# MARKET STUDY ON THE COMPETITIVENESS OF THE SEVEN-S BUILDING SYSTEM

Seven S Structures Inc.[1]

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# DISCLAIMER

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# 1.0 SEVEN-S BUILDING SYSTEM PRODUCT ANALYSIS

The Seven-S product is a prefabricated, stressed skin, load-bearing panel with continuous header, base, and top and bottom plates. The continuous header allows installation of doors and windows in almost any location without additional headers as in a conventional wall. The panels can be used for interior and exterior walls, flooring, ceiling, or roofing for any building of three stories or less.

Wall panels are constructed with a 3/8" oriented strand board (OSB) skin on either side glued to "C-studs" at 24" on centre using waterproof Phenol-Resorcinol glue. Roof panels are 6 1/2" thick and are constructed in a similar manner except for the elimination of the headers and base plates. Floor panels are constructed with a 5/8" OSB skin on the topside and a 3/8" OSB skin on the underside. Total thickness of the floor panel is 6 7/8" and the C-studs are spaced at 16" o.c. The foregoing product descriptions relate to "stock" panels, and the spacing of studs and thickness of skins can be varied to suit the requirements of the load/span insulation requirements.

## 1.1 Insulation Capabilities

While interior partitions are hollow, the core of exterior walls consists of polyurethane foam insulation which is foamed in place after panel assembly is complete. Polyurethane foam is a thermoset cellular plastic consisting of a solid mass of unconnected small closed cells with a density in the range of 16 to 32 kilograms per cubic metre. The Seven-S panel foam core has a density of approxi mately 29 kg per cubic metre (1.8 pounds per cubic foot). The combination of light weight and small unconnected closed cells, each containing a vapour which provides a thermal insulation value of R- 8 per inch of thickness, enables rigid urethane foam to out-perform all other insulating materials. When enclosed between two impervious skins, this high R-value is retained indefinitely. Thus the Seven-S wall panel achieves a rating of R-30 in a 4 1/4" thick wall. Roof panels have a rating of R-46, and floor panels may also be injected with foam yielding a rating of R-48.

The closed cell matrix combined with a high R-value per unit thickness provide the Seven-S panel with superior thermal insulation in a substantially thinner wall, relative to conventional buildings. Furthermore, the true insulation value of a conventional wall may be overstated as a result of three additional factors. First, thermal bridging occurs at the studs, significantly lowering the effective R-value. Studs comprise approximately 16 to 20% of a wall's area. Second, fibreglas batts tend to settle over time allowing heat to escape through the empty space created along the top of the wall. Third, a study presented by the A.S.T.M. at a recent symposium on thermal conductivity, indicated that an open cell insulation such as fibreglas batting may lose as much as 50% of its insulation capability upon absorbing even a small amount of water vapour. Given that fibreglas batts commonly arrive at the construction site already containing moisture, a 4 1/4" wall insulated with fibreglas batts may deliver an effective rating as low as R-6, less than one quarter the insulation value of a Seven-S panel of identical thickness.

Even when fibreglas batts are completely dry, a wall would have to be over 9" thick to deliver the R-30 rating of the Seven-S panel. This difference in exterior wall thickness would add an extra 50 sq. ft. of interior living space to a typical 1700 sq.ft. house.

Depending on the design of the building, foam insulation may be injected into either the roof or ceiling panels. Insulated roof panels can add heated attic space to the building or allow cathedral ceilings, a definite advantage in upscale homes or in recreational cottages or chalets.

Almost as important as the high R-value per unit thickness is the Seven-S panel's suitability for airtight construction. Airtight construction is becoming increasingly popular in recognition of the fact that up to 30% of a building's heat loss can occur through air leakage. Current airtight construction methods require installation of a continuous vapour barrier which must be both stapled and sealed, an extremely labour intensive endeavour. The Seven-S panel is completely impermeable to air and water vapour and when properly installed can meet the R-2000 air leakage standard without this additional labour expenditure.

## 1.2 Strength

The strength of the Seven-S panel stems from the use of oriented strand board (OSB) for the skins, spacers, reinforcing headers, and baseplates. OSB is strong and stiff due to the orientation of the fibres during manufacture and yet can be produced at lower cost than plywood. The current price differential is on the order of 10 to 15%. The polyurethane foam core also has a high strength to weight ratio and provides additional rigidity when cured inside the panel.

Structural tests completed to date indicate that the panel has superior strength. It is stiff and has good racking resistance when compared to a standard wood frame wall with sheathing on one side. The panel's stiffness allows limited deflections. Thus wall panels may be used under significant wind load conditions while floor and roof panels may be used under significant transverse loadings such as heavy snow.

## 1.3 Cost of Materials

There are three main components in the Seven-S panel: OSB, Polyurethane Foam, and glue. OSB is manufactured from the plentiful and inexpensive aspen, and as such offers greater strength than plywood at a lower cost. For this reason, OSB, along with other composites such as waferboard and particleboard, have virtually replaced plywood as a building material. The polyurethane foam core currently costs $1.33 per cubic foot. An impending change in the foaming process to replace freon with a less environmentally sensitive gas is expected to be on the market by mid-1990.

### 1.3.1 Oriented Strand Board

Many waferboard (random orientation) manufacturers are introducing OSB lines. There are two standards in Canada: Strand Board CAN3- 0437.0 and CAN3-0437.1 . Currently, all Canadian OSB is produced to the first standard.

OSB is sold by the railcar or truckload (1 railcar = 2.5 truckloads) and distributed through three channels:

1) brokers - buy and sell high volumes of lumber without taking delivery (called back-to-back);

2) reload wholesalers - take delivery and reload lumber in smaller quantities for delivery to customers without maintaining significant inventory, for example Marathon Forest Products;

3) stocking distributors - in addition to back-to back and reload sales, maintain sufficient inventory to provide customers with a wide range of dimensions and grades, for example Weldwood, Goodfellow, and Green Forest Lumber.

OSB is traded like lumber and thus prices may change hourly reflecting changing supply and demand. 7/16" is the Bellwether thickness and prices are generally quoted in dollars per thousand square feet.

| WAFERBOARD | U.S. dollars per thousand sq.ft. | | |
|---|---|---|---|
| | 1986 | 1985 | 1984 |
| High ............. | $177 | $169 | $164 |
| Low ............. | 143 | 145 | 136 |
| Average ............. | 154 | 156 | 149 |

U.S. supply and demand also has an impact on prices through the reloading points such as in Windsor Ontario; this impact is presently limited to Southern Ontario which receives OSB from the Southern Pine area of the States and some Fir which enters British Columbia. In the past, Canadian sawmills have adjusted the prices of their products in response to changes in relative rates of taxation, currency values, and transportation costs in order to ensure that their products remain competitive with products supplied by U.S. mills.

The OSB industry is highly seasonal reflecting the seasonality inherent in the construction industry. For example, Bellwether 7/16" currently (in early January) sells for $150 per thousand ($0.15 per sq.ft.) but is expected to sell for $180 per thousand by March. Price volatility and seasonality make contract purchasing the norm in the industry. Committing to a 90 day contract now would guarantee a price of $160 per thousand resulting in a 5 to 10% savings over purchasing on a spot market basis.

There are at least six mills now producing OSB in Canada; the dominant producer is Seven-S' current supplier, Pelican Spruce Mills which produces 240 to 260 tons per day. Another major Western producer is Louisiana Pacific which operates a mill in Dawson Creek B.C. Eastern producers all belong to the Waferboard Association and include:

1. Grant Waferboard, Englehart Ont. They now claim to be Canada's largest producer with two lines producing 500 tons per day or approximately 100 to 120 loads per week.

2.Normick Perron, La Sarre Que. They have just started production in late 1988 and are at 30% capacity producing 7/16" only.

3. The Waferboard Corporation. They are presently shut down.

4.Weldwood, Toronto Ont. Do not produce 8 x 24; only 4 x 8 and 4 x 16.

5. MacMillan Bloedel, Thunder Bay Ont. Also do not produce 8 x 24; shut down or will be shutting down due to oversupply.

6. Millette Waferboard in La Tuque near Grandmere. On strike.

7. Lanefor Company in St. Michel de Plain. New mill.

Most OSB demand is for smaller dimension (4 x 8 and 4 x 16) and as a result not many mills are capable or willing to produce the large dimension 8 x 24 used by Seven-S. To change the production line at Grant WB for example, the line is shut down for one hour while cranes lift four saws out of position. With costs of $15,000 per hour, this adds $30,000 to the cost for a one shot run of 8 x 24. This is one of the reasons why committing to a purchasing contract results in lower prices and also explains why for low volume orders there is a 10-15% premium on large dimension OSB (from Grant Waferboard).

Current (mid-January) spot prices for OSB are as follows (Toronto, tax-exempt to distributor):

| | | |
|---|---|---|
| 7/16" | 4x8 | ..... $155/thousand |
| 3/8" | 8x24 | .... $175-180/thousand |
| 5/8" | 4x8 | ..... $255/thousand |
| | 8x24 | .... $290-300/thousand |

According to Grant WB the distributor may add three percent to these prices. This markup is probably low given that Marathon suggested Seven-S might get 1 to 1.5 points for an increased volume order. Green Forest Lumber, a publicly-held independent lumber distributor, has had an average gross margin closer to five percent for the past five years.

Seven-S currently buys approximately one truckload per week or about 12 loads per quarter. Assuming a ninety day contract, volume purchasing would yield the following discounts:

12 loads/quarter - no discount (currently paying $190/thousand)
60 loads/quarter - 5% discount
120 loads/quarter - 10% discount

Probably the most critical consideration with respect to OSB prices is the current oversupply. One estimate is that OSB is now 20% oversupplied with the effect that mills are selling below normal (or shutting down). This situation is expected to last two years or more. Although the price spread between plywood and OSB is gradually widening over time, OSB is currently at a 25% discount to plywood, substantially lower than the 15% discount which held until recently.

### 1.3.2 Polyurethane Foam

Seven-S currently buys foam from Witco Ltd. through Fleck Brothers. The foam is generated by combining two components in equal quantities: isocyanate (A) and polyol (B) derived from propylene oxide. Both of these components have experienced substantial price increases in 1988, and apparently these costs have yet to be passed on to Seven-S. Isocyanate prices alone rose in 1988 by (U.S.) $0.24/lb.

The components to produce Isofoam are sold in 500 lb drums at a price of $1.88/lb. A blanket order of 500,000 lbs with a minimum release of 20,000 lbs (of each component) per shipment would cost \$1.45/lb. Panel production of \$200,000 per month implies foam usage of approximately 44,000 lbs per month.

### 1.3.3 Glue

Phenol-resorcinol glue is also purchased in 45 gallon drums at a price of \$3.17/kg. or \$720/drum. Woodline Ltd. will give a 5% discount on a purchase of six or more drums. Using the current price of \$4.02 per quart, then panel production of \$200,000 implies glue usage of 12 drums per month. Current production practice uses three to four times the glue necessary through wastage and this is one of the areas that Seven-S intends to cut its costs over the next year.

### 1.3.4 Transportation

As with any pre-manufactured building product, transportation costs from the plant to the construction site represent a significant cost component. Based on the volume occupied, transportation costs are approximately 50% greater for the Seven-S panel as compared to the building material requirements of a standard non-energy efficient home, but are 25% less when compared to the materials required to build an R-2000 home (using either 2x6, OR double stud 2x4 construction). These lower transportation costs further improve the competitiveness of the Seven-S system relative to conventionally designed energy efficient dwellings. Present transportation costs are in the range of \$0.65 to \$0.90 per kilometre for a twenty four foot truck - roughly large enough to transport the wall, roof and floor panels for an entire 2000 square foot house.

## 1.4 Speed of Construction/Labour Savings

The prefabricated nature of the Seven-S building system has opened the door to substantial improvements over conventional building techniques. The panels are easy to install and can be erected quickly by individuals with a minimum of training. A two storey home can be brought from a hole in the ground to lock-up in about four days using approximately one half the man-hours. A further benefit is that no additional framing is required around door and window openings again resulting in lower labour costs. Labour savings are higher still when compared to the more labour-intensive conventionally-built R-2000 home which requires a much greater effort to achieve the same level of airtightness. Finally, faster completion of the project also results in lower soft costs for the builder which usually amount to about seven to eight percent of the total cost.

## 1.5 Quality Assurance and Durability

To ensure that the panel manufacturing process is maintained at an acceptable standard, both CMHC and ICBO require implementation of a quality control programme which includes the maintenance of a Quality Control Manual. While the Chief Engineer at Seven-S is responsible for the development of the quality control system, the production manager currently holds the position of Quality Control Supervisor with responsibility for meeting Seven-S' goal of uniformity and high product quality. Warnock Hersey Professional Services has also been retained as a third party quality control agency. This agency will make periodic inspections of the Plant to ensure that the product is being manufactured in accordance with the policies laid out in the Quality Control Manual. These visits are random and unannounced, and performed at least four times per year. During these visits the agency will inspect production procedures, equipment, and ensure that the QC Manual is current.

## 1.6 Safety

A brief discussion of Regulatory Agencies and Associations is presented in Appendix A.

### 1.6.1 Foam

Formaldehyde is a chemical substance belonging to a group of organic compounds known as aldehydes. Formaldehyde gas is released into the air as a result of offgassing from household products and certain building materials, most notably urea formaldehyde foam insulation (UFFI). Individuals show varying tolerance to formaldehyde gas. While many people experience no negative effects, even at high levels, others may be sensitive to much lower concentrations. Exposure to formaldehyde can cause eye, nose, and throat irritation or respiratory problems. The severity depends on the concentration of formaldehyde in the air (generally measured in the parts per million) and the sensitivity of the individuals, their general health, smoking habits, and degree of previous exposure to the gas.

The polyurethane foam insulation used in the Seven-S building panel is completely unrelated to urea formaldehyde foam insulation and produces no formaldehyde offgassing. In fact, tests performed by Energy Mines and Resources Building Performance Centre, Materials Division indicated that no volatile organic compounds were emitted from polyurethane foam. In any case, the OSB skins provide an airtight barrier, permanently sealing the foam inside the panels.

### 1.6.2 Fire

Other findings of the EMR study are as follows:

> Polyurethane insulation applied directly to 14/2, 12/2, and 10/2 gauge residential electrical wiring causes excessive heat buildup when the rated electrical loads of 15, 20, and 30 amps, respectively, were applied. If, however, the load applied to each of the wires is one step down from the rated load, excessive heat buildup does not occur.
>
> The direct application of polyurethane foam insulation on recessed light fixtures produces temperatures greater than 150 Celsius over short periods of normal operation. This may be considered an unnecessary fire risk. The inclusion of a protective galvanized steel enclosure separating the polyurethane foam insulation from the recessed light fixture reduces the fixture temperature below 150 Celsius, but does not reduce the foam/steel interface below the acceptable level of 80 Celsius.
>
> Thermal degradation (discolouration and charring) of the foam was evident in all cases where the polyurethane foam had been exposed to temperatures greater than 80 Celsius.

As an organic material, the polyurethane foam core of the Seven-S panel is considered combustible. The unprotected Seven-S wall panel exhibited the following surface burning characteristics, when tested in accordance with CAN4 S102 and ASTM E84 Standard for Surface Burning Characteristics of Building Materials. Each index expresses the characteristics of the sample relative to that of select grade red oak flooring (100) and asbestos-cement board (0).

| STANDARD: | FLAME SPREAD CLASSIFICATION | SMOKE DEVELOPED | FUEL CONTRIBUTED |
|---|---|---|---|
| CAN4 S102 | 140 | 465 | 100 |
| ASTM E84 | 126 | 465 | 100 |

The unprotected Seven-S panel does not meet the requirements of the CAN4-S101-M82 and ASTM E119-84 fire endurance test standards. However, with proper finishes such as drywall and exterior cladding, the panel fully complieswith any reasonable fire test procedure, and thus will be suitable for structures upto three stories.

## 1.7 Patent Protection

Following a thorough review of competing building panel manufacturers, Seven-S Structures Inc. proceeded with patent appli cation for its panel system. All other existing patents for similar inventions were compared to the Seven-S system. While some of the Seven-S details have been used by other manufacturers, the design and integrity of the complete Seven-S Building System is unique. Consequently, the Seven-S System has been granted a patent in the United States (which also covers it in a number of other countries) and has been granted patent pending status in Canada. Applications have also been filed in Europe, Australia, and some Asian countries.

# 2.0 RESIDENTIAL CONSTRUCTION IN NORTH AMERICA

House building activity in North America is directly tied to the strength of the economy. While changes in the cost of borrowing influence the industry over the short term, demographic factors will determine longer term trends. Such factors include aging of the population, the trend toward smaller families, an increase in the number of two income families, and a reduction in the rate of family formation.

## 2.1 Housing Starts by Region

In Canada, strong consumer confidence, continued economic growth, and the lowest mortgage rates in nine years pushed the number of housing starts to over 240,000 in 1987. Nevertheless, the rate of new house construction is slackening (Exhibit 1). Even when the recession-weakened 1982 figures are excluded, a downward trend in the pace of new house construction is still evident.

EXHIBIT 1 AVERAGE NORTH AMERICAN HOUSING STARTS (THOUSANDS)

| PERIOD | CANADA | U.S. | TOTAL |
|---|---|---|---|
| 1967-71 | 200 | 1584 | 1784 |
| 1972-76 | 246 | 1701 | 1947 |
| 1977-81 | 202 | 1642 | 1844 |
| 1982-87 | 159 | 1619 | 1777 |
| 1988-91(est) | 185 | 1694 | 1879 |

The distribution of housing starts across Canada has seen a dramatic shift over the past decade. In the late 70's, the western provinces were the site of a disproportionately large share of Canada's new housing construction (Exhibit 2). The 1982 recession hit the resource based economy of British Columbia particularly hard; combined with the effects of lower oil prices on the Alberta economy in the mid-80's, Ontario and Quebec have displaced the West as the most active centres of new house construction.

EXHIBIT 2 HOUSING STARTS PER THOUSAND PEOPLE

| REGION | 1979 | 1987 |
|---|---|---|
| ATLANTIC | 6.1 | 6.0 |
| QUEBEC | 6.6 | 11.3 |
| ONTARIO | 6.7 | 11.4 |
| WEST | 12.7 | 7.1 |
| CANADIAN AVERAGE | 8.3 | 9.6 |
| NORTHEAST | 3.6 | 5.4 |
| MIDWEST | 5.9 | 5.0 |
| SOUTH | 10.1 | 7.5 |
| WEST | 11.1 | 8.5 |
| U.S. AVERAGE | 7.8 | 6.6 |

In the United States, pent-up demand from the early eighties led to an increased number of starts from 1983 to 1986 although new housing activity is now resuming its downward trend. This decline is expected to continue throughout North America over the next decade as the rate of family formation continues to fall.

The rate of new privately owned housing starts is basically stable in the northeast and midwest states, reflecting the fact that population growth in these regions is currently stalled. Consequently, the rate of new housing activity remains at approximately five starts per thousand, just enough to maintain the existing stock.

In contrast, population in the southern and western states is currently expanding by 1.6 percent annually and the number of new housing starts is correspondingly higher in these regions. As shown in Exhibit 2, new housing activity is currently 7.5 starts per thousand in the South, and 8.5 starts per thousand in the West.

## 2.2 Consumer Purchasing Trends

Three main factors will dictate how the residential housing market unfolds over the next decade.

1. A decline in the 25-34 age group

This is the age group at which most homeowners will purchase their first dwelling. During the 1980's, the peak of the baby boom generation passed through this age group creating unprecedented demand for starter homes. However, a lower birth rate throughout the 1970's and early 80's means that this age group will not be replenished. From 1991 to 2001 this group is projected to decrease by over 20% drastically reducing the demand for first-time housing.

2. An increase in the 45-54 year age group

Over three-quarters of the householders in this age group are homeowners. With the baby boom generation poised on the verge of entering this age group, demand for trade-up housing, largely single family residential, is expected to increase dramatically over the next decade.

3. Increased wealth of the population as a whole

The lower birth rate exhibited by the baby-boom generation has also resulted in an increase in the number of two income families. Furthermore, the average individual's income peaks in his early 50's while the 55-64 year group has the greatest wealth followed closely by the 45-54 year group. Given that the highest proportion of homeowners is in this 45-64 year group, demand for higher quality trade-up housing will increase as the baby boom generation approaches this age group.

Thus while the total number of housing starts may be expected to decline over the next decade, this does not necessarily imply a drop in residential housing investment. The housing market of the 1990's will be dominated by householders 45-54 years of age. The expected growth in both the affluence and number of middle-aged households will produce an increased demand for higher quality "move-up" housing.

## 2.3 Increasing Urbanization

In 1979, 77% of new dwelling starts occured in urban centres of 10,000 population and over. Today that figure is over 87%. The Atlantic provinces, and to a lessser extent Quebec, are responsible for most of this shift however, as an increasing number of dwelling starts occur in urban centres. Throughout the rest of the country, urban starts continue to comprise approximately 80 to 90% of the total.

With the exception of 1982 when single family dwelling starts plummeted, single units have consistently accounted for 55 to 60% of residential construction in Canada. Despite the movement to more residential starts in urban centres, there has been little change in the percentage of the market captured by multiple unit dwellings. An exception to this is Quebec, where multiple starts exceed singles by a wide margin. Otherwise, single detached houses remain popular with new home purchasers - particularly in Ontario and Alberta.

During the period from 1969 to 1973, mobile home construction captured 20% or more of the U.S. new housing market. Since that time, mobile (or manufactured) homes have settled back to a smaller 10 to 15% market share averaging about 250,000 annually. The high mortgage rates of 1981-82 had little effect on the demand for manufactured homes suggesting that this form of housing may occupy what can be described as a countercyclical market niche.

The remainder of new housing construction in the U.S. is split between single and multiple unit structures. On average, single unit structures accounted for 58% of the market from 1975 to 1987 while structures with two or more units captured 29%. These figures have shown little variation over the 1975-87 time period although there has been a slight trend in recent years toward more multiple unit structures. This is consistent with the trend to more starts inside metropolitan areas as discussed below.

The proportion of new housing starts occuring inside metropolitan areas (MSA's) stayed relatively constant, in the range of 66 to 74 % of the total, from 1967 through to 1981. Since 1982 however, this figure has increased such that at present, over 85% of new housing starts are occurring within metropolitan areas. Increased demand for housing nearer the city core will result in steady growth in renovation spending. We have already seen an increase in the proportion of residential construction that is spent on home improvements as opposed to new housing. The aging of existing housing stock from the building boom of the late 60's and early 70's is expected to further boost renovation investment over the next decade.

As with any premanufactured building product, transportation costs from the plant to the construction site represent a significant cost component. Based on the volume occupied, transportation costs are approximately 50% greater for the Seven-S panel as compared to the building material requirements of a standard non-energy efficient home, but are 25% less when compared to the materials required to build an R-2000 home (using either 2x6, OR double stud 2x4 construction). These lower transportation costs further improve the competitiveness of the Seven-S system relative to conventionally designed energy efficient dwellings. Present transportation costs are in the range of $0.65 to $0.90 per kilometre for a twenty four foot truck - roughly large enough to transport the wall, roof and floor panels for an entire 2000 square foot house.

## 2.4 Remote/Northern Locations

In Northern Canada, there are two main constraints on conventional building design and construction: the extreme climate; and the presence of permafrost. In addition, construction costs are much higher due to increased insulation needs, higher building material costs, and much higher transportation costs.

In the National Research Council paper "Prefabrication in Northern Housing", six different types of construction are discussed:

- conventional stick-built wood frame;
- wood frame panel;
- precut log;
- stressed skin panel;
- sandwich panel;
- arch rib and metal shell.

A cost comparison of these different systems found stressed skin panels (the category to which the Seven-S panel belongs) are the most economical. Although this particular report is somewhat dated, the reasons for this conclusion are still valid: lower transportation costs relative to stick frame buildings; and quick construction, largely handled by unskilled labour.

There is additional emphasis on fire-resistant construction in the north due to several factors: a longer heating season; difficulty in fire-fighting and evacuation in winter; and increased dryness of winter air and consequently of materials. Thus the full potential of the Seven-S panel for use in Northern locations will be dependent on successful development of the fire retardant coating discussed in Section 1.6.

## 2.5 Residential Renovation Investment

The term renovation investment covers a broad range of home improvement investments initiated for a variety of reasons.

1. Increase in number and average age of existing housing stock

According to Statistics Canada's 1982 HIFE survey, major repairs were required on 25% of housing greater than 40 years old, 17% of housing between 20 and 40 years of age, and 7% of housing less than 20 years of age for a total of one million dwellings. Considering that only 21% of Canada's housing stock fell into the first category (greater than 40 years) in 1982, whereas approximately 40% will be over 40 years of age by the year 2000, this market could possibly double over this time period.

2. Changing patterns of demand and more intensive use of existing stock

**EXHIBIT 5 U.S. SPENDING ON RESIDENTIAL RENOVATIONS**

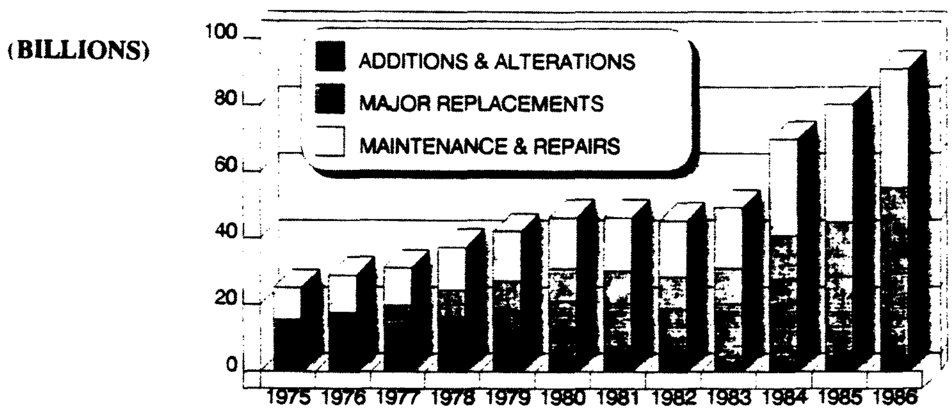
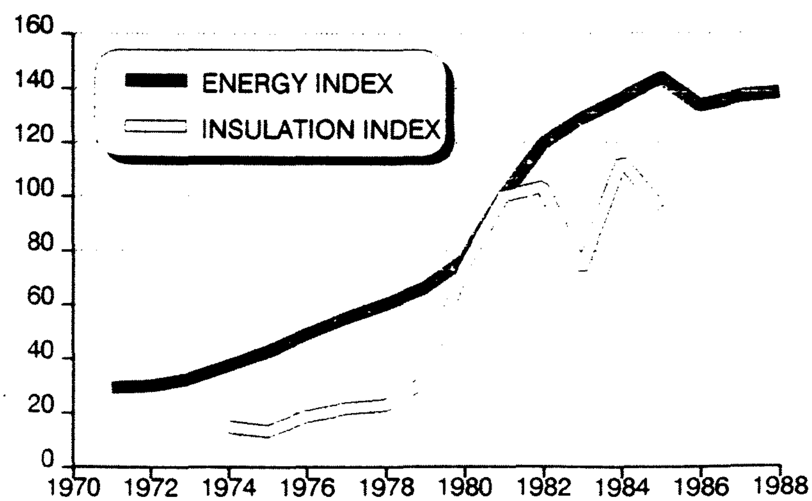



**EXHIBIT 6 COMPARISON OF ENERGY COST INDEX AND INSULATION PRODUCTION INDEX**



It is interesting to note that while bulk and granulated insulation that is used in retrofitting existing homes have experienced a very large increase in production, the production of batt insulation, used in new homes, has remained constant since 1974. Instead, fibreglas batt production has switched to thicker sizes which have more insulation value. Other changes have included: better-sealed, higher R-value doors and windows; more attention to insulating the foundation both above and below grade; and increased emphasis on the overall airtightness of the home. Airtight construction can be achieved using new materials such as Tyvek wrap, or through new building methods such as the airtight drywall approach.

The Seven-S panel is representative of the future evolution of building materials. The main component, oriented strand board, is manufactured from inexpensive, plentiful aspen and yet provides greater structural strength than conventional stick construction. The urethane foam injected into exterior-use panels has a thermal insulation value per unit thickness among the highest of any material thus allowing high R-values without reducing the dwelling's living area. The fact that the panel arrives on-site as a ready to install wall, floor or ceiling reflects another current trend in construction. Prefabricated or manufactured components are capturing an increasing share of the building market. Completing a greater portion of the building process in a factory as opposed to on the building site has a number of benefits: more uniform material, greater quality control, substantially lower on-site labour costs and as a result lower financing costs, faster attainment of lock-up which results in less pilferage and better working conditions for other tradesmen.

## 2.7 The R-2000 Home

Following the first energy crisis in 1973, attention in North America was focussed on the cost and inefficiency of home heating and energy use. Early designs for more energy efficient homes (for example solar heating) were simply too expensive and often only partially effective. The super energy efficient, or R-2000, home arose from the realization that modification of existing building techniques was the simplest and cheapest way to combat increasing energy prices.

In 1983, the Canadian Home Builders' Association, in cooperation with Energy, Mines and Resources, began encouraging builders to provide the public with state-of-the-art, energy efficient homes. To earn R-2000 certification, the home must meet a number of requirements:

> the homebuilder must be a member of a provincial home warranty programme and must have successfully completed an R-2000 Home builder training course;

the house plans must be reviewed and analyzed using the HOT- 2000 computer program developed by EMR to verify that the home will meet the R-2000 standard of energy efficiency;

during construction, the home must be visited by a qualified inspector to ensure that it is being constructed in accordance with the approved plans;

after completion, the home must pass an air leakage test performed by an independent agency.

The current R-2000 technical requirements are listed in Appendix B.

The R-2000 home designed to meet these technical specifications should experience 50 to 75% lower space heating costs relative to a conventionally built home. The most significant savings flow from attention to the following three areas.

1. Reduction of Infiltration and Ventilation

A conventionally built house can lose 30% or more of its heat from air leakage. The energy efficient home has a continuous air/vapour barrier to minimize air leakage and must pass an air leakage test (allow less than 1.5 air changes per hour at a pressure differential of 50 pascals) to qualify for true R-2000 status.

2. Placement and Design of Windows and Doors

Maximum use is made of solar heat; south-facing walls contain the largest window area nad north-facing walls the least. In addition, roof overhangs are designed to let the lower angled winter sun in, but to block the sun in summer. Windows are sealed, double or triple glazed and both window and door frames contain thermal breaks to reduce heat conduction as well as convection.

3. Insulation

An R-2000 home contains up to three times the insulation of a conventional house. Exhibit 7 gives this comparison in detail.

EXHIBIT 7 R-VALUE COMPARISON

| | CONVENTIONAL HOME | R-2000 HOME | SEVEN-S HOME |
|---|---|---|---|
| BASEMENT WALLS | R4-R8 | R20 | R30 |
| EXTERIOR WALLS | R12 | R28-R44 | R30-R45 |
| CEILINGS | R32 | R40-R60 | R48 |
| DOORS | R4 | R10 | R10 |

Despite the estimated 15% higher cost to purchase an R-2000 Home, the market for these houses has grown steadily since its beginning in 1983 (Exhibit 8).

EXHIBIT 8 R-2000 STARTS IN CANADA

| FISCAL YEAR (April to March) | STARTS | |
|---|---|---|
| 1983-4 | 300 | |
| 1984-5 | 300 | |
| 1985-6 | 300 | |
| 1986-7 | 500 | |
| 1987-8 | 1200 | |
| 1988-9 | 2000 | (1200 as of December 1988) |
| 1989-90 | 3500 | (R-2000 programme target) |

There are currently 150 builders registered with the Ontario Home Builders' Association to build R-2000 homes in Ontario. Nationally there are approximately 450 such builders. Some builders now specialize or deal exclusively with R-2000 housing while demand should be further boosted by pull-through demand created by directly targeting the energy-conscious consumer, and by intensive consumer awareness programmes initiated by the Federal Government.

Increased energy efficiency is only one of the factors that appeals to the R-2000 home purchaser. Other demonstrated benefits include: greater comfort, due to more even heating and a lack of drafts; quiet, due to increased levels of insulation; and improved air quality as a result of the heat recovery ventilator requirement.

The Seven-S panel is ideally suited as a building material for the R-2000 home. It provides a high R-value without requiring construc tion of thick walls which use up potential living space. It is completely impermeable to air and water vapour achieving greater airtightness with less effort. And finally, it allows openings in the frame to be cut to the exact dimensions reducing the time and inefficiency associated with conventional door and window framing techniques.

The most significant attribute of the Seven-S Building System becomes evident when both the monthly operating costs, and the cost to purchase, a Seven-S house are compared to an energy efficient and a non-energy efficient conventional (stick-frame) house. The life cycle analysis in Exhibit 9 demonstrates that at present energy prices, the additional cost of building an energy efficient house with the Seven-S system is almost completely paid for by the resultant energy savings. Moreover, the monthly carrying costs are substantially less when compared to a home built using current R- 2000 technology.

EXHIBIT 9 LIFE CYCLE COST ANALYSIS

| PANEL | NON-ENERGY EFFICIENT HOME | R-2000 DOUBLE-STUD HOME | R-2000 SEVEN-S HOME |
|---|---|---|---|
| PRICE (1) | $197,268 | $219,187 | $212,740 |
| DOWNPAYMENT | $40,000 | $40,000 | $40,000 |
| MORTGAGE | $157,268 | $179,187 | $172,740 |
| PRINCIPAL + INTEREST (2) | $1,622.85 | $1,849.03 | $1,782.51 |
| TAXES | $120.00 | $120.00 | $120.00 |
| HEAT (3) | $278.64 | $92.88 | $92.88 |
| MONTHLY CARRYING COSTS | $2,021.49 | $2,061.91 | $1,995.39 |

NOTES : (1) Based on a 2400 sq ft house (refer to Exhibit 12) located in a 3200 C degree day zone.

(2) 25 year amortization period at 12% interest.

(3) Forced Air Electric Space Heating at approximately $0.068 per kWh and assuming R-2000 design permits 66.7% savings on space heating costs.

Thus despite the substantial energy savings derived from constructing a conventional R-2000 Home, at current energy prices the purchase decision cannot be justified solely on the basis of cost. The popularity of R-2000 Homes thus far must be attributed to the other benefits associated with this type of construction (comfort, quiet, air quality) in addition to the expectation of real cost savings derived from future energy price increases. In contrast, the combination of lower puchase price and lower monthly carrying costs gives the Seven-S Building System a clear advantage over both energy efficient and non-energy efficient conventional housing even at current energy prices.

There is no doubt that as energy prices escalate, the R-2000 Home will capture an increasing share of the residential housing market. The Seven-S Building System is ideally suited to replace conventional building practices in this market. Furthermore, based on the example in Exhibit 9, the Seven-S Building System is already at the point where it may be sold on the basis of cost savings alone; combined with the other benefits associated with its Building System, Seven-S is poised to capture a significant portion of the residential building industry.

## 2.8 Manufactured Housing

A manufactured house can be defined as a dwelling in which one half or more of the structural frame has been produced in a factory remote from the job site. Although mobile homes are included in this definition, they comprise only a small percentage of the total. Kit home manufacturers are well established in Canada offering quality homes at a reasonable price. For example, Viceroy Homes of Scarborough, Ontario offers a kit for a 1735 sq.ft home at $22 per square foot. Fully installed, this might cost a purchaser $60-65 per square foot. Pan-Abode of Richmond, B.C. offers a 1919 sq.ft. home kit at $29 per sq. ft. which may cost the purchaser as little as $50 per square foot installed on a full basement.

Modular homes also represent a competitively priced option in the manufactured housing market. In this type of building, the entire house shell is completed in the factory and then shipped to the construction site in modules. Modular home manufacturers, like mobile home producers, have experienced a major market reduction, and less than 10% of them have survived the last six years. The demand for the small standard bungalows they produced so efficiently in the past for low and moderate income families has virtually collapsed. Present market demand calls for custom designs, two- storey units, and row housing. Athough modular homes have gained much-needed public exposure, largely through the Ontario government's "granny flats" showcase, the oversized modules are difficult to manoeuvre and will likely restrict this type of manufactured housing to localized areas within a small radius (400 km at most) of the factory.

The greatest activity in factory built components in Canada is in the area of structural panels. A number of firms have sprung up in recent years offering a wide variety of panelized products, usually incorporating insulation within the structural component. Insul-Wall of Dartmouth N.S., Nas-Cor (Cano Structures), and Plasti-Fab of Calgary all produce wood frame panels with rigid expanded polystyrene (EPS) as insulation. Teal Industries of Langley B.C. produces panels complete with exterior sheathing, insulation, interior drywall, and roughed-in electricals, windows, and exterior doors. The panels are edged with rubber gaskets that compress to form an airtight seal when assembled.

The manufactured housing industry finally turned the corner in 1986 after twelve years of steady decline. The magnitude of this decline is illustrated in Exhibit 10.

EXHIBIT 10 MANUFACTURED HOUSING SHIPMENTS

| | TOTAL CANADIAN HOUSING STARTS | MAUFACTURED HOUSING | | | PERCENT OF TOTAL |
|---|---|---|---|---|---|
| | | CMHI MEMBER | CMHI NON-MEMBER | TOTAL | |
| 1974 | 255213 | | | 49118 | 19.2% |
| 1978 | 227667 | 11307 | | | 5.0%* |
| 1980 | 158601 | 6800 | | | 4.3%* |
| 1982 | 125860 | 3838 | | | 3.0%* |
| 1984 | 134900 | 3741 | | | 2.8%* |
| 1986 | 199785 | 3585 | 2000 | 5585 | 2.8% |
| 1987 | 245986 | 4200 | 2060 | 6260 | 2.5% |
| 1988(est) | 212483 | | | 7512 | 3.5% |

* includes CMHI members only

SOURCE: CANADIAN MANUFACTURED HOUSING INSTITUTE (CMHI)

A number of factors should contribute to increasing the market share of manufactured housing in future. Success of the factory-built housing industry in North America will depend on the ability of manufacturers to overcome its negative image. This must embody changes on two fronts: proving the quality and aesthetic appeal of the product; and taking full advantage of the efficiencies inherent in mass production to produce a higher quality product at a lower price. The Canadian Manufactured Housing Institute (CMHI) is increasingly active in selling a new, brighter image to the public. The CMHI is currently working with the Ontario government to mount a demonstration project of 300-350 mobile homes. It is also taking an active role in convincing conventional builders and developers to accept manufactured components in their projects.

In Sweden and Japan, where the higher quality at competitive prices is recognized, factory-built housing takes 95% and 17% market shares respectively. The potential for increased productivity, reduced costs, and improved design flexibility offered by the manufactured home should allow it to attain steady growth in North America as well, even as the demand for other new housing drops off.

## 2.9 Granny Flats

Although it will be 25 years before the first members of the baby boom even reach retirement age, the elderly still represent a growing segment of our population. Within this group, the largest growth will occur in the frail elderly. Historically, Canada has housed this group in senior citizens apartments. Most provinces are now adopting the view that enough senior citizen housing has been built and that more efforts should be made to assist the elderly to stay in their own homes. In this regard, the development of granny flats as a housing solution for seniors wishing to live close to their families is creating a new market niche, particularly suitable for exploitation by the manufactured housing industry. As urban municipalities accept the newer generation of higher quality manufactured housing, mobil home parks, retirement communities, and modular or prefabricated housing components, granny flats will play an increasingly important role in satisfying demand for seniors' housing.

# 3.0 NON-RESIDENTIAL CONSTRUCTION IN NORTH AMERICA

In 1988, the total value of new non-residential construction in Canada was approximately $18.5 billion. As shown in Exhibit 11, there has been a dramatic shift in the location of new non-residential construction since 1983. While the value of non-residential construction has changed little over the past five years in the West, it has more than doubled in Ontario, Quebec, and Atlantic Canada.

Exhibit 11

TOTAL VALUE OF NON-RESIDENTIAL CONSTRUCTION PURCHASED BY R
(BILLIONS)

| REGION: | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|---|---|
| ATLANTIC | $0.8 | $0.8 | $0.7 | $0.8 | $1.0 | $1.1 | $1.2 | $1.4 |
| QUEBEC | $1.9 | $2.1 | $1.9 | $2.3 | $3.1 | $3.2 | $3.7 | $4.1 |
| ONTARIO | $3.5 | $3.6 | $3.3 | $4.0 | $5.1 | $6.0 | $7.3 | $7.9 |
| MAN/SASK | $1.0 | $0.9 | $0.9 | $1.0 | $1.1 | $1.2 | $1.1 | $1.2 |
| ALBERTA | $3.2 | $3.4 | $2.5 | $1.8 | $1.9 | $1.9 | $2.1 | $2.0 |
| B.C. | $2.3 | $1.9 | $1.8 | $1.8 | $1.9 | $1.6 | $1.9 | $2.0 |
| CANADA | $12.7 | $12.6 | $11.1 | $11.7 | $14.2 | $15.1 | $17.3 | $18.5 |
| U.S. | $86.6 | $89.7 | $86.0 | $102.5 | $118.9 | $117.5 | | |

This market can be broken down into seven segments comprised of different types of buildings based on the potential that the Seven-S panel has to capture market share for each of these building types.

The first segment - agricultural buildings - is one in which Seven-S has already proven its ability to produce a competitive product. Farm buildings currently account for $493 million or 2.7% of the total non-residential market down from a high of 7% in 1983. The western provinces, Ontario, and Quebec have all witnessed a shrinking demand for farm buildings over the past six years. The one bright spot here is the Atlantic provinces, particularly Nova Scotia, which has experienced a tripling of demand for farm buildings over the same period. In the U.S., agricultural building construction has been in steady decline dropping from $5.6 billion in 1979 to $2.0 billion in 1986.

The second segment, to which the Seven-S panel is also very well suited, is comprised of warehouses, refrigerated storage, and grain elevators. Although this segment has accounted for a relatively constant proportion (in the range of 4-6%) of the total Canadian non-residential building market, the past three years have seen the Ontario market quadruple in size from $161 million in 1985 to $636 million in 1988. The rest of the country is currently experiencing low or negative rates of growth in this segment.

The third segment, in which the Seven-S panel may have some market appeal, includes factories, workshops, food canneries, and smelters. This category currently accounts for 12% of Canadian non-residential construction, down from 18% in 1980-81. Ontario and Quebec have been responsible for most of the growth in this segment and indeed now account for 74% of the total. Industrial building construction (segments two and three) has been stagnant in the U.S. remaining in the range of $15-20 billion per annum since 1979.

The fourth segment is comprised of retail and wholesale stores, garages and sevice stations, laundries, dry cleaners, theatres, arenas, and recreational buildings. Again, the Seven-S panel has the potential to capture a portion of this market segment. Currently this type of construction is healthiest in Ontario and the western provinces although the Quebec market also appears to hold much promise with steady growth averaging 17% per annum over each of the past seven years. This segment has also experienced steady growth in the United States from $15 billion in 1979 to $28 billion in 1986.

The fifth segment - hotels, restaurants, and office buildings - is one in which Seven-S has little chance of gaining any market share. Ontario and Quebec account for the majority of this type of construction and continue to grow much more quickly than the West or Atlantic Canada. This is largest segment of the U.S. non-residential building market having tripled from $11.6 billion in 1979 to $36 billion in 1986.

Together, these last two segments account for over 55% of the total value of non-residential construction put in place in both Canada and the United States. This has grown steadily from about 44% of the market in 1979 (38% in the U.S.) and mirrors the ever increasing role of services in our economy. Although hotel and office building construction appears stagnant at the moment in the West, growth in the service sector of the economy can be expected to occur more or less equally throughout all regions of the country.

The sixth non-residential market segment includes all types of institutional buildings such as schools, hospitals, and churches. Wood products are not generally accepted in this market segment, largely due to a perceived fire risk. Seven-S is presently devel oping a liquid ceramic coating to reduce the susceptability of its panel to fire. Preliminary testing indicates this will allow the Seven-S panel to achieve a fire rating of zero thus completely opening this market segment with uses such as portable classrooms. This category currently accounts for 17.5% of the value of non- residential construction in Canada, down from 22.5% in 1983. Institutional building has experienced only slight growth in the United States increasing from $14.5 billion in 1979 to $20.9 billion in 1986.

The seventh and final segment includes all other commercial and industrial buildings not covered in one of the above categories. Although this segment has declined from 10.5% of the Canadian total in 1983 to 6.7% in 1988, a significant component of the segment is related to transportation and communication sectors of the economy (television and radio broadcasting facilities, railway buildings, aircraft hangars, bus, boat and air passenger terminals) and thus might be expected to experience more positive growth in future. Despite the wide variety of building types, Seven-S will be success ful in supplying a portion of this market segment.

# 4.0 THE PREFABRICATED BUILDING INDUSTRY OUTSIDE NORTH AMERICA

## 4.1 Japan and Asia

Prefabricated systems today account for approximately 17% of Japan's housing industry, up from 15% in 1983. The continued success of manufactured housing in Japan stems from several factors. First, the industry is quite concentrated, with 69% of the market held by the top four companies and over 90% held by the top eight. This, combined with the access that these companies have to a large concentrated market (particularly the Tokyo-Osaka corridor) has allowed them to benefit from the economies of scale associated with production volumes on the order of 1000 homes per month. Indeed one of the largest manufacturers, Sekisui, is a large vertically- integrated chemical company which has merely applied its process technology to the manufacture of housing components. Second, while taking advantage of the benefits of mass production, Japanese manufacturers have maintained an emphasis on the "free style" plan where each house can be customized to individual preferences. Thus prefabricated housing manufacturers have developed a positive image by actually offering more flexibility than traditional builders. Third, whereas all new building materials and methods in Japan are subject to rigourous government standards, the Building Centre of Japan administers a technical appraisal programme specifically for prefabricated housing systems. The Industrialized Housing Performance Approval System monitors the safety, strength, durability, and conformance to regulations of all new materials and has thus ensured that manufactured housing components are not just accepted, but are increasingly preferred, by the consumer.

As strong as the prefabricated building industry is in Japan, there is not a clear competitor to the Seven-S building system. As of 1984, 65% of the prefab housing market was held by systems using a light gauge steel frame with some sort of composite nonload bearing panel. Approximately 5% was held by precast concrete systems, while the remaining 30% was held by (prestressed) wood panel systems.

The main reason for this is that prefabricated building manufacturers currently concentrate selling efforts on the densely populated South-Central Honshu region. The moderate climate of this region means that little emphasis is placed on the insulation properties of the system. On the northern Island of Hokkaido however, a cooler climate prevails and the Seven-S panel's superior insulation properties would give it a competitive advantage.

The popularity of prefabricated housing in Japan is a result of its total integration into the Japanese economy as a distinct industry. A variety of prefabricated housing is now available from a number of large, well-established manufacturers committed to improving the market penetration of their products through national-scale marketing efforts, post sales followup, and the extension of product lines to include higher value-added components (furniture and fixtures).

With such a national strategy in place,Japan will lead the way in exporting its product to other Asian countries - Singapore, Hong Kong, Taiwan, Korea, and eventually China, and India.

## 4.2 Europe

Unlike the North American experience, growth in construction employment in Europe between 1960 and 1980 was far outpaced by the growth in value added by the construction industry. This trend is the result of two specific factors: rationalization of work at the building site, and increased use of prefabricated materials. Rationalization includes such effects as the repetitive production of many standardized buildings, and increased mechanization on-site, both of which lead to reduced labour requirements. Prefabrication has led to lower construction labour costs by reducing the labour- hours needed to build a house, and also by altering the task of building to one of assembly which requires a lesser skilled labour force.

Northern and Western Europe had been moving in the direction of highly prefabricated construction until the early 1970's. Up to this point, the prefab industry had depended on large-scale multi-unit buildings to achieve the cost efficiencies necessary for success. With the shift towards individually designed one and two family dwellings, an increased emphasis on renovation, and a high unemployment rate in the construction industry, the use of large prefabricated concrete panels faltered in the late 1970's. In the Scandanavian countries, well over half of all buildings rely on prefabricated components, usually of wood.

In the United Kingdom, the unfavourable reaction of residents to large scale multi-storey public sector housing has led to a significant decline in the prefabricated building industry. In the early 1980's, prefabricated construction accounted for less than 5% of publicly funded dwelling starts, down from 19% in 1975. While use of fully prefabricated building systems has declined, the industry has been making greater use of prefabricated and standardized components, especially prefabricated timber components. As in Canada, light-weight load bearing panels currently hold the dominant share of the prefabricated building market.

The trend toward increased prefabricated construction was very strong in Eastern Europe in the 1970's, particularly the use of large concrete panels for multi-storey buildings in urban areas.

Masonry and concrete generally dominate construction in Southern Europe, with little use made of prefabricated building components.

## 4.3 Soviet Union

Large-panel (concrete) construction is used in the majority of residential projects in the Soviet Union; 54% of the total, and as much as 75% in the major urban centres (in 1980). Large panel systems were found to provide a six to eight percent savings of on- site labour and a 30 to 40 percent reduction in construction time. As of the early 1980's, prefabricated wood components accounted for about five percent of new dwellings.

## 5.0 COMPETITIVE ANALYSIS

The selection of materials by the builder is determined by a number of factors, most importantly cost and familiarity with the material. An important determinant in the decision making process is also whether the builder is custom building or merely developing a property on speculation with no specific buyer in mind. Clearly, in the former case, the decision making process is shared beween the builder and the purchaser, while in the latter, materials are determined solely by the builder. Even in the case of a custom built house however, those materials of a technical nature (dealing with the foundation or structure of the house for example) are unlikely to be considered by the purchaser.

Thus with the exception of the superior insulating properties, all other attributes of the Seven-S structural panel - its strength, durability, potential cost savings, and speed of construction - will be of interest primarily to the builder.

### 5.1 Seven-S Versus Conventional Building Techniques

With higher standards in place for all new residential dwellings in Canada, consumers are no longer faced with the task of evaluating relative energy efficiency in addition to the other decisions associated with purchasing a new home. Hence the purchaser has little reason to become involved in the specification of any structural building materials. It is therefore the builders or developers who must be allowed to realize the benefits of the Seven- S Building System. When used as the main structural component throughout a house, the Seven-S panel creates a stronger house at a lower cost when compared to conventional 2 x 6 construction. Cost savings derived from the Seven-S system fall into three categories:

1. Lower direct material and labour costs.

   A detailed breakdown of labour and materials costs for each phase of construction is shown in Exhibit 12. At current prices, the Seven-S building system yields a cost advantage over conventional construction in the range of up to five percent.

2. Lower financing costs.

   Lower expenditures on materials and labour reduces the financing expense incurred by the builder. Moreover, the Seven- S panels speed construction thus reducing the period of time a builder must carry his construction loans.

EXHIBIT

COST COMPARISON OF SEVEN-S BUILDING SYSTEM TO CONVENTIONALLY BUILT HOUSING

| 1972 CONVENTIONAL HOME CONSTRUCTION COSTS | | | | 1987 CONVENTIONAL HOME CONSTRUCTION COSTS | | | | COST PER SQUARE FT LIVING AREA | | |
|---|---|---|---|---|---|---|---|---|---|---|
| OPERATION | MATERIALS | LABOUR | TOTAL | MATERIALS | LABOUR | TOTAL | COST CATEGORY | MATERIALS | LABOUR | TOTAL |
| INFLATOR '72 TO '87 | | | | 4.25 | 3.752 | | | | | |
| EARTHWORK | $489 | $665 | $1,155 | $2,080 | $2,496 | $4,577 | FIXED | $1.27 | $1.52 | $2.78 |
| BASEMENT | $948 | $604 | $1,552 | $4,029 | $2,265 | $6,295 | FIXED | $2.45 | $1.38 | $3.83 |
| FLOOR/ROOF/EXT | $2,125 | $480 | $2,605 | $9,482 | $1,891 | $11,373 | VAR B (2) | $5.77 | $1.15 | $6.92 |
| INTERIOR WALL | $217 | $108 | $325 | $922 | $404 | $1,326 | FIXED | $0.56 | $0.25 | $0.81 |
| INSULATION | $1,236 | $226 | $1,462 | $9,456 | $1,526 | $10,982 | VAR B (2) | $5.75 | $0.93 | $6.68 |
| SERVICES (PEH) | $1,849 | $414 | $2,264 | $7,860 | $1,944 | $9,804 | VAR A (3) | $4.78 | $1.18 | $5.96 |
| DRYWALL, TILE | $655 | $474 | $1,129 | $2,784 | $1,779 | $4,563 | FIXED | $1.69 | $1.08 | $2.78 |
| INTERIOR FINISH | $1,660 | $402 | $2,062 | $7,055 | $1,508 | $8,563 | FIXED | $4.29 | $0.92 | $5.21 |
| FINISH FLOORING | $581 | $260 | $841 | $2,469 | $976 | $3,445 | FIXED | $1.50 | $0.59 | $2.10 |
| EXTERIOR FINISH | $995 | $598 | $1,593 | $4,229 | $2,242 | $6,472 | FIXED | $2.57 | $1.36 | $3.94 |
| PAINTING | $126 | $436 | $562 | $537 | $1,636 | $2,173 | FIXED | $0.33 | $0.99 | $1.32 |
| MISCELLANEOUS | $17 | $246 | $263 | $74 | $922 | $996 | FIXED | $0.04 | $0.56 | $0.61 |
| TOTAL | $10,900 | $4,912 | $15,812 | $50,979 | $19,588 | $70,567 | | $31.01 | $11.91 | $42.92 |

NOTES : (1) 5.00% premium added to framing cost to account for 2x6 construction

(2) 80.00% premium added to account for greater insulation requirements

(3) 25.00% premium added onto labour to account for increased difficulty working around air tight barrier

(4) EACH OF THE 12 BUILDING STEPS HAS BEEN CATEGORIZED AS FOLLOWS:

FIXED - NO COST DIFFERENCE BETWEEN CONVENTIONAL AND SEVEN-S BUILDINGS

VAR A - SERVICES TRADES INCUR A PREMIUM WORKING WITH SEVEN-S PANEL = 10%

VAR B - LOWER MATERIAL AND LABOUR COSTS FOR 7-S PANEL VS. 2 x 6 CONVENTIONAL CONSTRUCTION

## COST TO BUILD A CONVENTIONAL HOME

| | 1600 SQ FT | | | 2025 SQ FT | | | 2400 SQ FT | | | 3025 SQ FT | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATION | MATERIALS | LABOUR | TOTAL | MATERIALS | LABOUR | TOTAL | MATERIALS | LABOUR | TOTAL | MATERIALS | LABOUR | TOTAL |
| EARTHWORK | $2,024 | $2,430 | $4,454 | $2,562 | $3,075 | $5,637 | $3,037 | $3,644 | $6,681 | $3,828 | $4,593 | $8,421 |
| BASEMENT | $3,921 | $2,205 | $6,126 | $4,963 | $2,790 | $7,753 | $5,882 | $3,307 | $9,189 | $7,414 | $4,168 | $11,582 |
| FLOOR/ROOF/EXT | $9,229 | $1,840 | $11,069 | $11,680 | $2,329 | $14,009 | $13,843 | $2,760 | $16,603 | $17,448 | $3,479 | $20,927 |
| INTERIOR WALL | $897 | $393 | $1,290 | $1,136 | $497 | $1,633 | $1,346 | $589 | $1,935 | $1,697 | $743 | $2,439 |
| INSULATION | $9,203 | $1,485 | $10,688 | $11,648 | $1,879 | $13,527 | $13,805 | $2,227 | $16,032 | $17,400 | $2,807 | $20,207 |
| SERVICES (PEH) | $7,650 | $1,892 | $9,542 | $9,682 | $2,394 | $12,076 | $11,475 | $2,838 | $14,312 | $14,463 | $3,577 | $18,039 |
| DRYWALL, TILE | $2,710 | $1,731 | $4,441 | $3,430 | $2,191 | $5,621 | $4,065 | $2,597 | $6,662 | $5,123 | $3,273 | $8,396 |
| INTERIOR FINISH | $6,866 | $1,468 | $8,334 | $8,690 | $1,858 | $10,548 | $10,299 | $2,202 | $12,501 | $12,981 | $2,776 | $15,757 |
| FINISH FLOORING | $2,403 | $949 | $3,353 | $3,042 | $1,202 | $4,243 | $3,605 | $1,424 | $5,029 | $4,543 | $1,795 | $6,338 |
| EXTERIOR FINISH | $4,116 | $2,182 | $6,298 | $5,209 | $2,762 | $7,971 | $6,174 | $3,274 | $9,448 | $7,782 | $4,126 | $11,908 |
| PAINTING | $523 | $1,592 | $2,115 | $662 | $2,015 | $2,676 | $784 | $2,388 | $3,172 | $988 | $3,010 | $3,998 |
| MISCELLANEOUS | $72 | $897 | $969 | $91 | $1,135 | $1,226 | $108 | $1,346 | $1,453 | $136 | $1,696 | $1,832 |
| TOTAL | $49,615 | $19,064 | $68,679 | $62,794 | $24,128 | $86,921 | $74,422 | $28,596 | $103,018 | $93,803 | $36,043 | $129,846 |

NOTE : ASSUME COST PER SQ. FT. DOES NOT INCREASE OR DECREASE WITH SIZE OF HOME

COST TO BUILD A 7-S HOME

| | MATERIALS | LABOUR (FACTORY) | SELLING PRICE | SELLING PRICE (incl FST) | SEVEN-S MARGIN | SEVEN-S MARGIN |
|---|---|---|---|---|---|---|
| WALLS | $1.71 | $0.50 | $3.59 | $3.85 | $1.38 | 38.4% |
| ROOFS | $2.15 | $0.50 | $4.19 | $4.50 | $1.54 | 36.8% |
| FLOORS | $2.24 | $0.50 | $4.51 | $4.84 | $1.77 | 39.2% |

| SQ.FT. floor space | SQ.FT. wall area | WALLS | ROOFS | FLOORS | BUILDER'S COSTS MATERIALS | BUILDER'S COSTS LABOUR | BUILDER'S COSTS TOTAL |
|---|---|---|---|---|---|---|---|
| 1600 | 1920 | $7,394 | $4,457 | $7,749 | $19,600 | $1,888 | $21,488 |
| 1644 | 1946 | $7,496 | $4,518 | $7,962 | $19,976 | $1,940 | $21,916 |
| 2025 | 2160 | $8,318 | $5,014 | $9,808 | $23,:40 | $2,390 | $25,529 |
| 2400 | 2352 | $9,058 | $5,459 | $11,624 | $26,141 | $2,832 | $28,973 |
| 3025 | 2640 | $10,167 | $6,128 | $14,651 | $30,946 | $3,570 | $34,515 |

ON-SITE LABOUR COST TO ERECT 7-S HOME ON EXISTING FOUNDATION = $1.18 PER SQ FT LIVING SPACE
AS COMPARED TO APPROXIMATELY $2.08 PER SQ FT FOR CONVENTIONAL CONSTRUCTION

MATERIALS AND LABOUR COST COMPARISONS - CONVENTIONAL VS. SEVEN-S

| COST COMPONENT | 1600 SQ FT CONVENTIONAL | 1600 SQ FT SEVEN-S | 2025 SQ FT CONVENTIONAL | 2025 SQ FT SEVEN-S | 2400 SQ FT CONVENTIONAL | 2400 SQ FT SEVEN-S | 3025 SQ FT CONVENTIONAL | 3025 SQ FT SEVEN-S |
|---|---|---|---|---|---|---|---|---|
| FIXED | $37,380 | $37,380 | $47,310 | $47,310 | $56,071 | $56,071 | $70,672 | $70,672 |
| VAR A | $9,542 | $9,731 | $12,076 | $12,315 | $14,312 | $14,596 | $18,039 | $18,397 |
| VAR B | $21,757 | $21,488 | $27,536 | $25,529 | $32,635 | $28,973 | $41,134 | $34,515 |
| TOTAL | $68,679 | $68,599 | $86,921 | $85,154 | $103,018 | $99,640 | $129,846 | $123,585 |
| MATERIALS & LABOUR | $68,679 | $68,599 | $86,921 | $85,154 | $103,018 | $99,640 | $129,846 | $123,585 |
| LAND | $36,531 | $36,531 | $46,235 | $46,235 | $54,797 | $54,797 | $69,067 | $69,067 |
| FINANCING | $11,690 | $9,644 | $14,795 | $12,206 | $17,535 | $14,466 | $22,101 | $18,234 |
| OVERHEAD | $22,649 | $22,649 | $28,666 | $28,666 | $33,974 | $33,974 | $42,821 | $42,821 |
| PROFIT | $6,576 | $6,576 | $8,322 | $8,322 | $9,863 | $9,863 | $12,432 | $12,432 |
| TOTAL | $146,125 | $143,999 | $184,939 | $180,583 | $219,187 | $212,740 | $276,267 | $266,138 |
| PRICE REDUCTION | | 1.5% | | 2.4% | | 2.9% | | 3.7% |

NOTE : THE LOWER FINANCING COST FOR THE SEVEN-S HOME IS BASED ON TWO FACTORS:
SLIGHTLY LOWER MATERIAL COSTS, AND EARLIER ATTAINMENT OF LOCK-UP BY ABOUT ONE MONTH.

3. Lower overheads and other costs.

Seven-S panels are produced under controlled factory conditions to high standards. This plus the high strength and minimal shrinking of the panels combine to reduce the number of callbacks. Finally, with lock-up being achieved in a few days as opposed to a month or more, pilferage of materials from the construction site is substantially reduced.

Depending on the size of the home, savings derived from use of the Seven-S Building System total about two to four percent of the purchase price. Of course the purchaser is also benefitting from the Seven-S panel's greater strength and higher R-value per unit thickness, which results in more living space, a quieter home, and reduced energy costs.

According to a survey completed by the Canadian Housing and Mortgage Corporation in early 1986, awareness and adoption rates of new building materials in Canada is low. This suggests that despite the many positive factors inherent in adopting the Seven-S building system, a concerted marketing effort will still be necessary to overcome the traditional resistance builders have shown to adopting new building materials and techniques.Another finding of the CMHC survey was that summary information received by mail is the single most effective channel of information for providing builders with technical information on new home building materials, followed closely by demonstrations and trade shows.

## 5.2 Seven-S Versus Other Building Panel Manufacturers

As the trend toward factory produced prefabricated building components continues, other building panel manufacturers will continue to enter the market. Currently available panel systems generally rely on rigid sheets of expanded polystyrene (EPS) which has a much lower R-value per unit thickness than polyurethane foam and thus do not offer the advantages of increased living area and lower transportation costs. EPS insulation does have a better fire rating than polyurethane foam though Seven-S is currently addressing this issue through development of a fire retardant coating. This coating should eventually improve the fire rating of Seven-S panels for use as firewalls.

Few of the other panel manufacturers incorporate the continuous header which provides Seven-S' main competitive advantage - the versatility to place door and window openings of any size at any location within the panel without reducing its structural integrity. It is the lack of this feature which requires competitors to either custom-make panels that require window or door openings at a higher cost, or to add additional framing on-site, which slows construction and increases the builder's costs. Moreover, many of the competing manufacturer's products are limited to walls, with no application for floors or roofs.

Exhibit 13 compares the Seven-S building system to conventional building as well as to other panel manufacturers.

of this market by 1992. These advantages include: high R-value in a thin but strong wall, resulting in lower transportation costs to the construction site and greater usable living space in the completed home; incorporation of a continuous header allowing complete flexibility in the placement of door and window openings; availability of roof, floor, and ceiling panels as well as wall panels allowing the benefits of the Seven-S panel to be realized throughout the entire building; and competitive pricing.

Exhibit 14 shows Innisfail based Seven-S Structures Inc. capturing just less than 30% of the prefabricated panel market in Western Canada by 1992. Seven-S Structures' share of the Eastern Canadian market drops to zero over this same period reflecting the opening of the Eastern Canadian licensee.

CANADIAN RESIDENTIAL DWELLING STARTS: FORECAST BY REGION (ALL DOLLAR FIGURES IN MILLIONS)

| SEGMENT | 1989 TOTAL RESIDENTIAL STARTS | 1989 PREFAB PANEL MARKET POTENTIAL (%) | 1989 PREFAB PANEL MARKET POTENTIAL (STARTS) | 1989 SEVEN-S % SHARE | 1989 SEVEN-S PROJECTED SALES | 1990 TOTAL RESIDENTIAL STARTS | 1990 PREFAB PANEL MARKET POTENTIAL (%) | 1990 PREFAB PANEL MARKET POTENTIAL (STARTS) | 1990 SEVEN-S % SHARE | 1990 SEVEN-S PROJECTED SALES | 1991 TOTAL RESIDENTIAL STARTS | 1991 PREFAB PANEL MARKET POTENTIAL (%) | 1991 PREFAB PANEL MARKET POTENTIAL (STARTS) | 1991 SEVEN-S % SHARE | 1991 SEVEN-S PROJECTED SALES | 1992 TOTAL RESIDENTIAL STARTS | 1992 PREFAB PANEL MARKET POTENTIAL (%) | 1992 PREFAB PANEL MARKET POTENTIAL (STARTS) | 1992 SEVEN-S % SHARE | 1992 SEVEN-S PROJECTED SALES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ONTARIO EAST | 151960 | 4.5% | 6838 | 0.7% | 49 | 126325 | 5.5% | 6948 | 3.1% | 212 | 125034 | 6.5% | 8127 | 3.1% | 254 | 121173 | 7.5% | 9088 | 0.0% | 0 |
| MANITOBA WEST | 52447 | 4.5% | 2360 | 0.7% | 17 | 48557 | 5.5% | 2671 | 3.1% | 82 | 48133 | 6.5% | 3129 | 14.4% | 450 | 46994 | 7.5% | 3525 | 28.7% | 1012 |
| TOTAL | 204407 | | 9198 | | 66 | 174883 | | 9619 | | 294 | 173167 | | 11256 | | 704 | 168167 | | 12613 | | 1012 |

| SEGMENT | 1989 TOTAL RESIDENTIAL INVESTMENT | 1989 PREFAB PANEL MARKET POTENTIAL (%) | 1989 PREFAB PANEL MARKET POTENTIAL (millions) | 1989 SEVEN-S % SHARE | 1989 SEVEN-S PROJECTED SALES (millions) | 1990 TOTAL RESIDENTIAL INVESTMENT | 1990 PREFAB PANEL MARKET POTENTIAL (%) | 1990 PREFAB PANEL MARKET POTENTIAL (millions) | 1990 SEVEN-S % SHARE | 1990 SEVEN-S PROJECTED SALES (millions) | 1991 TOTAL RESIDENTIAL INVESTMENT | 1991 PREFAB PANEL MARKET POTENTIAL (%) | 1991 PREFAB PANEL MARKET POTENTIAL (millions) | 1991 SEVEN-S % SHARE | 1991 SEVEN-S PROJECTED SALES (millions) | 1992 TOTAL RESIDENTIAL INVESTMENT | 1992 PREFAB PANEL MARKET POTENTIAL (%) | 1992 PREFAB PANEL MARKET POTENTIAL (millions) | 1992 SEVEN-S % SHARE | 1992 SEVEN-S PROJECTED SALES (millions) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ONTARIO EAST | $10,640 | 4.5% | $71.8 | 0.7% | $0.515 | $8,845 | 5.5% | $73.0 | 3.1% | $2.227 | $8,755 | 6.5% | $85.4 | 3.1% | $2.670 | $8,484 | 7.5% | $95.4 | 0.0% | $0 |
| MANITOBA WEST | $3,672 | 4.5% | $24.8 | 0.7% | $0.178 | $3,400 | 5.5% | $28.0 | 3.1% | $0.856 | $3,370 | 6.5% | $32.9 | 14.4% | $4.727 | $3,290 | 7.5% | $37.0 | 28.7% | $10.625 |
| TOTAL | $14,312 | | $96.6 | | $0.693 | $12,245 | | $101.0 | | $3.083 | $12,125 | | $118.2 | | $7.397 | $11,775 | | $132.5 | | $10.625 |

CANADIAN NON-RESIDENTIAL INVESTMENT: FORECAST BY SEGMENT

ONTARIO EAST

| CATEGORY | 1989 TOTAL INVESTMENT | 1989 PREFAB PANEL MARKET POTENTIAL (%) | 1989 PREFAB PANEL MARKET POTENTIAL (millions) | 1989 SEVEN-S % SHARE | 1989 SEVEN-S PROJECTED SALES (millions) | 1990 TOTAL INVESTMENT | 1990 PREFAB PANEL MARKET POTENTIAL (%) | 1990 PREFAB PANEL MARKET POTENTIAL (millions) | 1990 SEVEN-S % SHARE | 1990 SEVEN-S PROJECTED SALES (millions) | 1991 TOTAL INVESTMENT | 1991 PREFAB PANEL MARKET POTENTIAL (%) | 1991 PREFAB PANEL MARKET POTENTIAL (millions) | 1991 SEVEN-S % SHARE | 1991 SEVEN-S PROJECTED SALES (millions) | 1992 TOTAL INVESTMENT | 1992 PREFAB PANEL MARKET POTENTIAL (%) | 1992 PREFAB PANEL MARKET POTENTIAL (millions) | 1992 SEVEN-S % SHARE | 1992 SEVEN-S PROJECTED SALES (millions) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FARM BUILDINGS | $270 | 4.0% | $1.6 | 0.7% | $0.012 | $280 | 6.0% | $2.5 | 3.1% | $0.077 | $292 | 8.0% | $3.5 | 3.1% | $0.110 | $290 | 10.0% | $4.5 | 0.0% | $0 |
| WAREHOUSES, GRAIN ELEVATORS | [illegible] | 3.0% | $4.0 | 0.7% | $0.028 | $946 | 5.0% | $7.1 | 3.1% | $0.216 | $1,014 | 7.0% | $10.6 | 3.1% | $0.333 | $1,077 | 8.0% | $12.9 | 0.0% | $0 |
| FACTORIES, WORKSHOPS | $1,747 | 2.0% | $5.2 | 0.7% | $0.038 | $1,782 | 3.0% | $8.0 | 3.1% | $0.245 | $1,843 | 4.0% | $11.1 | 3.1% | $0.346 | $1,924 | 5.0% | $14.4 | 0.0% | $0 |
| STORES, GARAGES, THEATRES | $3,226 | 0.5% | $2.4 | 0.7% | $0.017 | $3,441 | 1.0% | $5.2 | 3.1% | $0.158 | $3,635 | 1.5% | $8.2 | 3.1% | $0.258 | $3,821 | 2.0% | $11.5 | 0.0% | $0 |
| HOTELS, OFFICE BUILDINGS | $4,531 | 0.0% | $0.0 | 0.7% | $0.000 | $4,871 | 0.0% | $0.0 | 3.1% | $0.000 | $5,147 | 0.0% | $0.0 | 3.1% | $0.000 | $5,429 | 0.0% | $0.0 | 0.0% | $0 |
| INSTITUTIONAL | $2,214 | 1.0% | $3.3 | 0.7% | $0.024 | $2,330 | 1.5% | $5.2 | 3.1% | $0.160 | $2,456 | 2.0% | $7.4 | 3.1% | $0.231 | $2,550 | 3.0% | $11.3 | 0.0% | $0 |
| ALL OTHER COMMERCIAL/INDUS | [illegible] | 0.5% | $0.6 | 0.7% | $0.005 | $864 | 0.5% | $0.6 | 3.1% | $0.020 | $895 | 1.0% | $1.3 | 3.1% | $0.042 | $930 | 1.0% | $1.4 | 0.0% | $0 |
| TOTAL | $13,730 | | $17.2 | 0.7% | $0.124 | $14,314 | | $28.7 | 3.1% | $0.876 | $15,285 | | $42.1 | 3.1% | $1.317 | $16,056 | | $56.2 | 0.0% | $0 |

MANITOBA WEST

| CATEGORY | 1989 TOTAL INVESTMENT | 1989 PREFAB PANEL MARKET POTENTIAL (%) | 1989 PREFAB PANEL MARKET POTENTIAL (millions) | 1989 SEVEN-S % SHARE | 1989 SEVEN-S PROJECTED SALES (millions) | 1990 TOTAL INVESTMENT | 1990 PREFAB PANEL MARKET POTENTIAL (%) | 1990 PREFAB PANEL MARKET POTENTIAL (millions) | 1990 SEVEN-S % SHARE | 1990 SEVEN-S PROJECTED SALES (millions) | 1991 TOTAL INVESTMENT | 1991 PREFAB PANEL MARKET POTENTIAL (%) | 1991 PREFAB PANEL MARKET POTENTIAL (millions) | 1991 SEVEN-S % SHARE | 1991 SEVEN-S PROJECTED SALES (millions) | 1992 TOTAL INVESTMENT | 1992 PREFAB PANEL MARKET POTENTIAL (%) | 1992 PREFAB PANEL MARKET POTENTIAL (millions) | 1992 SEVEN-S % SHARE | 1992 SEVEN-S PROJECTED SALES (millions) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FARM BUILDINGS | $226 | 4.0% | $1.4 | 0.7% | $0.010 | $231 | 6.0% | $2.1 | 3.1% | $0.063 | $239 | 8.0% | $2.9 | 14.6% | $0.420 | $244 | 10.0% | $3.7 | 29.3% | $1.070 |
| WAREHOUSES, GRAIN ELEVATORS | $192 | 3.0% | $0.9 | 0.7% | $0.006 | $201 | 5.0% | $1.5 | 3.1% | $0.046 | $211 | 7.0% | $2.2 | 14.6% | $0.324 | $224 | 8.0% | $2.7 | 29.3% | $0.785 |
| FACTORIES, WORKSHOPS | $493 | 2.0% | $1.5 | 0.7% | $0.011 | $532 | 3.0% | $2.4 | 3.1% | $0.073 | $566 | 4.0% | $3.4 | 14.6% | $0.498 | $591 | 5.0% | $4.4 | 29.3% | $1.297 |
| STORES, GARAGES, THEATRES | $1,449 | 0.5% | $1.1 | 0.7% | $0.008 | $1,475 | 1.0% | $2.2 | 3.1% | $0.068 | $1,523 | 1.5% | $3.4 | 14.6% | $0.502 | $1,599 | 2.0% | $4.8 | 29.3% | $1.403 |
| HOTELS, OFFICE BUILDINGS | $1,205 | 0.0% | $0.0 | 0.7% | $0.000 | $1,295 | 0.0% | $0.0 | 3.1% | $0.000 | $1,368 | 0.0% | $0.0 | 14.6% | $0.000 | $1,443 | 0.0% | $0.0 | 29.3% | $0.000 |
| INSTITUTIONAL | $1,052 | 1.0% | $1.6 | 0.7% | $0.011 | $1,052 | 1.5% | $2.4 | 3.1% | $0.072 | $1,083 | 2.0% | $3.2 | 14.6% | $0.476 | $1,128 | 3.0% | $5.1 | 29.3% | $1.485 |
| ALL OTHER COMMERCIAL/INDUS | $368 | 0.5% | $0.3 | 0.7% | $0.002 | $363 | 0.5% | $0.3 | 3.1% | $0.008 | $371 | 1.0% | $0.6 | 14.6% | $0.081 | $394 | 1.0% | $0.6 | 29.3% | $0.173 |
| TOTAL | $4,985 | | $6.6 | 0.7% | $0.048 | $5,148 | | $10.8 | 3.1% | $0.331 | $5,360 | | $15.7 | 14.6% | $2.300 | $5,622 | | $21.2 | 29.3% | $6.213 |
| TOTAL, ALL MARKET SEGMENTS | $33,027 | | $120 | | $0.864 | $31,907 | | $141 | | $4.290 | $32,770 | | $176 | | $11.014 | $33,452 | | $210 | | $16.837 |

## APPENDIX A

### REGULATORY AGENCIES AND THEIR ROLE

### CANADA

Under Canadian law, the regulation of buildings is a provincial responsibility and is carried out through various laws, Acts, codes, and regulations, often administered at the Municipal level. To promote uniformity, a model set of requirements, the National Building Code of Canada (NBC), was published in 1941 under the auspices of the National Research Council. By 1987, nine editions of the NBC had been published. From its inception, the NBC had a major unifying influence on building code requirements although it had no legal status unless adopted by an authority having jurisdiction. As of 1987, mandatory provincial codes based on the National Building Code have been adopted in British Columbia, Alberta, Manitoba, Ontario, Quebec, and Nova Scotia. Saskatchewan and New Brunswick do not have provincial codes but do have legislation requiring municipalities that adopt a building code to use the NBC. The National Building Code is also in general use in the remaining provinces despite the lack of a provincial code.

The National Fire Code was first published by the National Research Council in 1963 and is now in its fifth edition (1985). The National Fire Code has been adopted or has formed the basis of fire prevention requirements in British Columbia, Alberta, and Manitoba; is referred to in the legislation of several other provinces, and has been adopted by many municipalities.

The National Research Council also produces the Canadian Plumbing Code, Canadian Farm Building Code, and Measures for Energy Conservation in new buildings. All of these are written as model legislation for adoption by the appropriate authority.

The NBC also refers to 192 standards on various aspects of building, including standards for construction materials, design, installation, equipment and testing. Provincial Acts also refer to such standards or base their regulations on them. For example, the Canadian Standards Association produces the Canadian Electrical Code which forms the basis for electrical requirements in every province. Other standards-writing bodies in Canada include the Canadian General Standards Board, Underwriters Laboratories of Canada, and the Canadian Gas Association.

Where no standards exist, the Materials Evaluation Department of the Canadian Mortgage and Housing Corporation will evaluate a new product and publish a Building Material Evaluation Report. CMHC has prepared such an Evaluation Report (11669) on the Seven-S Building System. This allows the Seven-S System as an acceptable building product in Canada, subject to the restrictions as set out in the Report.

UNITED STATES

The International Conference of Building Officials (ICBO) performs much the same function in the United States as the Materials Evaluation Department of the CMHC does in Canada. The ICBO is in the process of evaluating the Seven-S System for general use as a standard building component in the United States. Seven-S is confident that it will gain ICBO approval for its Building Panels once a U.S. supplier of the polyurethane foam component Has been named.

ASSOCIATIONS

Canadian Home Builders' Association
5218 Yonge Street
Willowdale, Ontario
(416) 224-1436

National Research Council of Canada
Division of Building Research
Montreal Road
Ottawa, Ontario
K1A 0R6 (613) 993-2607

Canadian Mortgage and Housing Corporation
Montreal Road
Ottawa, Ontario
K1A 0P7 (613) 748-2000

B.C. Dry Coast Kiln Association
(604) 684-0211, and
Coucil of Forest Industries of B.C.
1500 Guiness Tower
1055 West Hastings Street
Vancouver, B.C.
V6E 2E9 (604) 684-2321

Building Supply Dealers' Association
3875 Canada Way
Burnaby, B.C.
(604) 435-4447

Lumber and Building Materials Association of Ontario
4500 Sheppard East, Unit "F"
Agincourt, Ontario
M1S 3R6 (416) 298-1731

dilution air must be provided, with automatic flue dampers, at a temperature not less than 10 Celsius. Woodstoves and fireplaces must have tight-fitting doors, dampers, and flue connections and must have a separate outdoor air supply. Consideration must also be given to supply replacement air for each appliance exhausting air from the home.

5. Windows

Windows must be at least double glazed with a minimum airspace of 12.5 mm between panes. Aluminum or metal windows, sashes, and/or frames must be thermally broken in areas in excess of 3200 Celsius degree days.

6. Walls

Exterior above grade walls must be at least R-20 (RSI-3.5).

7. Water Heaters

Water Heaters must have factory installed insulation with at least R-10 (RSI-1.75). A "heat trap" or insulation for the first three metres of hot water pipe should be installed. The hot water tank should be set for no more than 50 Celsius.