24,050 for a 3 bedroom house of 1100 sq. ft.

Modulars range from 960 sq. ft. (2 bedrooms) to 1248 sq. ft. (3 bedrooms). No prices are available at present.
This is the ideal family home with space to grow in. Features large living/dining/foyer areas with that open feeling, a pleasantly-different floorplan with gracious living overlooking the rear garden, cozy den and family-size kitchen.

Mayfield
2 Bedroom, Den, 1 ½ Bath, 1152 sq. ft.

STANDARD PLAN

REVERSE PLAN

Mayfield
2 Bedroom, Den, 1 ½ Bath, 1152 sq. ft.

STANDARD PLAN

REVERSE PLAN
Summary of Description of Products:

1. Off-site work:

   (a) The essential components or preassembled parts such as roof trusses, exterior and interior walls, or floor sections are manufactured and sold only as parts of complete "packages".

   (b) They are manufactured specifically for a particular order in the case of "package" housing, that is, no stock piling is done.

   (c) "Modulars" are not assembled from wall units and floor units manufactured for "package" housing. They are constructed, piece by piece, in a process similar to a site-built, conventional stud-wall construction.

   (d) Some components are installed with services and insulation.

   (e) "Modulars" are supplied as complete, pre-finished and prefurnished units, depending on the order.

2. On-site work:

   (a) With the exception of sporadic instances, it is a policy of the manufacturers to limit their commitments and services up to the
site-delivery stage.

3. **Ultimate product:**

(a) With the exception of a project concept by one of the manufacturers (Mariner Homes), all manufacturers have geared their production efforts for supplying conventional looking, single family, detached houses of one or two storeys.

(b) All houses conform to the National Building Code of Canada and local building codes. Their production is based mainly on predetermined designs.

(c) Factory prices do not include costs for delivery, on-site work*, land purchase and sales taxes.

* Service installation costs are additional in the case of a "package" house.
Inferences:

In reading through the preceding description and the literature supplied by the manufacturers, and from personal observations made during the visits, the following is inferred:

(1) In terms of economy, the manufactured housing does not offer considerable savings to the customers in comparison to the conventionally built average house.

To the purchaser, the factory price for a "modular" is approximately between $15 to $20 per square foot.*12 This may include setting up of the "modular" on already constructed foundations, but does not include the costs for delivery and on-site construction work.

A "package" house could cost (factory listed price) from approximately $9 to $12 per square foot,13 depending on the area of the house and on the features included in the package.

These figures are exclusive of all on-site costs, delivery costs, contractor's margin and service installation. The provincial sales taxes, other local taxes, land purchase prices and fees for legal services are additional costs both in the cases of "package" and "modular" houses.

* Mariner Homes, however, provided a figure of approximately $22 per sq. ft.
Such extra costs bring the total price of a completed house to approximately $25 to $30 per square foot. In some areas of the province, where the on-site labour and the materials required for the necessary construction are either in short supply or are expensive, the total cost may be even higher. For example, a study by the Department of Housing quoted the figure of $32.38/square foot in Fort Nelson for a 957 square feet "modular" house.14

In comparison, the per square foot costs for a conventionally built house are in the order of approximately $27 to $30 (exclusive of land price) in the Lower Mainland, more in the Interior and much higher in the Northern parts of the province.15

Mobile homes are not included in the detailed study. However, in connection with the current discussion it is appropriate to note that the retailing prices for new mobile homes* set up in a mobile home park are between $16 to $20 per square foot. These figures are both for single-wide and double-wide mobile homes.16

The conclusion is clear: although manufactured housing at present offer comparable prices with those of

* All new mobile homes sold within the Province are required to conform to CSA Z240.
conventionally built housing, the manufacturers will have to find ways to lower the prices in order to increase their share in the market.

As will be discussed later, this has not happened because the full potentials of mass production are not yet realized in their present methods of production. As a result, the factory listed prices are neither low nor attractive enough to make an impact over the market prospects of manufactured housing.

(2) On the other hand, the industry has realized some advantages over conventionally built housing, for example:

(a) Partial benefits are gained by manufacturers through mass purchase of materials, reduction of wastage and increased labour output within the factory where close supervision is maintained. These benefits, however, have not always influenced the prices offered.

(b) Stoppages of work due to weather conditions are reduced as the production is carried out inside a sheltered area.

(c) By manufacturing totally finished and furnished

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* Even when compared with the prices for the new and improved mobile homes which must conform to CSA Z240.
"modulars" the input of time and effort is considerably reduced on the part of the customer.

(d) The amount of time and effort spent between placing an order and receiving its delivery is reduced.

Under normal circumstances, the delivery time for a "package" or a "modular" house averages between 3 to 6 weeks. During periods of low sales -- for example, in winter -- the delivery time is reduced to about one week. If foundations and other necessary features are ready, the assembly of a "package" house normally takes one week and the setting-up of a "modular" merely takes one or two days.17

(3) In spite of such advantages, the manufactured housing sector of this province falls short of realizing the full benefits and potentials of industrialization in housing. Beyond a certain point it has not yet adopted the basics of industrialization. This is partly because production for the unpredictable and fluctuating market of detached housing does not offer suitable conditions for continuous mass

* Mobile homes also offer the same advantage, but the manufactured housing are built in accordance with approved standards, i.e. National Building Code of Canada.
production, and partly because of the work procedure of the manufacturers.

All manufacturers and their promotional literature claim that they offer a range of "models", that is, predetermined house designs and facilities for "custom designs".

A look through the plans supplied has shown that the dimensions do not follow a particular system and that they are arbitrarily chosen.* The layouts and orientation of spaces are also arbitrary, having no logical criteria and no apparent relation to site or surrounding.

Some of the essential points of their work procedure are as follows:

(a) There seems to be no standard and no rational basis for house designs.

(b) As all "custom designs" are catered for, it is likely that the design and the production of components or parts necessary for those designs will vary. This means there can be no rationalized standard possible in the design and dimensions of the components.

(c) There are no standard manufactured components or preassembled parts which may be bought singly by customers willing to buy them. As mentioned earlier in the "Summary" (pp. 50) the components are made available only as parts of "packages". In the case of "modular"

* Some of the fundamental criteria of industrialization are standardization and system. See pp. 16-21
production no prefabricated components (except trusses and cabinets) are used, that is, "modulars" are conventionally built "stud-wall" structures.

(d) All manufacturers wait for a customer to come and choose one design from those already prepared by their design staff; or, the customer may choose to offer his own design and place an order accordingly. His design may not have a relation to the "readymade" designs.

The manufacturer, having received the order, advises the customer to secure a mortgage. Only when this is accomplished does the manufacturer proceed with the production for that particular order. Once a sufficient number of components necessary for the particular order are manufactured, the production line is discontinued unless the same type of design has been ordered by another customer. The same procedure is repeated each time an order is received.

(e) A customer has to make a choice by looking at the plans and perspective sketches of houses. He may be shown the photographs of the houses actually built by the factory. However, as there are no standard components available unless an order for a package house has been received, the customer has to rely on the written specifications in order to determine the quality of the materials and components which may be used for his house. In case he cannot visit the factory in person, his judgement for the product must depend entirely on the information supplied to him by the dealer in his area.
The following is concluded from the foregoing points:

(1) The production is done individually/separately each time for each order. It is, thus, non-continuous.

(2) Although the work procedure or the sequence for production may have been standardized, the components or the parts have not been standardized and systematized. They are manufactured only when a customer places an order and secures a mortgage.

None of the manufacturers offers a range of standard components with which a range of designs can be made or houses can be assembled. Instead, they offer a range of predetermined styles and designs arbitrarily planned. This will limit the scope for a further improvement and revision in the production processes and for a wider market.

(3) Some of the components or parts are still "built" singly with craft labour except for certain purposes such as nailing, stapling or glueing. This may have much to do with the material used -- wood, which does not
Some components, such as trusses, are industrially manufactured. The assembly of these components is largely a handi-craft process.
lend itself to mechanization or automation as compared to, for example, concrete or steel.

(4) Non-continuous production and a lack of standardization means that other requirements of mass production are not fully satisfied such as system, easy handling and minimum duplication of work.

Non-standardization and individual production for each order can hardly achieve interchangeability of parts even between the products manufactured by the same factory. Thus, the prospects concerning the possibility of replaceable products are not promising.

In comparison to the construction phase of conventionally built houses, all of the above-mentioned factors result in equal, if not more, duplication of effort and costs in the production phase of factory built houses. In the case of a conventionally built house, for example, a builder repeats the complete process of: receiving a contract, obtaining and processing the necessary materials while proceeding to erect the house according to the particular design and its specifications.

Basically there is hardly any difference between the two sets of procedures. The only differences which have
resulted in some advantages in the procedure of manufactured housing production, can be listed as follows:

(a) A major portion of the complete production process is carried out inside a factory, that is, in a controlled environment with centralized supervision and management. No independently controlled trades and sub-trades are involved.

(b) The procurement of materials is made easier and cheaper through mass purchase.

(c) Some degree of mechanization is used in production, for example, in stapling or nailing the framing members or in sheathing the frames, which allows a saving of time and labour in the factory.

In summation, it is noted that the essential characteristics of industrialization—mass production—is largely absent in the provincial industry of manufactured housing. The main reasons are the absence of a large, stable market in most areas and the lack of a large capital investment. However, besides mass production, the organization of an industry and its planning in view of the local situations are also essential in any form of industrialization.
Manufactured home production inside a factory is done piece by piece resembling the production of a site-built house.
Illustration: Some components of a typical package home.

Illustration: Components, such as walls, are industrially manufactured on an assembly line.
Organization and Planning:

In order to determine the organizational approach of the local manufactured housing industry a uniform questionnaire (pp. 189) was prepared for selected manufacturers (pp. 78). The findings which are noted in the following pages are derived from the response to these questionnaires, the author's observations during visits to factories and some available references. The organizational approach of the industry is examined in terms of the following aspects:

(1) Research.
(2) Design.
(3) Transportation and site delivery.
(4) On-site assembly and construction.
(5) Financing.
(6) Land purchase and development.
(7) Promotion and marketing.

Some of these aspects such as research, design, transportation, assembly, financing, and marketing are common to most industries. These are essential work-components of all industries whose end-products are physical commodities.
(1) Research

The representatives of Westwood, Fowler and Mariner indicated that no research related to housing is being done by their firms except to improve the quality of materials or construction. However, this kind of research also is being carried out by almost all conventional builders who have been using industrially produced durable products, tools and materials with increasing frequency.

The Pan-Abode representative mentioned that his company does occasionally engage in some form of technical research, again, basically relating to materials. Westwood, on the other hand, has had plans to go into the production of "service core" houses for some time. The Westwood representative agreed that there is a need for more research into other aspects of housing as well.

Reasons for the lack of appropriate research into all issues of industrialization in housing are, in part, general shortage of capital in the fluctuating business of housing production and supply; the lack of incentives to introduce innovative concepts and methods; and the commercial motives of the manufacturers to gain maximum return with minimum investment in non-commercial and apparently non-productive activities, such as research.
(2) **Design**

All of the firms have their own design staff. The size of the staff and the qualifications of its members vary. Most of the work by the staff involves preparation of drawings and documents for municipal approval, mortgage release and on-site construction. When a house is "custom designed", drawings for the customer and for the production crews are prepared by the staff. The reason for this is that a majority of the designs are predetermined for which a set of required drawings have been already made. None of these designs or their specifications can be changed except for some minor details in furnishings or finishings. A customer must, otherwise, be prepared to bear the costs for major modifications.

Apart from this, the staff has little involvement with the product or the production because of the following reasons:

(a) Owing to predetermined designs, there is little scope for refinements, changes and modifications.

(b) A majority of the decisions regarding the products are largely made by the sales and the production staff.
(3) Off-site production

All firms fabricate their own components or precut their own parts. Some products such as aluminum window frames, glazed windows and prehung doors are bought from subsidiary industries. Some firms which supply "modulars", also fabricate their own cabinets and stairs.

Some of this fabrication work is carried out with electrically driven tools and machines. However the assembly of components and parts inside the factory is done by workers in a manner largely similar to the on-site work done by a construction crew for a site-built house.

Most firms have orderly laid-out production facilities in an enclosed area covered by a roof. An exception is "Fowler and Associates" where components are manufactured and handled under a roof, but the construction of "modular" units takes place outside in an unsheltered area.

(4) Transportation and site delivery

The basic modes of transportation used by manufacturers are barges and trucks. "Package" housing is transported on ordinary trucks, while "modulars"--because of their completeness in finishing and furnishing--are transported on specially built trucks which provide a "cushion" support.
Westwood, Beaver and Fowler use barge transportation to reach coastal communities. One barge can usually carry 10 "packages" or 3 "modulars". With the exception of Mariner Homes and Elba Homes who have their own trucks, other firms hire private truck companies for transportation.

According to a Department of Housing report, the transportation costs are not prohibitively high in relation to the total value of a completed house.* A package house costs $1.25 to $1.80 per mile to transport by a truck, whereas a modular house costs $2.50 to $4.00 per mile. Mariner and Elba, who have their own trucks, may transport their modulars at $2.50 to $3.00 per mile.19

In the northern parts of the province** the traffic

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* For example, according to the report, if a "modular" house valued at $27,000 after completion was transported 100 miles @ $4.00 per mile, the total transportation cost would equal $400.00 or 1.5% of the final value of the house. Similarly, the transportation costs for a "package" house valued at $27,000 would be $180.00 for 100 miles @ $1.80 per mile. This will be equal to 0.75% of the final value. It should be noted here, however, that the transportation costs are low only in relation to the final costs of a completed house. In the cases when two or more modules are to be transported for a completed house, the transportation costs may double or triple depending upon the number and size of the modules. Each module would require a separate truck, assuming the maximum allowable dimensions for transportsations on highways -- 12' x 60'. Besides this, for an ordinary customer the transportation cost is a major factor in relation to the factory prices. The reason for this is that the final costs of a completed house tend to fluctuate and therefore they are difficult to predict.

** The Central Interior and the Peace-Liard region.
is light and great distances can be covered in a day. However, during winter, although the transport is not greatly impeded, it does become slow and restricted due to heavy snowfall and ice formation on the roads.

(5) **On-site assembly and construction**

For this work, most firms depend on conventional builders and contractors. An exception is one firm: Elba Homes of Prince George, which has its own construction and assembly crew to perform this work including foundations, basements and finishings. Mariner Homes recently completed an experimental project in Penticton using its own construction crew.

The rest of the firms* do not take responsibility beyond the site delivery stage, leaving the post-delivery work to the customer. This means that co-ordination of this essential work is rarely achieved by the management. The on-site work is performed in a way basically similar to the way followed by builders of site-built houses. As a result, the degree of efficiency which may have been achieved in the off-site (or factory) work, is not achieved to an equal extent in the on-site work. In the case of a "package" home, the on-site work could consume a substantial amount of time, labour and money.

* Including Mariner Homes, as the recently completed project is their only experiment.
The case of a "modular" home is slightly different in that a "modular" is complete by itself in most respects. However, on-site work for foundations, joining of modules and utility connections is still required.

Firms such as Pan-Abode and Westwood claim that their "package" housing system allows customers to perform the on-site assembly by themselves. Pan-Abode representative said that almost 30% of their houses are assembled by self help. However, besides the simple assembly work, a majority of the customers continue to depend on others for the work which requires skill, experience, time and effort.

Thus, only few manufacturers have considered this important aspect of housing, that is, on-site and post-delivery work. As mentioned earlier in this thesis, both the off-site and on-site works are essential to achieve efficiency. The on-site work may be delayed or threatened due to the inability of the customers to find contractors and to obtain building approval and permits. Some firms do provide names of contractors who are familiar or experienced with their systems. On the whole, it is the customer's own responsibility to contact and hire a contractor, and to supervise the work. Delays and inefficiency can result also due to the following factors:
(a) Unexpected weather changes, especially in view of the provincial weather conditions.

(b) On-site construction labour problems and strikes.

(c) Conflicts in the co-ordination of sub-trades for service installation and construction work in the case of "package" housing.

One of the major reasons for the popularity of mobile homes is that the only major work after its production comprises transportation and connection to utilities. The unit is usually located on a "pad" supplied by a mobile home park owner. In most cases, the park is either solely owned by the manufacturer of the mobile home or it is jointly owned by him and the land supplier.

The more or less conventional organization of post-delivery or on-site work is also a major reason that manufacturers of "package" and "modular" housing have been unable to offer greater efficiency. Due to the same reason some of them experience a slack in production and sales during winters and labour conflicts.

Consequently, the reputation and success of their products largely depend on the performance and abilities
of customers, builders and on-site labour to carry out site work.

(6) Financing

This is an essential criterion which influences the complete business of house building. Of all the firms surveyed, none of them proceeds with the production until the customer secures a mortgage. As mentioned earlier, this is entirely the responsibility of the customer. Fluctuations and delays in this process result in stoppages of production.

The Department of Housing reports that one manufacturer had 70 orders on file which were not proceeded with, because the customers had been unable to secure a mortgage for various reasons. Some mortgage institutions hesitated to provide a mortgage for those customers who planned to assemble "package" houses by themselves. 20

In connection with this, the experience of National Homes, one of the largest home manufacturers in North America based in the U.S.A., demonstrates that the customers are more readily attracted to those firms which provide their own mortgage services in order to make it easier for their customers to obtain funds. 21
Westwood is the only firm which has given some thought to this important aspect. Pan-Abode, to a certain extent, provides an active assistance in locating willing mortgage institutions. However, to a great extent a customer is on his own.

(7) Land Purchase and Development

Similar to most of his counterparts in the conventional house building sector, a housing manufacturer waits for an individual customer to purchase and develop the land. Because of the nature of the detached housing markets, the location of lots are dispersed and situated in varied conditions. In view of this situation, advanced planning for production and deliveries—that could increase efficiency—has been difficult to achieve by manufacturers. Perhaps due to such a situation, the conventional builders have remained small in size. This allows them to adjust easily to different conditions.*

Mariner Homes has completed a subdivision in Penticton where the firm purchased and developed the land for a group of "package" houses. This project is considered as an

* Although this does not allow them to take an advantage of the mass purchase of materials and of keeping a permanent inventory of equipment and labour.
experiment by the firm to test the advantages of a land development program. This should also help the firm in determining the benefits of employing its own construction crew. This is one of the few instances where a firm assumed the full responsibility for the entire process of house building: from pre-production to post-delivery. Such a program, besides providing control over the production and supply of houses, can become a permanent "exhibition" by itself for the particular firm and its products. This is not a minor aspect considering the permanent publicity it can provide.

(8) Promotion and Marketing

All firms sell their products through dealers located in major regional centres of this province as well as some cities of Alberta. Some manufacturers such as Mariner, Pan-Abode and Westwood occasionally engage in publicity of their products through exhibition displays but mainly through advertisements in newspapers. It seems peculiar that none of them have attempted to promote their products via the more direct media of radio and T.V.

Mariner Homes, which completed its first experimental project for more publicity of its products, has also now started its own sales division apart from the establishment
of dealers. This division hopes to attract customers directly to the factory. In a different experiment, Westwood was actively engaged in the promotion of its products through a project (comprising of 97 houses) built in 1969. All houses were built with Westwood components manufactured for "package" houses.

According to the Department of Housing report, Mariner Homes and Fowler and Associates have recently formed an export consortium with Structural Wood Components, Chateau Homes and Fraser Pacific Industries for the purpose of exporting package houses outside Canada.

As far as the services such as building permits, approvals and post-sales services are concerned, there is no noticeable movement by any firm in that direction, at present, leaving a customer on his own to perform the tasks. On-site supervision is also the customer's responsibility.
In addition to the previous description of the various stages involved in the production and distribution of an industrialized house, the following overview of the industry provides a basis for an overall conclusion about the industry. This overview is presented in terms of: (a) Production capacity and actual sales; (b) Market area and supply; and (c) Ultimate products and "styles".

An Overview of "Package" and "Modular" Housing Industry:
Production capacity and actual sales:

The Department of Housing Report states that during the last few years (specifically from 1971 to 1974) there have been an average of 19,041 single detached housing starts per year in the Province.

In view of this, the following table provides a quick check in determining the contribution of the firms surveyed toward the single detached housing production.
### APPROXIMATE PRODUCTION IN 1975
(i.e. on-site deliveries both for package and modular housing)

<table>
<thead>
<tr>
<th>FIRM</th>
<th>NUMBER OF ACTUAL/ESTIMATED DELIVERIES*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fowler &amp; Associates</td>
<td>200 (actual)</td>
</tr>
<tr>
<td>Mariner Homes</td>
<td>260 (actual)</td>
</tr>
<tr>
<td>Westwood Building Systems</td>
<td>500 (actual)</td>
</tr>
<tr>
<td>Pan-Abode Bldgs. Ltd.</td>
<td>1400 (actual)</td>
</tr>
<tr>
<td>Elba Homes</td>
<td>140 (estimated)</td>
</tr>
<tr>
<td>Beaver Homes</td>
<td>245 (estimated)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>2745</td>
</tr>
</tbody>
</table>

The manufacturers were not able to provide the exact figures of sales made in various areas. However, they stated that most of these sales have taken place within British Columbia. Assuming that approximately 1/4 of their production was sold outside the province, it is calculated that the

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* Some of the figures were provided by the manufacturers during the interviews. Others are taken from the Department of Housing Report.22
share of these six manufacturers was approximately 10.9% of the annual detached housing production within the province. Given the fact that the estimated demand for housing starts is approximately 46,000 units per year* and that the number of manufactured houses is approximately 3,000 units per year, it is clear that manufactured houses actually comprise an insignificant amount of the total provincial demand—that is, approximately 6.52%.

Also, the table shown below indicates that the actual production of these firms falls short of their existing production capacity.

<table>
<thead>
<tr>
<th>FIRM</th>
<th>ACTUAL/ESTIMATED PRODUCTIONS</th>
<th>EXTG. CAPACITY</th>
<th>FUTURE CAPACITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fowler &amp; Associates</td>
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<td>700</td>
<td>700</td>
</tr>
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<td>Mariner Homes</td>
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<td>950</td>
<td>1400</td>
</tr>
<tr>
<td>Westwood Building Systems</td>
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<td>1350</td>
<td>1600</td>
</tr>
<tr>
<td>Elba Homes</td>
<td>140</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>Beaver Homes</td>
<td>245</td>
<td>1000</td>
<td>1750</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1345</strong></td>
<td><strong>4200</strong></td>
<td><strong>5750</strong></td>
</tr>
</tbody>
</table>

Note: Pan-Abode Buildings Ltd. is excluded from this table as figures for the existing and future capacities are not available.

The Interdepartmental Study Team retained by the Province of British Columbia in 1975 concluded from various statistics that the total housing requirements for the province up to 1981 are estimated at about 45,890 units/year.24
Assuming no major sudden change in the housing demands within this province in the next few years, (which seems likely in view of the slow growth of population, households and economy of the province and the surplus of houses in some areas of the province), the actual annual production of these firms may remain at an average of 1500 (+) houses. This means that their total annual production will be only about 36% of their existing capacity and about 26% of their future capacity.* This, in turn, indicates that the plants will operate at a lower—than—full capacity. In this case the capital, which is in scarce supply, will remain tied up in the under-utilized factory buildings, equipment and storage facilities.**

There are many reasons—some direct while others indirect—for the difference between the figures showing the actual production and those showing the maximum capacity.

Some of the indirect reasons are to be found in the work procedure (organization) of manufacturers and their limited commitments toward the complete process of house

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* The figures for the existing and the future capacity are computed from the Department of Housing report figures.25

** The bankruptcy of the Kelowna-based mobile home plant—Homeco Industries—is a recent example of the effects of underutilization of costly facilities due to continued low production and sales.26
building and supply; for example: non-standardization, non-continuous work, duplication of effort, and dependence on the capabilities of inexperienced customers to organize on-site work. Such factors have resulted in some inefficiencies and delays indirectly affecting the actual production.

The following are somewhat direct reasons:

1. Dependence on others for site deliveries.

2. A low level of publicity and planning or in other words a "passive" approach to the market in comparison to other industries.

3. A large amount of money and effort being spent on the production of single detached housing for individual customers. The fluctuating market of these housing and the small scale requirements of individual customers provide little scope for introducing significant efficiency and innovative approaches in the production of these housing.

4. Slowdowns/Stoppage/Delays:
   i. The traditional work slowdowns and stoppages during winters, which potential customers take for granted,
result in them postponing the placing of orders until the spring.

ii. As mentioned previously, the methods adopted for on-site work are similar to the ones used for site-built houses. Therefore, delays in work during winters are as common as in the case of site-built houses.

iii. Due to the bulkiness and completeness of manufactured houses, specifically "modulars", the storage costs and requirements are high—a factor which does not allow manufacturers to have houses on stock. The delivery of the bulky modulars is slowed down due to highway regulations on the transportation of large loads within the province (pp.131). Additionally, the experience has shown that some of the customers make alterations to the ready-made designs offered by manufacturers. Depending on the nature of such alterations, delays and slowdowns occur within the factory.
iv. Such delays, slowdowns and stoppages bring the factory operations nearly to a standstill, particularly during winters. This makes it difficult for manufacturers to retain their key staff. The necessity of training new personnel each time contributes to a decrease in efficiency and an increase in losses. These losses must be recovered from the sales made during the peak period of summer and therefore the prices offered must be high enough to recover the losses. High prices attract fewer customers, resulting in low sales. Thus, the constant cycle of "slowdown-loss-high price-low sales-slowdown" is continued.

5. Another reason for low production level is the mortgage market for housing in general. Usually mortgage funds are supplied at high interest rates and with rigid conditions, particularly when the housing market is booming. The difficulties of obtaining a mortgage are compounded in the case of individual, inexperienced customers. As stated earlier in this thesis,
until mortgages are secured manufacturers do not proceed with an order. Production, therefore is slow and unpredictable. The unpredictability of production and the lack of incentives for innovative production methods is also a result of the fiscal policies of senior governments who tend to fluctuate housing programs and money flow each year.  

**Market area and supply:**

No specific statistics or studies are available to determine the number of deliveries made to or orders received from different areas of the province. Some of the manufacturers, however, stated that the supply of their products is approximately 50-50 in the Interior and the southernly metropolitan areas of the province.

With the exception of Fowler, the manufacturers stated that they supply their products to almost anywhere in the province and that a portion of this supply also takes place in Alaska, Yukon Territory and parts of Alberta. However, in reality the actual marketing has remained limited largely to certain parts of the province due to restricted transportation conditions. (Illustration: 7)
Illustration: Market Areas of Firms
ILLUSTRATION: (cont'd...)

1 - Vancouver & Lower Mainland
2 - Victoria
3 - Nanaimo
4 - Penticton
5 - Kelowna
6 - Vernon
7 - Kamloops
8 - Cranbrook
9 - Trail
10 - Nelson
11 - Williams Lake
12 - Quesnel
13 - Prince George
14 - Dawson Creek
15 - Fort St. John
16 - Fort Nelson
17 - Prince Rupert
18 - Kitimat

APPROXIMATE DISTANCES BETWEEN SOME COMMUNITIES:

<table>
<thead>
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<th>Prince George</th>
<th>Penticton</th>
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<tbody>
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<td>513</td>
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<td>Nanaimo</td>
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<td>Kelowna</td>
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<td>Kamloops</td>
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<td>328</td>
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<td>Prince Rupert</td>
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<td>989</td>
</tr>
<tr>
<td>Dawson Creek</td>
<td></td>
<td>741</td>
<td>256</td>
<td>727</td>
</tr>
<tr>
<td>Vancouver</td>
<td></td>
<td>0</td>
<td>487</td>
<td>245</td>
</tr>
<tr>
<td>Prince George</td>
<td></td>
<td>487</td>
<td>0</td>
<td>472</td>
</tr>
<tr>
<td>Penticton</td>
<td></td>
<td>245</td>
<td>472</td>
<td>0</td>
</tr>
</tbody>
</table>
This is particularly evident in the case of modulars. Although maximum width of any load that is allowed to be transported on the provincial highways is 12'-1", the highway regulations require that all vehicles carrying a load of over 8'-6" width may be moved only with a special permit.* Because of the narrow tunnels, bridges and mountain passes even 12'-0" wide loads are not allowed at any time on most provincial roads.**

In addition, a pilot car is required to precede the vehicles carrying wide loads on highways. Unlike many other regions of Canada, British Columbia still largely has a two-lane highway system with a 24'-0" wide paved road surface. According to the highway authorities, this situation makes driving and passing by motorists difficult when they are following the vehicles carrying loads up to 12'-0" width and 68'-0" length.28 The modulars, because of their high degree of completeness, also require maximum protection from weather and other hazards while being transported. The package homes, on the other hand, because of their relatively small bulk and compactness are easier

* These permits allow transport only in daylight hours and the permits are subject to cancellation during periods of inclement weather and hazardous road conditions.

** The same situation and similar rules exist in the case of railway transportation.
to transport and have larger market area.

In practice it has been found that there is a certain limit for efficient transportation of factory manufactured homes -- both modulars and package homes. As mentioned earlier, for systems using wood as the chief material for the manufacture of homes, this limit is generally considered to be approximately 250 to 300 miles from the factory (pp.). This may vary by a few miles depending on local situations. Considering the mountainous terrain and the prevalent highway restrictions of the province, the probable change in the limit of efficient transportation may be more on the minus side than on the plus. In the absence of exact figures, (which manufacturers were unable to provide), 300 miles may be assumed as the efficient limit in most cases.

In view of this assumption and the large concentration of manufacturers in the Greater Vancouver region,* the efficient supply of their products is likely to remain limited to areas lying within about 300 miles of this region. Therefore, it remains doubtful that the supply of manufactured homes particularly of modulars from a factory based in the Greater Vancouver or the Lower Fraser Valley to areas such as the Central Interior and the Columbia Kootenay region (or outlying areas like the Yukon Territory, Alberta
Approximately 75 to 80% of the total number of manufacturers operating in the province (about 35 to 40 firms were in business in 1975) have located their facilities in the Greater Vancouver region. The rest of them have located the facilities in the Interior areas such as Kelowna, Penticton, Kamloops and Prince George. Some of the reasons given for their concentration in these areas are: (9) the greater availability of services such as transportation, communication and utilities; (b) the greater availability of raw materials and products such as plywood, particle boards, windows and doors; (c) the availability of a building such as an abandoned warehouse; and (d) the existence of a large urban population which provide stable urban markets. The reason (d) may be questioned, as a majority of the small and large experienced builders of site-built houses are also operating in those areas. Unlike manufacturers, these builders have flexible and limited commitments in terms of capital, materials inventory, construction methods and equipment. They can also offer greater choices to their customers in prices, designs and styles. The manufacturers' share in the market is likely to remain small in view of this as well as their limited capital availability and marketing capability. See pp. in this con-
junction.
and Alaska can be considered efficient.*

Since the manufacturers have restricted their marketing largely to the manufacture and supply of single detached houses,** a majority of the orders they receive are for small, individual houses. The reason for this is the nature of the detached housing market. It is dominated by individuals and families who have limited budgets. As a result, orders for houses in large quantities are rare. This is largely the case unless the manufacturer is involved in some land development programmes (as Mariner did in its experimental project at Penticton) or finds, through large scale promotion a client involved in multiple housing (as

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* Transportation costs are normally quoted as per mile cost. Therefore, they increase in direct proportion to the increase in the number of miles. This means that the degree of economy decreases as the distance is increased. For example, a house with the factory price of 20,000 dollars if transported 100 miles @ 4 dollars per mile, would have 400 dollars (or 2% of the factory price) as delivery cost. The delivery cost would be three times as much if the same house was transported 300 miles. Therefore, the transportation of homes--particularly in the case of single houses--to all areas of the province from a single location is neither efficient nor desirable.

** Some of the reasons for this are the popularity of single detached houses and the flexibility in the manufacture and assembly of products for these houses. The main reason for the latter is the material used--wood.
A large percentage of orders for small, individual houses means that the delivery is limited to a few houses at a time to a certain area. For both manufacturers and customers, transportation for individual houses one at a time is less efficient and less economical than for a group of houses. Mass distribution—one of the necessary requirement of industrialization—is rarely achieved.

**Ultimate products and "styles":**

At present, the industry mainly concentrates on the fluctuating market and production of single detached houses. However, the changing character and requirements of the housing market in this province perhaps suggest

* pp. 123.

** Although the single detached houses are largely preferred by many British Columbians over other forms of housing, according to an Interdepartmental Study Team retained by the provincial government (1975), multiple housing construction (apartments, townhouses, row houses) is likely to increase in the next few years. The reasons are: (a) rising costs of single house construction, labour, maintenance and repairs, (b) rising pressure to limit suburban growth in view of rapid urbanization and increase in cost of supplying basic amenities to suburbs (transportation, utilities, and such social services as police), (c) diminishing supply of agricultural land in the province, and (d) rising costs of serviced land suitable for housing. 29
that it should concentrate equally on other concepts of housing production and distribution. For example high density, multiple housing which may provide more stable market conditions.

Most manufactured homes offered on the market are produced from predetermined "styles" and designs. These designs and styles are arbitrary and irrelevant in view of the possible climatic and social differences as well as the physical differences of sites. According to the Department of Housing report most customers opt to alter the standard designs for various personal reasons or they offer their own designs.  

The standard designs offered by manufacturers are based on conventional stud-wall structures. Hence, in the factory the manufacturing process for these designs is more or less geared to the direct transfer of the construction process of a site-built house. The design and the manufacturing processes do not reflect an industrial production process and its essential elements such as system, speed, easy handling and minimum duplication of effort.

The reason for the standard designs and "styles", perhaps, is that house designs based on familiar and popular styles are—relatively easy to create, produce and
sell. This means that less financial risks are involved resulting in a secured profit. It is the opinion of this author that an unnecessary amount of effort, time and money is being spent in preparing these irrelevant styles. Manufactured homes are not likely to have large-scale success with irrelevant styles and designs. This is particularly evident today when the single detached housing market is dominated by competitive builders of site-built houses. These builders are able to provide houses of similar styles at prices comparable to or lower than those of manufactured homes. In addition to the price factor, they are also able to offer a greater choice and flexibility in the design and construction of houses. Houses based on familiar styles do appeal to certain buyers. However, the mere production of arbitrary styles with no basis for standardization is a piecemeal approach to industrialization of housing. Without standardization and systematization the current industry's chances of becoming a true mass production industry are low. The adoption of a standard system could provide a logical base for production, eliminate time consuming process of creating styles and co-ordinate changes that might occur in designs or production.

* Manufactured housing industry.

** For example, see Systems Ecologic by Laurence Cutler and Sherrie Cutler. See pp. 169, "Appendixes".
In the current process of creating irrelevant styles and arbitrary designs, some of the important issues of industrialization in housing remain neglected—such as the following ones:

(a) Establishing a basis of standardization for typical dwelling elements or components of houses rather than standardizing complete dwelling units.

(b) Extending the efficiencies gained in the off-site work to the equally important on-site work by promoting greater co-ordination of various phases of site work.

(c) Planning for regional conditions which could affect production and distribution; for example, the supply of affordable houses to rural communities in areas where the supply of houses by road or railway may not be efficient and where local climate or lack of skilled labour may make house building on site difficult with traditional methods.

(d) Introducing methods for greater participation by users in design and production of manufactured homes; for example, mobile production
plants as introduced in the Manitoba experiment (R.T.M.) (pp. ) or as suggested in the recommendations of a study sponsored by the Atlantic Industrial Research Institute of Nova Scotia (pp. 161-8).

These issues however could remain neglected for reasons of the profit motive present in our society, an aggressive salesmanship to retain and increase the profit level and the continuing popularity of arbitrary home styles as well as the lack of incentives to introduce innovative housing concepts.

Conclusion:

The manufactured housing industry of British Columbia is characterized by uncertainty, experimentation, low production and frequent slowdowns. This "industry" lacks the characteristics of industrialization such as mass production, mass distribution, efficient co-ordination of all work, organization and planning for the production of housing within this province. As a result, the inherent benefits of industrialization are sporadic and not available on a regular basis to the ultimate users of industrialized housing--the dwellers. These benefits could be
listed as: lower production cost resulting in prices low enough to attract a larger market, more control over the quality of the product; greater speed of production, and greater efficiency in the distribution and assembly of products. The reason for the unavailability of these benefits appears to be largely the unreliability or unavailability of some of the necessary prerequisites of industrialization in British Columbia. They are as follows: (a) The availability of a market, (b) the availability of capital funds, and (c) the availability of transportation.

(a) Availability of a Market

This does not mean merely a large "potential" market but a specific, well-defined one that can be counted on to yield a steady flow of sales. The fluctuating market of detached dwellings, the absence of province-wide long-range planning policies, the concentration of markets (which provide suitable conditions for a continuous volume production) in the few metropolitan and urban areas of the province, large competition from the builders of site-built houses and a "passive" approach to marketing by
manufacturers are main reasons for the unavailability of a specific, well-defined market.

(b) Availability of Capital Funds

The financial risks of manufacturing are high, especially when a specific volume production cannot be continuously sustained. Capital funds are generally in short supply in housing production due to the fluctuating and fragmented nature of the housing business—especially in the case of detached housing. Since governments in this province have traditionally relied on and encouraged the private enterprise system for housing production and supply, the manufactured housing industry cannot hope for a benevolent government to provide large scale and direct financial support.

(c) Availability of Transportation

Although highway and railway infrastructures exist in British Columbia, connecting major communities, the efficiency of transporting manufactured homes from a single location to all parts of the province cannot be considered high. This is particularly evident in the case of modulars. The reasons for this are transportation restrictions, large distances between communities of sizeable populations and the nature of the detached housing market. The latter
refers to the production and supply that is largely limited to individual orders versus mass orders for small houses in various locations.

In spite of this situation and its limitations, the industry has made a slow but steady contribution to the provision of basic houses which conform to the prevalent building codes at prices comparable to most site-built houses.

Even though it may seem that the industry will grow in the future perhaps due to more aggressive marketing, more experience and improved production methods the industry's approach to industrialized housing should remain questionable from the following points of view:

(1) Characteristics of housing (the mass production and supply of complete units based on preconceived, irrelevant styles is not always appropriate.)

(2) Provincial conditions (relatively few communities of sizeable populations which may generate markets on a regular
basis to justify large, permanent plants.)

(3) Transportation restrictions.

(4) Low level of capital investment.

(5) Fluctuating market of detached houses.

(6) Essentials of industrialization (the need for standardization, organization and planning).

The current approach of the industry is characterized by the presence of a number of small, autonomous firms that have entered the business with limited experience, expertise and financial capability largely with a view to make rapid profits. This approach has given a rise to the proliferation of a number of commercialized firms within British Columbia. Mainly because of their commercial motives, a number of these firms lack planning, long term commitments in the industry and an overall perspective of industrialization in housing. Therefore, they ignore the importance of standardization, system and a co-ordinated approach to both off-site and on-site works. This neglect is partly due to also the lack of incentives. Their over-emphasis on production capacity rather than on sound marketing and planning results in their plants running at lower than actual capabilities, even during peak sales.
periods. These reasons are largely responsible for the current unplanned and unorganized development of industrialized housing in this province. This development is due to also a lack of long-range, comprehensive policies on the part of both federal and provincial governments.

This kind of unorganized development is not likely to generate industrialized housing methods more suitable—than the current ones—to the characteristics of housing and provincial conditions; it is more likely to increase commercialism and consumerism.

Industrialization has an economic basis. Capital investment in a continuous production must be justified by a guaranteed market providing the basis for a minimum-volume production. On a long term basis, this requirement can be fulfilled only with organization and planning in which equal importance is attached to design, production, distribution and assembly. This kind of development, (that is intended in the long run to lead to the supply of industrialized housing which are related to provincial conditions and housing characteristics), cannot rely only on the individual efforts and initiatives of architects, engineers or manufacturers. In addition to their efforts, it calls for the participation of housing authorities and policy makers: the local governments.
Unlike in the socialistic countries of Europe, it is apparent that the local governments cannot provide large scale and direct encouragement or support to a particular industry. However, their participation could take the form of guidelines for the long term development of industrialized housing. In these days of increasing use of industrialized products for housing such participation by responsible authorities is warranted. Some guidelines and incentives could be provided for increased planning in areas that would be essential for desirable long term development of industrialized housing. These areas are:

(a) Increased planning for standardization of dwelling elements or components intended for use in industrialized housing. This should result in the gradual elimination of predetermined, irrelevant styles. An example of such standardization is included in the "Appendixes", pp. 169 to 186. The adoption of standardization would provide a greater opportunity for interchangeability of dwelling elements, replacement of dwelling elements and some participation by dwellers in assembling of these elements.

(b) Increased planning for co-ordination of both
off-site work and on-site work. Demonstration projects could be initiated in which the suppliers of industrialized housing (selected through tendering) would be given an opportunity to become involved in land development, planning, design and final assembly. In this case, cooperation and coordination on their part with builders, developers, designers and labour would be considered essential.

(c) Introduction of methods (of industrialized housing) which would utilize a lower amount of capital and extend the market range of industrialized housing to those communities which may not otherwise benefit from industrial manufacturing.*

In British Columbia there are few large communities with steadily growing populations which might attract a manufacturer to locate a factory there. Most of the province has a large percentage of rural and semi-urban populations living in small communities.

* Either because of their distance from the urban centres where manufacturers tend to locate their facilities or because of their small populations and slow growth they are unable to create market for a continuous volume production.
Mobile production plants is considered to be one of the methods that has a potential for providing some benefits of industrial manufacturing to small communities.

In view of the existence of few large urban communities and the prevalent transportation restrictions, the method of using mobile plants (or other similar methods) should be considered as a supplementary to the existing methods of industrialized housing in this province.

In order to test the viability of such a method, an experiment could be conducted, upon a detailed analysis of market and similar experiments, in those areas of the province that are not within the economic range of the existing permanent plants. Most of the permanent plants are located in the southwest part of the province. Therefore, the method of mobile plants would appear to be more suitable for coastal communities, Vancouver Island and northern communities.

* See "Appendixes", pp. 161 to 168 for description.

** Similar methods for such communities have been advocated by a number of studies. These studies include a 1969 report prepared by the National Research Council of Canada and a 1975 study conducted by the School of Architecture (Halifax) in Nova Scotia, for the Atlantic Industrial Research Institute. An experiment called R.T.M. (Ready-To-Move) using this method was started in the northern Manitoba, as well. See Bibliography for references.
Until market conditions in British Columbia improve to the extent of attracting a large-scale investment in mass-produced housing industries, the introduction of a mobile plant would be justified in addition to the existing small but permanent plants. This method could be an intermediate step between the traditional methods of individual site-built houses and those that require a large, continuous market and a long-term investment in advanced technology.

It is emphasized that a long-range, comprehensive policy—both in terms of economics and physical planning—by the provincial government and an increased co-operation by those concerned are essential requirements for planning in the areas (a, b and c) outlined above. Without the fulfillment of these requirements the commercial motives of individual manufacturers would continue to prevail in the industry. A desirable development of industrialized housing providing maximum benefits of industrialization to the ultimate users of these housing—the dwellers—would continue to be a difficult task. The concerns expressed above and throughout this thesis assume a significant role in the likely event that the role of industrialization for housing production will continue to expand.
FOOTNOTES:


5. The Vancouver Sun, Friday, September 3, 1976.


11. Ibid., pp. 60, 68.


13. Ibid.


16. Ibid.


18. Ibid., p. 9.

19. Ibid.

20. Ibid., p. 20.


24. Ibid., p. 75.


27. Interdepartmental Study Team, *Housing*.


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Blake, Peter. "Can technology solve the housing crisis?" Atlantic, October 1975, pp. 52-60.


Ekistics, February 1971.


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In addition to these books, periodicals, and reports various articles in Industrialization Forum, Ekistics, Architectural Design, Vancouver Sun, and Province as well
as the proceedings of the United Nations Conference on Human Settlements, 1976 have helped in formulating and channeling some of the thoughts presented in the thesis.
APPENDIXES
A.1 MOBILE PRODUCTION PLANTS:

The following are extracts from a study of the use of portable plants for building component production carried out by the School of Architecture, Nova Scotia.

"The introduction and development of dynamic building methods has in many cases been the answer to general sluggishness in construction activity, tight money, inflation and labour problems. New production facilities are being opened in all provinces. Some of these are gigantic enterprises well mechanized or automated, well financed and carefully planned. The operators are usually contractors or developers, but government is showing increasing interest. The Province of Nova Scotia, for example, is considering the formation of an industrial design corporation -- the second of this kind after Ontario's Polymer Corporation, "to carry responsibility for industrialized system development in Nova Scotia". Developing systems for housing would be the biggest task of that company.

However, before any industrialized building method for housing can be introduced, serious consideration must be given to specific conditions of the whole building industry in that specific area or region. Assuming the acceptance of industrialized building by a generally conservative public, all possible side effects should be studied and evaluated and the scale of the industrialized operation perhaps modified in order to provide the market with a new product without causing undue damage to the existing setup of the house building industry.

Another consideration is the cost of the operation. The average unit cost of new housing varies not only with the kind of units (single, semi-detached, apartment) but also with the specific geographic area. There are great regional variations in wages of construction workers, transportation and materials costs.

As for the scale of the operation, a great many studies carried out in the area of industrialization by governmental agencies or private consulting firms have tried the introduction of prefabricated methods to the 1,000 unit/year level, established on the basis of justified capital investments and output-input ratios. This level assumes certain conditions - a large market
with potential customers and the availability of funds to launch sophisticated industrialized production. In the absence of these conditions, low market pressures, unreadiness of the public to accept revolutionary changes, or the threat to small building firms posed by highly competitive enterprises could jeopardize the whole effort.

What is needed in the presence of these unknowns is a system that would allow for the introduction of building industrialization at volumes considerably below the 1,000 unit/year figure without precluding the eventual adoption of the more ambitious systems. The semi-mobile or portable on-site production plant offers several advantages of industrialized production at very modest cost. It has been used in various places in France, Italy and Great Britain with great success. The portable plant combines low capital investment for new technologies of industrialized production with high operational flexibility and relatively higher economy in producing small housing series. These advantages coupled with other non-technical planning features will be the subject of this study."

The following is a summary of this study.

"SUMMARY OF STUDY

One of the possible outcomes of a decision to introduce
greater mechanization into the building industry of Nova Scotia could be the emergence of portable or temporary on-site plants for the production of building components in dispersed locations around the Province. This study has examined the possibility from the point of view of costs and general effects on employment and community structure and has arrived at a number of conclusions which have been condensed as follows:

1. The main feature of a portable on-site plant is that all equipment and machinery can be put on wheels and transferred to the building site. This feature would find appreciation, especially among developers who, pressed by high mortgage rates, require precise time scheduling and fast erection.

2. Previous experience and enclosed estimates suggest capital investments in the range of $150,000 to $220,000. These figures include the portable building envelope and the necessary equipment and machinery for production, site transportation and erection.

3. The production output of the portable on-site plant would be in the range of 300 to 450 housing units per year. Since the capital investment is relatively
low and does not assume automated handling or such complex processes as low-pressure steam curing, these output figures seem to represent a fairly economical process.

4. The portable on-site plant, as an intermediate step between traditional and highly sophisticated semi-automated production, will substantially reduce demands for skilled labor, thus providing the opportunity for the employment of unskilled labor after a very short training period.

5. At the same time the plant could be used as an on-the-job training facility for some workers under the auspices of the Cooperative Housing and Manpower Training Programs.

6. The production process in the on-site-plant will not be subject to changing weather conditions and will actually guarantee continuity of employment in the case of a year-round operation or temporary employment for the seasonally unemployed in the winter when their normal jobs are not available."
"TABLE OF APPROXIMATE COSTS"

PORTABLE ON-SITE PLANT FOR WOOD PANEL PRODUCTION:

Planned output: 300 units/year or 780,000 sq. ft./year

all prices—suggested retail prices, taxes included.

<table>
<thead>
<tr>
<th>Building envelope (with insulation)</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Steel construction, respecting N.B.C. 1971, 18 ft. clear height)</td>
<td></td>
</tr>
<tr>
<td>Floor area needed = 10,000 sq. ft. cost/sq. ft. = $4.20</td>
<td>$42,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Foundation—concrete slab</th>
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</thead>
<tbody>
<tr>
<td>10,000 sq. ft. cost/sq.ft. = $0.50</td>
<td>$5,000</td>
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</table>

<table>
<thead>
<tr>
<th>Heating unit (hot air)</th>
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<tr>
<td></td>
<td>$3,000</td>
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<table>
<thead>
<tr>
<th>Wood-cutting machinery*</th>
<th>Manufacturer or Dealer</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 saws@ $500 each (tax incl.)</td>
<td>$1,500</td>
</tr>
<tr>
<td>component spike driver $3300 x 1.35 (made in USA)</td>
<td>Triad Corp. (Neb.) $4,455</td>
</tr>
<tr>
<td>stud stitcher $6750 x 1.35 (made in USA)</td>
<td>Triad Corp. (Neb.) $9,112.50</td>
</tr>
<tr>
<td>Panel stapler $8950 x 1.35 (made in USA)</td>
<td>Triad Corp. (Neb.) $12,082.50</td>
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<tr>
<td>option $130 x 1.35 (made in USA)</td>
<td>Triad Corp. (Neb.) $175.</td>
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<td>3 framing tables = $500 each (made in USA)</td>
<td>Triad Corp. (Neb.) $1,500.</td>
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<td>wall builder $12510 x 1.35 (made in USA)</td>
<td>Triad Corp. (Neb.) $16,888.50</td>
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<tr>
<td>24&quot; truss cutter $13790 x 1.35 (made in USA)</td>
<td>Idaco Co. (Calif.) $18,616.50</td>
</tr>
<tr>
<td>crane (3 ton) - gantry crane</td>
<td>Mack Maritime $26,000</td>
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</table>

<table>
<thead>
<tr>
<th>Storage of finished panels</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(steel construction) $2.00/sq.ft. 200 sq. ft.</td>
<td>$4,000</td>
</tr>
</tbody>
</table>

Supervisors and workers facilities, lighting $4,000

$156,330.50

* The price of machinery manufactured in USA had to be modified by the coefficient of 1.35
As shown in this study the mobile plants are capable of being transported to different areas, being erected on any suitable site and of being dismantled after completion of a project for transportation and reuse elsewhere. These plants, the study suggests, could be owned either privately by a manufacturer or by a public agency or jointly by a manufacturer and an agency. The method of mobile plants utilizes a lower amount of capital and does not require long-range commitments in comparison to permanent factories. As indicated in the table of costs, for a mobile plant with a capacity to supply 300 houses per year (utilizing wood as the chief material for production) the capital required is estimated to be in the range of 156,000 dollars. In comparison to this, a permanent plant with an equal capacity for production utilizing similar materials requires approximately 300,000 dollars as working capital. This figure is based on the Department of Housing report and interviews conducted by the author with some local manufacturers. On the basis of capital justification and input-output ratios, to become economical, a permanent plant may require a continuous volume production of 800 to 1000 houses per year. Such permanent plants have inflexible commitments of capital and time, yet they must supply their products to areas
within a certain radius by using available (but limited) transport. They must also comply with prevalent highway restrictions. It may be noted that in addition to the lower capital requirement and the possibility of a larger market range, one of the attractive aspects of a mobile plant method is the possibility of local community involvement in the design and production phases of houses. The other aspect is the extension of the benefits of industrial manufacturing to areas that cannot support long-range commitment of continuous volume production.
A.2 "SYSTEM ECOLOGIC"—An Example of Standardization for Industrialized Housing:

Standardization is one of the most conspicuous characteristic and an essential aspect of industrialization. Standardization of various elements of a product provides greater opportunities for interchangeability and flexibility in assembly. It also provides an opportunity for reduced wastage, efficiency and control in production. The following is an extracted description of standardization that could be used for efficient production of industrialized housing.

"Under a research contract with the National Endowment for the Arts, exploratory work has been undertaken to study the possibilities of applying past research as a basis for the development of a transitional building system, the prime objective being to develop SYSTEM ECOLOGIC, a design technique, a kit, capable of performing immediately within the present range of building codes, union constraints, and economic considerations which collectively have retarded the U.S. building industry.

Variation in the architectural solutions to the

problem of supplying lower cost housing in different locations is influenced by factors such as natural environment, local social and aesthetic values, available building materials, and the characteristics of the particular setting in which the housing is to be built. It is an essential ingredient of modern man's freedom of choice that the selection of an appropriate solution be made anew on each occasion. Years ago, architects could rely on clearly defined technological solutions and relatively static values, but today's rapid technological and social changes demand new decisions criteria for choosing among alternative design solutions.

Despite these changes, there are some definite signs as to what can and, quite probably, will happen in the future. We are told, for instance, that no radical changes in materials and/or products will be made in the U.S. in the next ten years. (See "The State of the Art of Prefabrication in the Construction Industry.") We also know that most manufacturers' research and development programs are directed toward new markets and new applications for existing materials rather than the development of new materials and/or products. We know, too, that the inherent potentials of existing products and building systems permit the designers a great degree of flexibility, if approached correctly.
Therefore, the architectural problem of developing more immediate lower-cost housing methods that are available and acceptable to a wide range of developers and contractors is one of making the best of existing technologies and materials.

The majority of homes presently being built are the houses and garden apartments built by the small contractor and the limited developer. These forces do not have the present capabilities to launch into the research, the capitalization in plant or equipment, and the promotion required to aggregate a supporting market required by the "technologically advanced" massive production systems.

The major effort of SYSTEM ECOLOGIC has been to refine the basic design assumptions and to cull and utilize selectively those elements, in combination with one another, as appropriate to a particular generic housing problem—the immediate and continued provision of housing by the existing forces of builders.

SYSTEM ECOLOGIC is the extension of a general philosophy which, in a nutshell, is summarized by the subtitle "A Transitional Building System."
1.1 Design Objectives

As a direct outgrowth of this analysis and research, a certain number of basic assumptions regarding the development of SYSTEM ECOLOGIC have necessarily manifested themselves—providing a framework for systems development and created from logic and pragmatic analysis. They are:

(1) Flexibility -- greater choice in plan type and building type, and, in a sense, creating an "open system".

(2) Quality building and rapid speed of construction.

(3) Reduction of cost.

(4) Freedom of design.

(5) Housing objectives:
   a. provide public and private amenities
   b. develop a healthy environment
   c. overcome sterile patterns of living
   d. create a sense of identity--pride in the dwelling unit.
1.2 **Design Criteria**

(1) The structure itself can be factory produced on a modular basis.

(2) Use pure geometry and dimensional standards in order to provide more flexibility and compatibility between manufacturers.

(3) All assemblage can be done at the site -- work on and off the job site is organized to promulgate reasonable work efficiencies.

(4) Maximum size of the units are 12' x 36' and are prescribed by the need for easy transport under present-day standard road conditions and restrictions.

(5) Financing is conventional, i.e., no use is necessarily made of F.H.A., H.U.D., or similar agency programs.

(6) All environmental requirements are achieved through alternate materials and space module combinations.

(7) Use of existing components, subsystems, and materials presently available and selectively
utilized will achieve lower total cost.

(8) Only low density situations are provided.

1.3 Design Elements

(1) The fewest number which will create the greatest amount and variety of spaces.

(2) Availability of parts and ease of maintenance and replacement.

(3) Ease of assembly and erection.

DESIGN CRITERIA: A KIT

SYSTEM ECOLOGIC is essentially the development of a kit of parts; the parts comprise large spatial elements which are, basically, sleeping units and living units, which, when combined, form total units. Each of the spatial units (i.e., sleeping and living) is made up from a select list of subcomponents such as: closure components, flooring components, interior components, roof components, etc. These are selected according to the particular client's program requirements.
The total units themselves break down into three categories of building types:

A = Single family
B = Row house
C = Garden apartments

A notation technique for the total units, combined from a selection of a sleeping unit and a living unit will carry the total unit enumeration, which includes the letter prefix A, B, or C, indicating the building type and the numbers which follow, indicating the particular spatial units combination.

4.1 Criteria Assumptions: Standardization

ASTM defines standardization as "the process of formulating and applying rules for an orderly approach to a specific activity for the benefit and with the cooperation of all concerned."

A mandatory standard is a standard whose use is compelled by law. In the U.S., most mandatory standards, except for the fundamental units of weight and measure, are written to protect health and safety.
The standards set for SYSTEM ECOLOGIC are a procedure established to evolve a rule of behavior. This rule is described in the following paragraphs, and it is demonstrated in the graphic kit of parts—which limits the number of elements, yet widens the choices and alternative solutions.

The main objective in standardizing choice is to develop a building system which is able to be assembled by either skilled or unskilled labor and which can be universally applied to both minimal and expanded housing projects.

Selection criteria are (See also: Appendix 5):

General Standards

Human Being:  
Sociological change  
Multipurpose use  
Individualism  
Natural light

Technological:  
Mass production  
Prefabrication  
Urban design  
Multipurpose space  
Combination

Specific Standards

(1) The spatial units must form a total assembly
which integrates all building functions (structure, enclosure, mechanical, electrical) into one system.

(2) The elements must be related in detail, line, surface, and form, to all other elements of the assemblage.

(3) The elements must be factory fabricated, machined, prefinished, and assembled, either on-site or preassembled.

(4) A minimum of pieces capable of assembly by skilled workmen.

(5) The total units must satisfy the basic code requirements, plan flexibility, and ease of addition for future expansion.

4.2 **Structure: Open/Closed**

The main danger involved in dealing with system design, either open or closed, is that the building industry will become dominated by a relatively small number of mutually exclusive systems which will retard the progress of the building industry. Also, the lack of incentive for
improvement will so standardize the built environment that it will become intolerable for human habit.

Therefore, the aim in selecting a structure has been to make maximum use of factory-made components and a minimum use of wet processes. The structures shown are easily adaptable to technological change; witness the main structural components: base frames -- easily assembled and transportable over highways; the frame may be steel, wood or simply panelized pieces."
INTERIOR COMPONENTS

KITCHEN TYPE 1
U-SHAPED (BASE 8' x 6')

KITCHEN TYPE 2
PARALLEL (BASE 8' x 9')

KITCHEN ADDS
BATHING L'S

TOILET TYPE 1
1/2 BATH (5' x 3')

TOILET TYPE 2
FULL BATH (5'6' x 6')
SHOWN WITH TOILET ADD

TOILET TYPE 2
FULL BATH (5'6' x 6')

SYSTEM ECOLOGIC
A TRANSITIONAL BUILDING SYSTEM

NEA
GRANT no.
A70-1-5
INTERIOR COMPONENTS

STORAGE PARTITIONS / CLOSETS
(3' x 2'1/2') (6' x 2'1/2')

SPECIAL PURPOSE CLOSET
STACKED WASHER/DRYER (3' x 2'1/2')

STAIR TYPE 1
STRAIGHT RUN (8' x 1' - 8')

STAIR TYPE 2
SPLIT RUN (6' - 8')

DESK - BENCH
DESK - BED

WET WALLS
FIREPLACE

Illustration 22

A TRANSITIONAL BUILDING SYSTEM

ECODESIGN
NEA
GRANT no. A70-1-5
INTERIOR COMPONENTS
CLOSURE COMPONENTS

1. FULL GLASS
- Sliding glass door panels 6'-0" x 8'-0"

2. VERTICAL HALF GLASS
- Left panel solid, right panel solid
- Adds one alternative - entrance panel 6'-0" x 8'-0"

3. HORIZONTAL GLASS
- Panel 6'-0" x 8'-0"

4. QUARTER GLASS
- Panels 6'-0" x 8'-0"

5. SOLID PANEL
- Panels 6'-0" x 8'-0"

6. PROJECTED PANEL
- Panel 6'-0" x 6'-0" x 4'-0"
SYSTEM ECOLOGIC
A TRANSITIONAL BUILDING SYSTEM
Illustration: 25
### Table 1

<table>
<thead>
<tr>
<th>GEOGRAPHIC SUBDIVISION</th>
<th>CITIES AND TOWNS</th>
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<td><strong>TOTAL</strong></td>
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</table>

| **2. COASTAL**         | PRINCE RUPERT        | 15,747     | 14,754     |
|                        | KITIMAT              | 11,803     | 11,956     |
|                        | TERRACE              | 9,991      | 10,251     |
|                        | COURtenAY            | 7,187      | 7,733      |
| **TOTAL**              |                      | **121,593** | **135,222** |

*Total population figure is not the sum of the figures for cities and towns given here.*
This table is based on figures given for Census Divisions of British Columbia by Statistics Canada.
A.4 SAMPLE QUESTIONNAIRE FOR MANUFACTURERS:

1. NAME OF THE FIRM:

2. LOCATION:
   (address)

3. REASONS FOR LOCATING THE PLANT IN THIS PARTICULAR AREA: (including the reason, if any, for choosing British Columbia)

4. IN OPERATION SINCE (i.e. the year in which the actual production started):

5. PRODUCTION IN 1975 (total number of products produced or houses assembled): (approximately)
   in factory:
   on site:
   If this does not represent an average production, what is the average:

6. AVERAGE SALES PER YEAR: $ approximately

7. TOTAL CAPITAL INVESTED SO FAR: $ approximately

8. WORKING CAPITAL OF THE FIRM or ANNUAL BUDGET OF THE FIRM: $ approximately
9. WHETHER CONTINUOUS PRODUCTION OR SEASONAL PRODUCTION (which part of year):

10. SERVICE RANGE: miles or kms. approximately:

11. OUTSIDE B.C.: yes no

12. IF THE RANGE LIES OUTSIDE B.C., WHETHER IT IS BECAUSE THERE IS MORE MARKET THERE THAN IN B.C.:
   yes no
   percentage of market within B.C.:
   percentage of market outside B.C.:
   (* based on the number of orders received by the firm.)

13. WITHIN B.C.:
   percentage (approximately) of market in rural areas *:
   percentage (approximately) of market in urban areas *:
   (* consider areas with 10,000 or less population to be rural and the areas with more than 10,000 population to be urban for this purpose)

   OR in other words do you receive (either directly or through dealers) more orders from rural areas or from urban areas? Northern areas?

14. LINE OF PRODUCT: (such as factories, apartments or multifamily housing, schools, motels, single family detached houses, mobile homes). Please provide approximate percentage:

15. REASONS FOR THIS PARTICULAR LINE OF PRODUCT?
16. PLEASE DESCRIBE BRIEFLY THE FACTORY PRODUCTS OR COMPONENTS: (If a brochure describing this is available, please attach one).

17. AVERAGE SQ. FT. OF HOUSES SOLD:

18. AVERAGE SELLING PRICE (Factory price):
   approximately $[blank]

19. SALES TAX ON THE PRODUCTS OR HOUSES SOLD:
   yes (how much)
   no

20. APPROXIMATE TIME FOR PRODUCTION OF A HOUSE IN THE FACTORY:

21. APPROXIMATE TIME TAKEN TO ASSEMBLE OR DELIVER A HOUSE FULLY ON SITE AFTER AN ORDER IS RECEIVED (under normal conditions):

22. BRIEF DESCRIPTION OF THE ACTIVITY THAT WOULD TAKE PLACE AFTER AN ORDER IS RECEIVED UNTIL THE ACTUAL ASSEMBLY ON SITE:

23. DOES THE FIRM PERFORM ON-SITE CONSTRUCTION such as foundations, finishing etc.?
   yes what kind?
   no who does it?

25. WHO DOES THE ON-SITE INSPECTION/SUPERVISION?

26. CONSIDERING NORMAL WEAR AND TEAR, WHAT IS THE USEFUL LIFE OF A PRODUCT (COMPONENT) or/and THE HOUSE?

WAY OF OPERATION:

27. FINANCING:

28. SHORT-TEAM OR LONG TERM MORTGAGE

29. DESIGN (components and buildings)

30. PRODUCTION:

31. MARKETING:
   through dealers: yes % of orders
   no by dealers:
   through developers or builders: % of orders by these:
   through firm's own retail department to individual clients (private clients): yes no

% of orders thus received:

32. POST-SALES SERVICE (such as repairs, renovations, replacement of old products with new products):
   done by the firm? yes no
   done by others? yes no
33. WHAT TYPE OF RESEARCH, IF ANY, IS DONE BY THE FIRM?

34. WHAT % IS SET ASIDE FOR THIS IN THE ANNUAL BUDGET (OR WORKING CAPITAL)?

35. DOES THE FIRM TAKE ANY OUTSIDE HELP, ADVICE, OR CONSULT OTHER GROUPS, CONSULTING FIRMS OR GOVERNMENT DEPARTMENTS FOR THIS TYPE OF WORK?

36. ARE THERE ANY SPECIAL PROBLEMS OR SPECIFIC DIFFICULTIES? ANY SPECIAL REMARKS?

Besides these formal questions, informal discussion had also taken place with some of the manufacturers, for example: future of prefabrication in housing; political assistance; dialogue with various groups such as labor, builders, developers, professionals, CMHC, GVRD and governments; standardization; flexibility etc.

Many questions contained in the formal questionnaire had remained unanswered owing to a lack of statistics and studies, for example, percentage of market within B.C. and outside B.C., or percentage of rural and urban markets. Some manufacturers were not able to provide specific or approximate figures about the sales, capital and service range.