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ANALYSIS OF 2X4 TECHNOLOGY TRANSFER TO THE JAPANESE RESIDENTIAL HOUSING INDUSTRY

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EXECUTIVE SUMMARY

Japan is the largest export destination for the US and the second largest export destination for Canada (after the US). The Japanese residential construction housing industry is the main driver of forest products exports to Japan. There were 1.4 million residential housing starts in Japan compared to 1.5 million starts in the US in 1997. Japan has roughly the same level of housing starts as the US but has only half the population on a land mass the size of California.

North American-style 2x4 housing has grown at double-digit rates over the past 10 years. In 1997, 2x4 houses commanded 13% of the wooden house market share and 6% market share of the overall housing industry. 2x4 housing starts are expected to grow further because of active promotion of imported housing by the Japanese government, deregulation of the industry, and increasing appreciation for western design by Japanese consumers.

2x4 home construction in Japan has been observed to be less efficient and accurate than in North America. The differences in construction techniques increase the cost and time of construction of the house, and decrease its overall quality. Various strategies are currently used by North American companies to provide technical assistance in 2x4 construction technology to Japanese construction industry professionals. This technical assistance allows Japanese professionals to be more aware of proper construction techniques to reduce costs and increase the overall quality.

This project was undertaken to identify the technology transfer strategies that North American companies use, which of them are most effective, and which parties should be the most important targets of technology transfer training programs. An understanding of the most effective technology transfer methods would allow various parties involved with exporting 2x4 houses to Japan to implement more successful training programs.

Survey of North American companies involved in the 2x4 housing industry in Japan

A census of all companies in the Pacific Northwest involved in North American-style 2x4 construction projects in Japan was conducted. A total of 270 companies based in the US (191 firms) and Canada (79 firms) were mailed a four page survey regarding their delivery of North American 2x4 construction technology transfer to Japanese construction industry professionals. The response rate for US and Canadian companies was 48% and 58%, respectively, with an overall response rate of 52%.

Overall quality of 2x4 housing built by Japanese construction industry professionals

The respondents indicated that the overall quality of 2x4 houses built by Japanese construction industry professionals, relative to North American standards was only average. In addition, respondents reported that the quality of structural framing was also average while the quality of architectural design ranked well below average.

Understanding of 2x4 construction technology

Survey respondents were asked to rank Japanese contractors' understanding of 14 components of 2x4 construction technology. The components least understood were drywall, ventilation and architectural design. To improve the overall quality of a 2x4 house built in Japan, these three components should have more emphasis during technical transfer training activities. The components of the 2x4 construction system that were best understood included interior carpentry, roofing, flooring, doors, windows, exterior finishing, and weatherproofing. In an open-ended question, the respondents most often identified the structural framing of 2x4 houses as the one area where Japanese construction industry professionals have the weakest understanding, with 19% of all open-ended responses.

Respondents were next asked to rank which components of the 2x4 construction system they emphasize when providing technical assistance to Japanese construction industry professionals. All of the components except foundation and roofing were identified as being important.

Promotion of 2x4 construction technology

Despite the fact that 2x4 houses have been built in Japan for over 25 years, the overwhelming majority of respondents indicated that continued efforts to promote 2x4 construction technology are very important, with 63% indicating that was very important. There were few major differences between US and Canadian companies, and despite the double digit growth rate of 2x4 housing starts over the past 10 years, North American builders and exporters still feel that it is important to continue promoting technical transfer of the North American 2x4 construction system.

Respondents were asked to rank their use of eight different training methods. It was found that hands-on construction in Japan and employing North American site supervisors in Japan were the two methods respondents most frequently use. Instructional videos, hands-on construction training in North America, and classroom seminars in Japan and North America were rarely used. When asked to identify the single most effective strategy for achieving technology transfer, 20% of the respondents identified hands on construction training in Japan.

Respondents felt that North American construction companies and North American building material exporters would be the most effective in promoting technology transfer. North American construction companies were the most frequently cited group, with 27% of the open-ended responses. The organizations that were perceived to be least effective in promoting technology transfer were Japanese building material distributors and both North American and Japanese colleges.

Factors restricting export potential of 2x4 houses

The most important factors restricting the export potential were a lack of builder and carpenter familiarity with imported building materials and 2x4 construction technology. In terms of non-technology transfer related factors, the current severe economic condition was mentioned most often. The idea that "2x4 housing [is] a fad that will fade" was not an important factor restricting exports.

Conclusion and Recommendations

This study suggests that North American builders and building material exporters perceive that many Japanese construction professionals do not have strong technical understanding of the North American-style 2x4 construction technology. The vast majority of respondents indicated that they have developed technical training programs for their Japanese customers. However, several recent technical assessments of 2x4 construction projects in Japan suggest that this lack of technical understanding is much more pervasive and the extent of technical deficiencies in 2x4 homes built in Japan is much greater than exporters are aware. These studies suggest that it is time for North American builders and building materials exporters to work with the Japanese construction associations to develop a comprehensive technical training program to ensure that 2x4 homes are built correctly in Japan. The recently passed Housing Quality Assurance and House Inspection Laws further emphasize the need for a comprehensive and effective 2x4 technology transfer training program. The alternative, sporadic and uncoordinated technical transfer programs provided by individual companies, will not lead to effective and widespread transfer of the North American-style 2x4 construction technology in Japan. Ultimately, it is in the best interest of North American and Japanese companies to ensure that 2x4 homes are built properly in Japan. Otherwise, consumer perceptions that 2x4 homes in Japan are inferior in terms of overall quality or long-term performance, relative to other types of housing technologies, will lead to the decline of this important segment of the residential construction market in Japan.

ACKNOWLEDGMENTS

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INTRODUCTION

Japan is the single largest importer of forest products in the world today (Sedjo *et al*. 1994). Japan is also the United States' largest export market for forest products: in 1997, 31% of the total $8.2 billion of forest products exports went to Japan. The Japanese market is also a major export destination for Canadian wood products.

The major reason for the large volume of trade to Japan is the Japanese residential construction market, one of the largest in the world today with 1.4 million residential housing units built in 1997 (*Japan Lumber Journal* 1998a). In comparison, the United States built 1.5 million units even though Japan has roughly half the population living on a land mass the size of California (Stat-USA 1998; CIA 1998).

North American style 2x4 houses are a growing component of the residential housing industry in Japan. Sales of these houses are expected to increase due to government promotions to increase housing imports, the beneficial qualities of 2x4 houses, and because 2x4 construction is less expensive than the traditional post and beam method of construction. 2x4 houses have many benefits to offer Japanese consumers including improved earthquake resistance, lower prices, and improved thermal and sound properties (JETRO 1996a). The Japanese government's commitment to imported housing provides an excellent opportunity for manufacturers and suppliers of building materials, value-added wood products, and related products located in North America.

Currently, 2x4 houses built in Japan have been observed to be constructed differently than a 2x4 house built in North America. A study by Eastin *et al*. (1994) showed differences in construction technology (foundations, structural framing, drywall, and finish carpentry), labor specialization, and project management. These differences are known to increase the cost and time of construction, and detract from the overall quality and long-term performance of 2x4 houses.

There are various methods used by North American companies in providing technical assistance in North American-style 2x4 construction technology to Japanese construction industry professionals. This project was undertaken to identify the strategies that North American companies use, determine which strategies are perceived to be most effective, identify what group would be most effective in conducting technical training activities, and identify groups to whom technical training activities should be targeted.

An understanding of the most effective technology transfer strategies will allow the various parties involved in exporting 2x4 houses and building materials to Japan to implement more successful training programs. These training programs will increase the quality of 2x4 houses built in Japan, help improve their long-term performance, and ultimately expand market opportunities for North American-style 2x4 homes and building materials.

LITERATURE REVIEW

Forest Products Trade Flow Between North America and Japan

Japan is the single largest importer of forest products in the world today (Sedjo *et al*. 1994). Japan is also an important trade partner to the United States and is the single largest market for US primary and secondary forest products exports. In 1997, 31% of the $8.2 billion of total US forest products exports went to Japan (see Figure 1). Incidentally, more forest products were exported to Japan than to the NAFTA trade partners of Canada and Mexico combined.

The Japanese market is also a major export destination for Canadian wood products (Figure 2), although the US takes the greatest share of Canadian exports by value at 78%. Canadian exports to Japan make up 67% of all wood products exports by value going to countries outside the US. In addition, it has been estimated that of the 650,000-plus wooden housing starts per year in Japan, some Canadian wood is consumed in over half of the starts (Jahraus and Cohen 1997).

Japan is heavily dependent on forest products imports because their forest resource has been unable to meet recent domestic needs. The domestic forest has been considered too poor in quality or too expensive to harvest due to

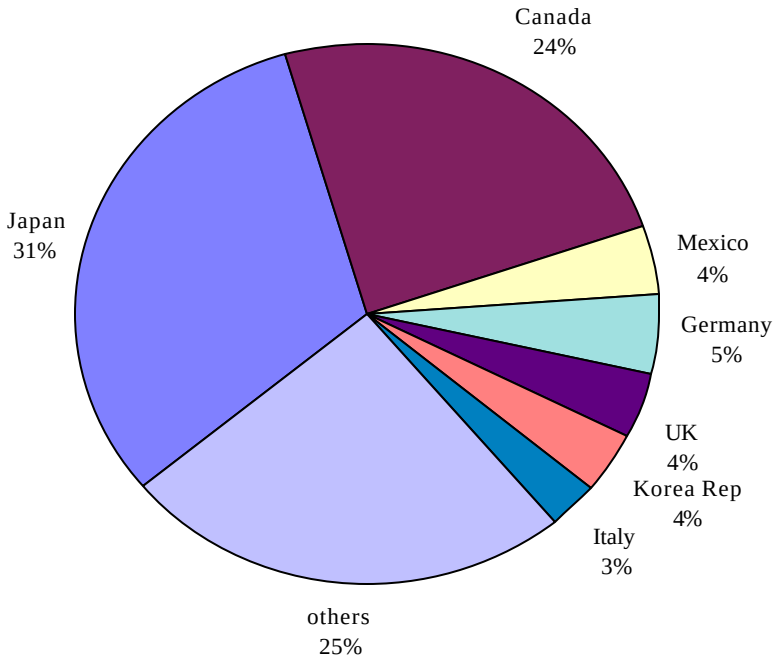

Figure 1. US primary and secondary forest products export destinations by total value in 1997.
Source: US Department of Commerce 1998.

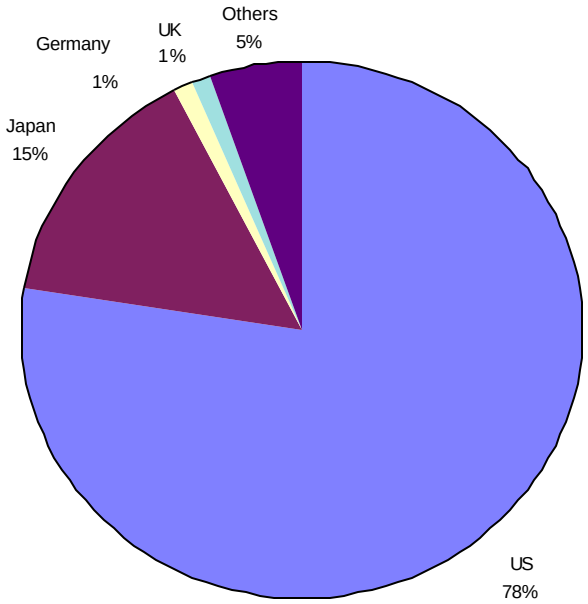

Figure 2. Canadian wood products export destinations by total value in 1997.

severe site conditions (Gaston 1997). Jahraus and Cohen (1997) also suggest that Japan has increased its reliance on imported forest resources due to the high cost of domestic production relative to imports as well as in response to the labor shortages faced by the forest products industry.

Japan has been dependent on imports since 1923 when a large volume of lumber was imported to rebuild following the Great Kanto earthquake that destroyed much of Tokyo. At that time, the domestic supply of lumber was inadequate and North American lumber imports were required (WWPA 1994). In 1961, the Japanese government officially implemented a policy of promoting the import of softwood lumber from North America to meet surging housing and pulp demand (Pesonen 1993). The Japanese government has recently introduced new policies to promote the import of houses. One of its goals is to increase the import of houses as a way to reduce housing costs by 33% by the year 2000 (Yamakoshi 1994).

Since the early 1960's, the US has built up its forest products trade with Japan to the point that the US is now Japan's largest supplier of forest products by total value imported. As Figure 3 shows, Japan imported 22% of its $15.1 billion worth of timber products from the US in 1997 (*Japan Lumber Journal* 1998b). Trade in forest products has increased to the point that the American Forest and Paper Association (AFPA) recommended in 1996 that Japan be removed from the Super 301 trade protection watch list (Washington State CTED 1997). They believe Japan has removed substantial barriers to US forest products exporters and will continue to do so. The US had been lobbying Japan since May 1989 under the Super 301 provision of the 1988 Omnibus Trade Act to open up its forest products market to foreign competition (Coaldrake 1990).

Japan's Residential Housing Market

The greatest single end use for imported wood in Japan is the housing industry (JAWIC undated). In 1992, it was determined that 79% of lumber shipments went into housing construction (Gaston 1997). Japan's residential housing

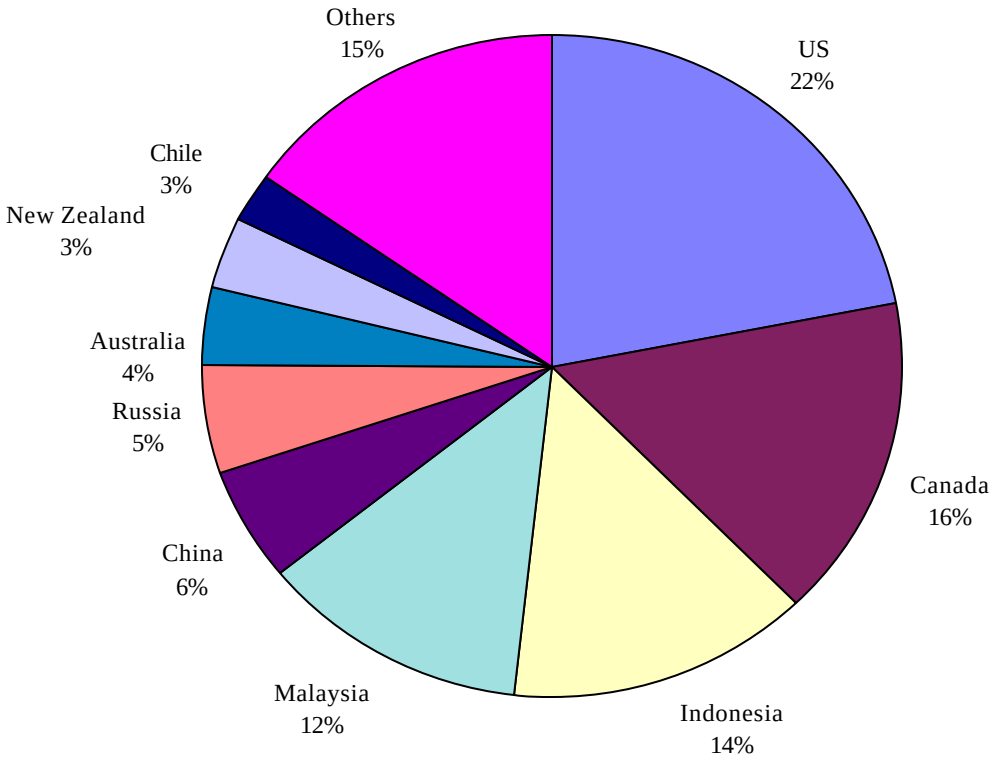

Figure 3. Sources of timber imports into Japan by value in 1997.
Source: *Japan Lumber Journal* 1998b.

Table 1. Comparison of key demographic factors between Japan and US.

Demographic factor	Japan	US
Total Area (sq. km)	377,835	9,629,091
Population (1997 estimate)	125,732,794	267,954,764
Housing Starts (1997)	1,387,014	1,474,000

Source: CIA 1998; *Japan Lumber Journal* 1998a; and Stat-USA 1998

market has consistently been one of the largest and most dynamic in the world. Since 1987, Japan's housing starts have been approximately equal to those in the United States even though Japan has only 46.9% of the population and 3.9% of the land mass of the US (Table 1) (CIA 1998). Another way of viewing Japan is to place half the US population into an area the size of California: population densities are very high in Japan. The high population densities have an impact on the type of housing, especially in the cities.

In 1997, housing starts in the US and Japan totaled 1.5 million and 1.4 million units respectively (see Figure 4). The US and Japanese housing starts follow similar world economic trends and exhibit differences based on domestic trends as well. Both countries experienced rapid economic growth in the early 1970's as indicated by the high level of housing starts. Then, the OPEC oil crisis of 1973 deflated both countries' housing starts. Both countries also experienced housing slumps in the early 1980's and 1991 during the recession and the Persian Gulf War, respectively.

Japan's housing starts also experienced dramatic decreases at the end of the "Bubble Economy" in 1991 and the "Asian Flu" in 1997 while US housing starts were relatively unaffected by these events. In Japan, housing starts were very high during the late 1980's and 1996. 1996 was the first time since 1987 during the Bubble Economy when housing starts grew by double-digit increases over the previous year (see Figure 5). The high volume of housing starts in 1996 was caused in part by the rebuilding of damage from the Hanshin earthquake in Kobe, which occurred in 1995. The earthquake damaged 147,600 houses (*Japan Lumber Reports* 1995) and displaced 400,000 households (*Pacific Rim Wood Market Report* 1996).

In 1996, housing starts were also high because homeowners rushed to purchase houses before the Ministry of Finance increased the national consumption tax from 3 to 5% on April 1, 1997, the start of the fiscal year. The consumption tax applies to housing, so consumers wanted to avoid paying hundreds of thousands of yen in extra taxes.

The dramatic decrease in housing starts in 1997 can be attributed to four factors: an increase in the consumption tax from 3% to 5%; an increase in the cost of living due to the removal of income tax reduction; an increase in the cost of medical care, which was expected to total 9 trillion yen; and a lack of funds for large public works by the government due to the anxiety over the troubled banking system and an overall slump in the economy (*Japan Lumber Reports* 1998a). The government's implementation of various fiscal policies were expected to knock a full point off private spending in 1997 (Bremner and Takahashi 1996). Late 1997 was also the time of currency devaluations and economic instability throughout Asia.

A combination of factors in Japan has historically supported high levels of housing starts. These include: active construction of rental housing; low mortgage interest rates; active government support for providing inexpensive housing; sustained growth of per capita income; population growth; rapid turnover of existing housing stock; large migration to urban centers; large volumes of existing low quality housing in need of overhaul; improved tax benefits or housing; and stability of land prices (JETRO 1995; Robertson and Waggener 1995). For example, since 1950 the population in Japan has increased by 50%. In addition, household size has fallen from 5.02 to 3.01, indicating a trend away from extended families (Robertson and Waggener 1995). The increase in population and the number of nuclear family households have increased the demand for housing.

Currently, Japanese houses are typically replaced every 20-25 years (Jahraus and Cohen 1997). Most new housing starts are on building sites on which homes have been demolished. Given the poor quality of most post-war housing, it is more cost-effective and efficient to these older homes rather than repair or remodel them (Eastin 1994).

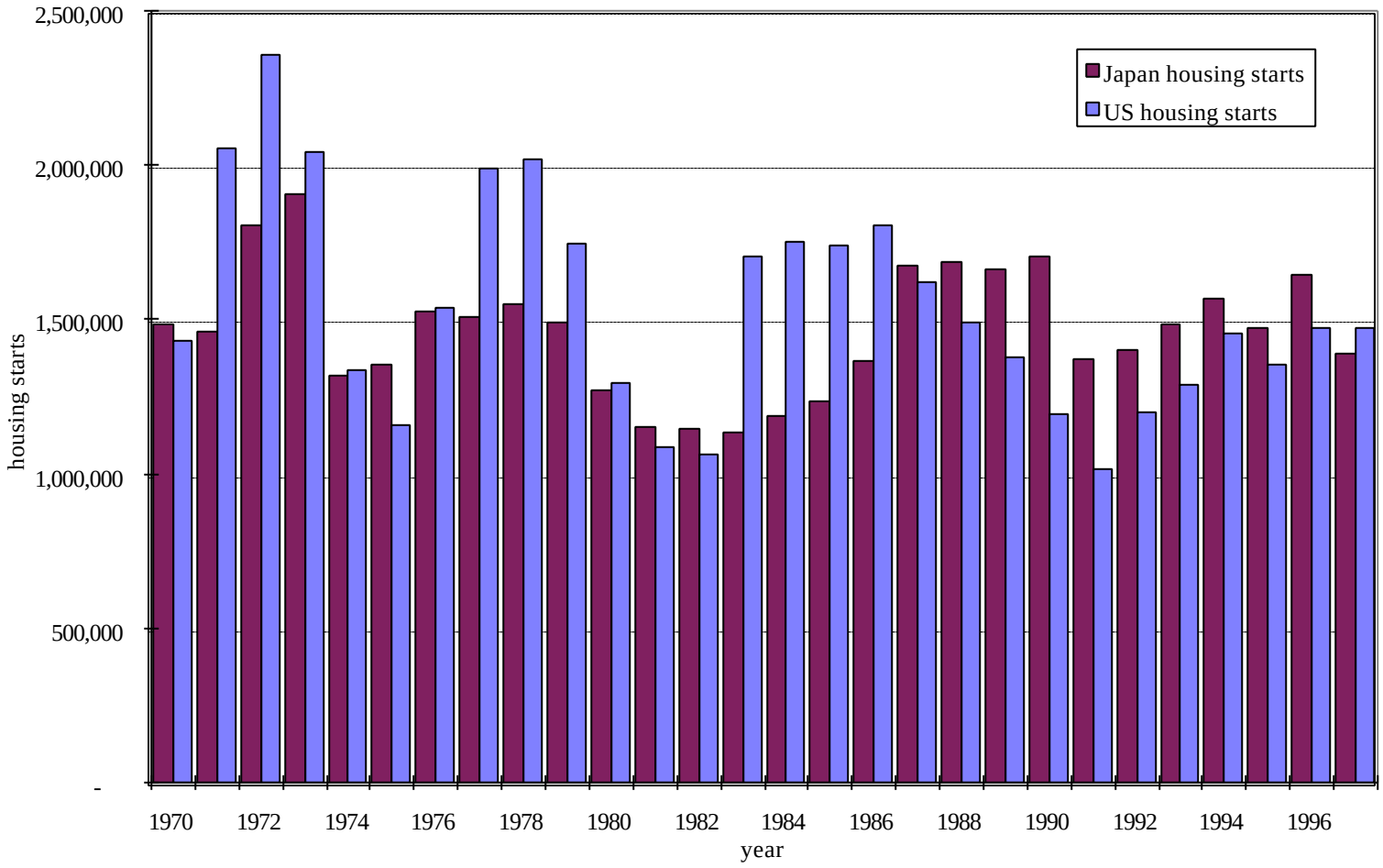

Figure 4. Comparison of US and Japan housing starts since 1970.
Source: derived from data provided in Stat-USA 1998 and *Japan Lumber Journal.*

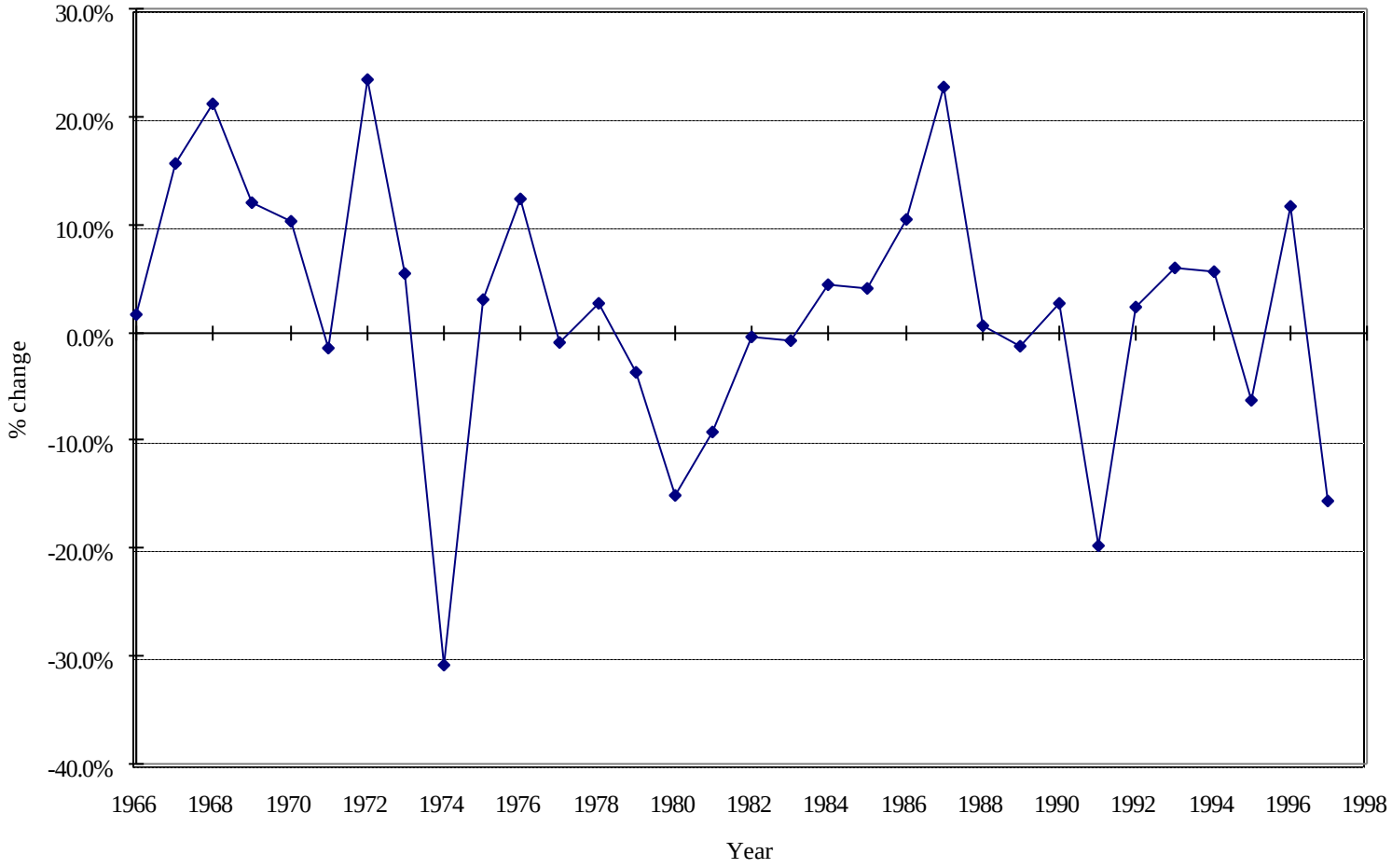

Figure 5. Growth rate (%) in total Japanese residential housing construction.
Source: derived from data provided in the *Japan Lumber Journal.*

Types of Residential Housing*:* Although there are many ways to classify residential housing in Japan, all houses must meet the requirements of the Building Standards Act (JETRO 1993). These building codes cover all aspects of the construction industry in Japan. The Act ensures that the building site and structure are constructed in a manner that does not endanger the occupant's life, health, and property from preventable disasters. All housing must also meet the strict fire prevention and flammability guidelines of the Fire Laws. Fire prevention requirements are strict because of a past history of devastating fires in Japan's residential areas. Major fires burned down numerous houses during the Great Kanto earthquake in 1923, centered in Tokyo, and the Hanshin earthquake in Kobe. Bombings during World War II also burned down many houses. These fires in urban areas have historically caused many fatalities and, in response, the government implemented strict guidelines regarding the construction of fire-resistant houses to prevent future catastrophic fires. In addition, residential lots are small in urban areas and the footprint of the house covers most of the lot, resulting in houses being very close together. This factor further contributes to the requirements for fire resistant housing.

One of the ways that residential housing can be classified is by occupancy type: single-family detached versus multiple-family collective housing residences (including apartments and Nagoya-style townhouses) (JETRO 1996a). JETRO (1996a) determined in 1994 that multiple-family residences made up the majority of total housing starts at 52.9% of the total. There is a clear trend towards building multiple-family residences to house the dense population, particularly in the large urban areas. In Tokyo for example, 65.3% of all residences are multiple-family units. Throughout all of Japan however, multi-family units comprise only 41.8% of the existing stock of housing.

JETRO (1996a) and the *Japan Lumber Journal* (1998a) also divides total housing starts based on whether the houses are constructed from wood or non-wood materials such as concrete and steel (see Figure 6). There are two main types of wooden housing built in Japan: traditional Japanese post-and-beam houses, and North American style 2x4 houses. The 2x4 housing industry has experienced healthy growth within the wooden house segment.

Wood has always been an important part of Japanese culture and trees were thought to be the places where the native gods first descended to earth. As a result, wood has traditionally had strong religious meaning and most temples and shrines are constructed with wood framing. The Japanese people are deeply drawn to the aesthetic beauty, strength, and aroma of wood. Wood's attractiveness is also demonstrated by the high value Japanese consumers place on wood in their homes. A survey conducted by the Japanese Prime Minister's Office showed that nearly 80% of respondents, given the choice, would prefer to live in a wooden house (Coaldrake 1990).

In 1997, wood was used in only 44% of new residential housing starts. The majority were constructed with steel or concrete. In 1965 however, 76.7% of all new residential housing starts were constructed of wood. Wooden houses comprised the majority of annual residential housing starts until 1984, since when the wooden house market share has been consistently below 50%. The percentage of new wooden housing starts reached a low in 1988 when only 41.4% of new residential housing starts were constructed of wood. In 1997, roughly 490,000 units were constructed using the traditional post-and-beam system (*Japan Lumber Reports* 1998a). The wooden housing market experienced slower starts in 1997 due mostly to the drop in starts of post-and-beam houses.

The *Japan Lumber Journal* (1998a) also differentiates total housing starts by four types of utilization: owner occupied units, rental housing units, company-owned houses rented to their employees, and units built for speculative sales (Figure 7). In 1997, the majority of the houses were rental units (38%) followed closely by houses occupied by the owner (25%).

The type of financing used for new houses is another way of that government and industry associations have classified the residential housing industry (*Japan Lumber Journal* 1998a; Pesonen 1993). The two sources of financing are private and public (Figure 8). The majority of all house financing in Japan is through private sources at 61% in 1997. The remaining 39% of financing is through public mortgage lenders, in particular the Government Home Loan Corporation (GHLC). The GHLC was established by the government in 1950 in order to provide middle-class home buyers with low interest loans (JETRO 1995). The interest rate for GHLC mortgage loans is below market interest rates. In 1995, the GHLC interest rate was 3.1% compared with a commercial interest rate of 4.4% set by the financial institutions (*Japan Lumber Journal* 1996). The GHLC has strict rules regarding eligibility criteria for potential borrowers and house size. In 1993, the income ceiling was raised to ¥13.225 million to allow a

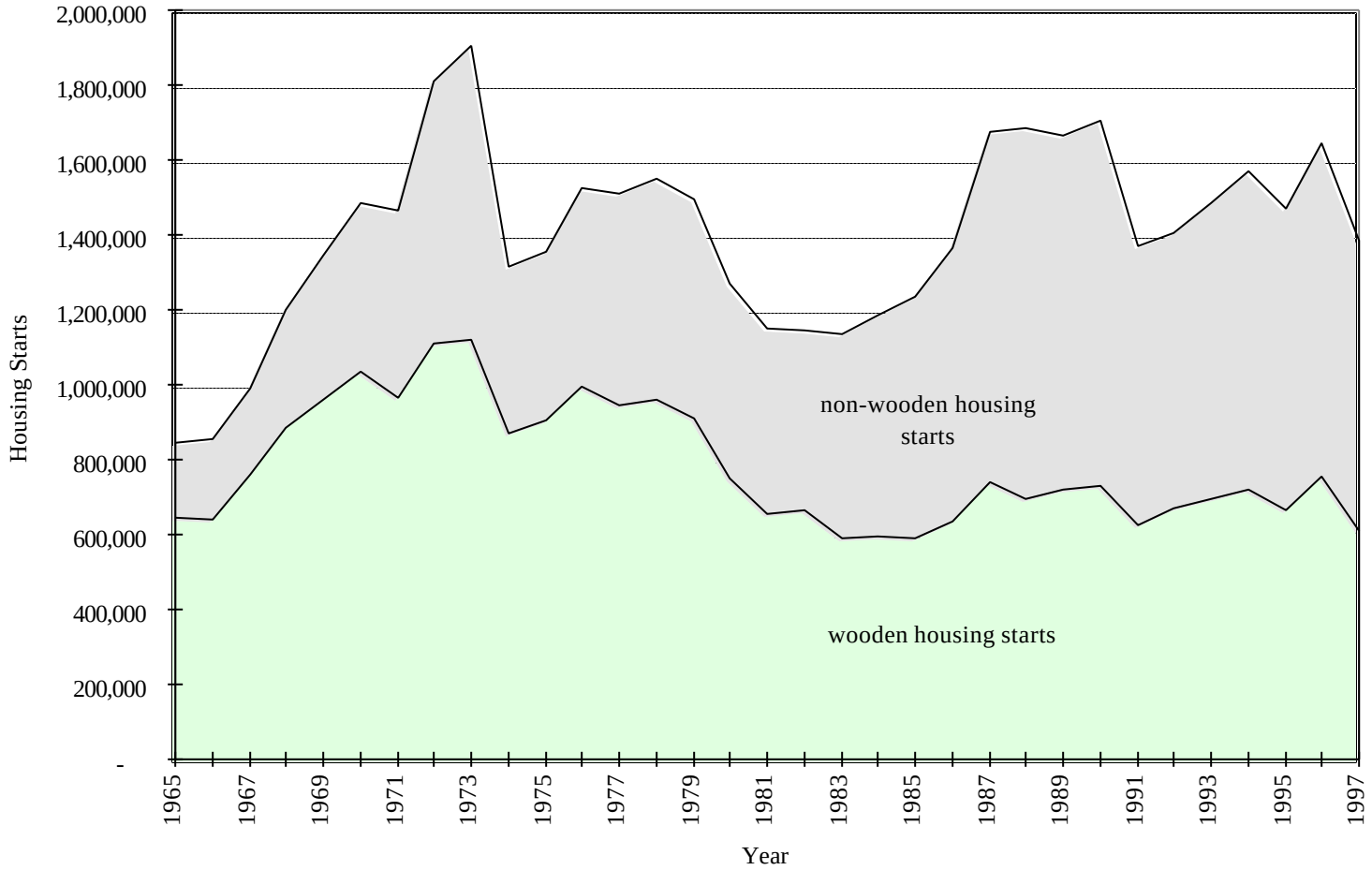

Figure 6. Japanese housing starts since 1965 based on structural material used.
Source: derived from data provided in *Japan Lumber Journal.*

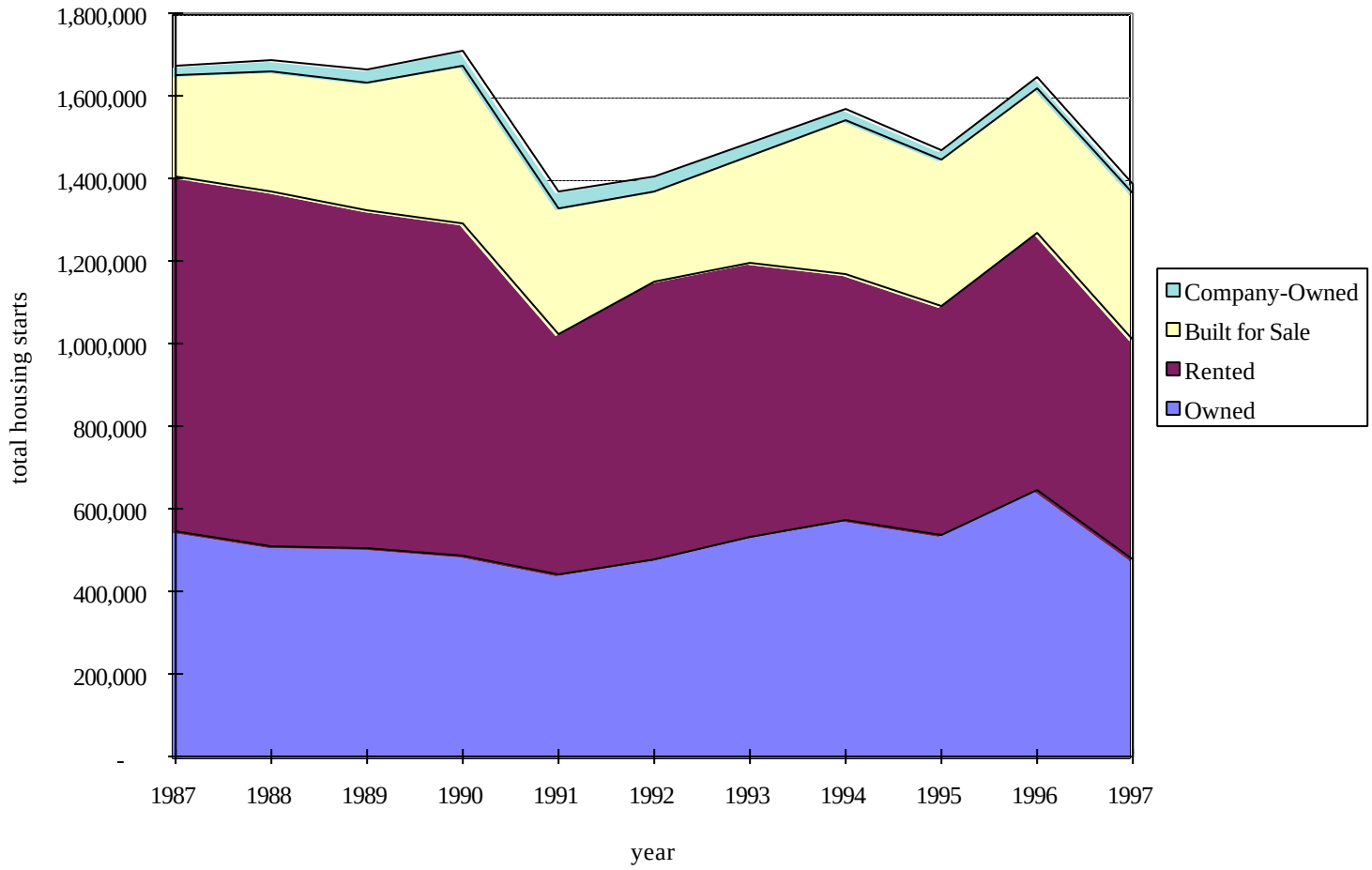

Figure 7. Total housing starts segmented by utilization type.
Source: *Japan Lumber Journal.* 1998a

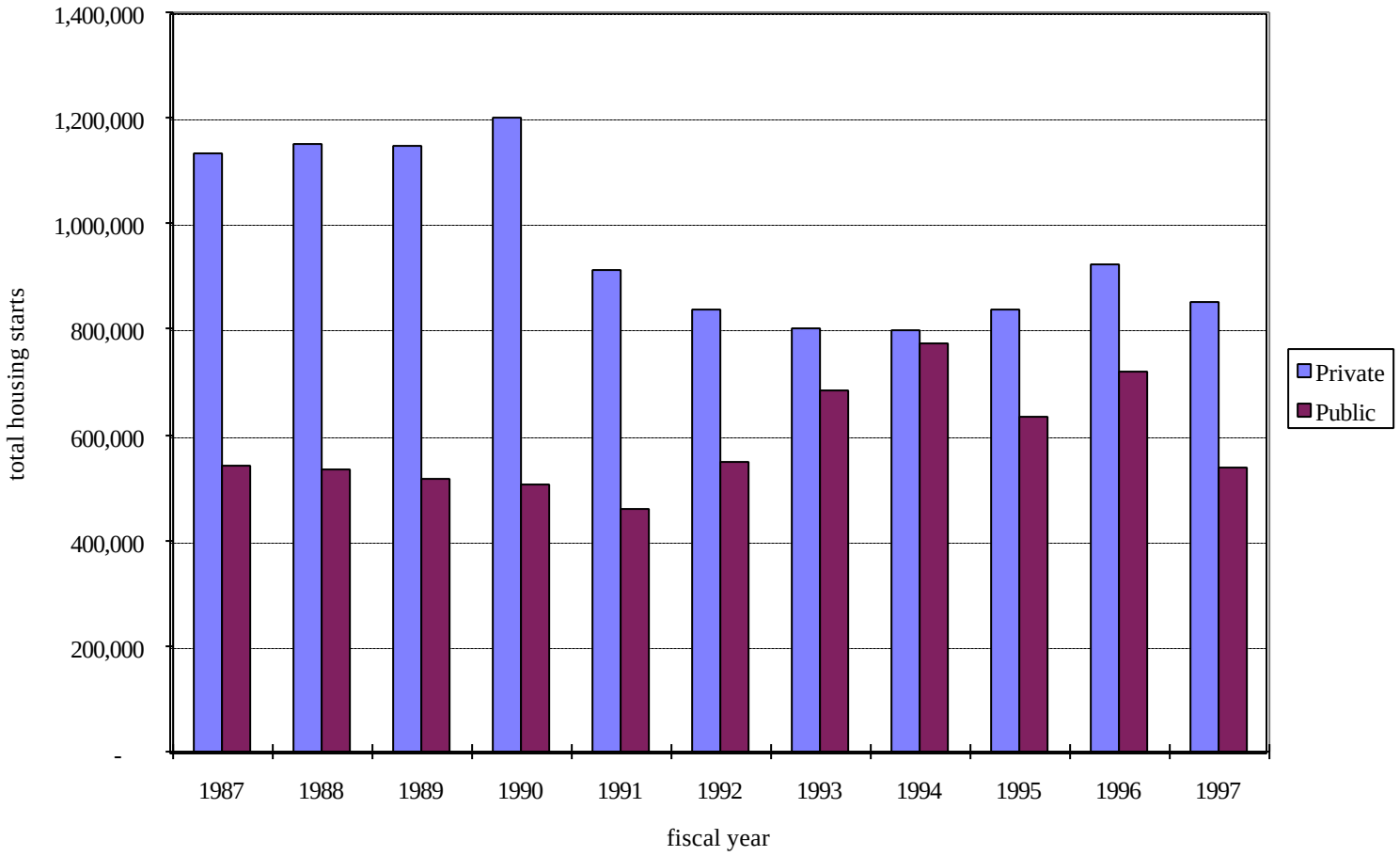

Figure 8. Number of total housing starts segmented by source of mortgage funding.
Source: JETRO 1993; *Japan Lumber Journal* 1998a.

larger proportion of the population to qualify for the mortgage loans. Financing was also expanded to houses up to 240 m^2 floorspace from 220 m^2. This resulted in a record 667,118 mortgages being granted by GHLC in 1994. In 1997 however, GHLC loans only totaled 245,497.

Residential Housing Industry Structure: Housing is mainly constructed through two methods: subdivision sales and owner-constructed housing (JETRO 1996a). Subdivision sales are like sales in the US where a developer sells both the new house and land in a new residential development. These developments are sometimes referred to as "New Towns." The companies involved in large subdivision developments do most of the development. They redevelop land tracts, sell the houses, and usually design and construct the house. Other companies acquire small tracts of land to develop and sell houses. These are the "Tateuri" (Build and Sell) or "Mansion" (Condominium) companies. Incidentally, in Japan, the term "mansion" is commonly used to refer to high rise apartments or condominiums, even though they usually have a smaller floor area than detached single-family houses.

Owner-constructed housing consists of construction of a new house for personal dwelling. In many cases, the landowner tears down an older house and builds a new house in its place. These types of houses are mostly custom-built to fit the shape and size of the lot (McKellar 1995). The owners have very strict specifications for their new house and their input is constantly solicited throughout the design and construction process. As suggested by Leonard Guss Associates, Inc. (1992), homes with a unique appearance are desired and "cookie-cutter" houses do not do well in this market segment.

JETRO (1996a) describes the three main groups of Japanese single-family house builders as large, national housing manufacturers; medium-sized, regional housing companies, and small, local home builders (*kohmuten*) and/or carpenters. The large housing manufacturers have powerful, nation-wide sales networks. In fiscal 1994, there were eight large housing manufacturers which each had annual sales of 10,000 units or more. They supply materials manufactured in their factories even though the actual construction is subcontracted out to smaller companies. The regional housing companies are based in the local communities and they provide design, sales, and construction services. The medium-sized companies typically build approximately 50 houses annually. These companies see high potential growth because they construct most of the 2x4 houses, sales of which are expected to grow very rapidly (*Pacific Rim Wood Market Report* 1996). On many occasions, the actual construction is subcontracted out to smaller companies.

The smallest housing companies do most of the actual construction of houses for both themselves, and for the larger companies. The small companies include self-employed carpenters who work as labor subcontractors. The small companies build roughly three to five houses annually. Historically, small companies have controlled the largest market share within the housing industry. The Japan 2x4 Homebuilders Association describes how most of the North American 2x4 houses are constructed by small and medium sized companies (Roos and Eastin 1998). The large companies primarily construct Japanese-style 2x4 houses (based on a 3x6 module). The large national companies have seen their market share increase to roughly 20-30% of the single-family housing market, partly because they also construct steel and concrete multiple-family units whose market share have grown very rapidly.

Cohen (1993) came up with an interesting way to segment the residential construction market into six different categories. This is based on the two construction techniques of post-and-beam and 2x4 construction and the three assembly locations of on site, prefabricated, and components assembled on site.

Pesonen (1993) alternatively describes five main types of house builders and building contractors: large building contractors; local builders and carpenters; post-and-beam precutters; prefabricated housing companies; and platform-frame construction companies. The large building contractors consist of 6-8 major contractors who account for 15% of total residential construction. These companies deal primarily with concrete and steel-based multi-family residences. The local builders and carpenters include approximately 50,000 small companies who account for about 60% of total residential construction. These companies are primarily involved in the construction of wooden post-and-beam houses. The post-and-beam precutters are comprised of about 240 companies. These companies have "industrialized" the production of building components and construct about 60,000 units annually. The prefabricated housing industry is capital-intensive and oligopolistic. The 10 largest companies produce over 90% of total units.

The platform-frame or 2x4 construction companies are comprised of 750 companies with the five largest accounting for over 50% of total 2x4 housing units.

A survey by the Management and Coordination agency found there were 92,500 companies directly involved in wooden house construction in Japan (JETRO 1996a). In addition, there were about 62,000 firms acting mainly as carpentry subcontractors. The average number of employees per housing company was 5.1 while it was 2.9 per carpentry business. These figures illustrate the fact that the majority of companies in the residential construction industry are small operations.

When a large housing company gets an order to build a house, it typically will subcontract the work to a construction company which, in turn, subcontracts work to companies which specialize in various jobs such as foundation, framing, roofing and electrical work. After this level of subcontractors, another layer of subcontractors ususally does the construction. Levy (1990) has suggested there are potentially seven layers of subcontractors between the consumer and the actual workers who construct the house. This complex system is referred to as the "multi-layered" or "multi-tiered" subcontracting structure (JETRO 1996a). This system makes constructing a house in Japan more complex and expensive than in the US. In addition, constructing a house in Japan is also different than in the US because it is a common practice to include labor costs when invoicing material costs. This practice is called the "Total Material and Labor" system (JETRO 1996a). This system makes it difficult to calculate the construction cost of a house.

Changing Nature of the Residential Housing Market: Historically, post-and-beam housing dominated the residential housing market. In 1963, 86.2% of all residential housing starts utilized the traditional post-and-beam construction method (Coaldrake 1990). However, in 1996, they represented only 39.3% of all new residential housing starts (JETRO 1996a). Great inroads have been made mostly by the steel and ferro-concrete construction industry. Since 1968, the share of multiple-family housing units increased 16.6%. High-rise, high-density condominium or "mansion" buildings characterize multiple-family housing units, where steel and concrete are used for structural integrity as specified in the building codes. In large cities such as Tokyo and Osaka, they are an absolute requirement to house the enormous population. Japan is already is one of the most densely populated countries in the world at 857.1 people per square mile overall. However, the actual population density increases to 2,571.3 people per habitable square mile because only 33% of Japan is habitable. The other 67% is made up of mountainous and uninhabitable terrain. In addition, for many people, mansions are more affordable than a detached single-family house (WWPA 1994). The only drawback to mansions is that their floor space is usually smaller. On average, the floor space for a single-family residence is 2.7 times greater than for a multiple-family residence (JETRO 1996a).

Inroads by prefabricated houses and 2x4 houses have further taken market share away from post-and-beam houses. Prefabricated units constructed of all materials comprised about 15% of residential housing starts in 1997 (*Japan Lumber Journal* 1998a). In addition, 2x4 units comprised about 6% of residential housing starts in 1997. JETRO (1996a) noted that 6.5% of new single-family residential starts in 1995 were 2x4 whereas only 2.2% of multiple-family residential housing starts were 2x4 style.

Post-and-beam housing construction has also decreased because of an aging labor force. Many young people dislike entering the construction workforce because of the harsh and dirty work involved. The construction industry is not viewed as a favorable place to work because of a poor industry safety record in past years. It also takes seven years of apprenticeship training to become a post-and-beam carpenter, another factor which discourages entrance into this profession (Cohen *et al*. 1996). As a result, the average age of a carpenter is almost 53 years. In addition, the number of post-and-beam housing construction workers is decreasing; it is estimated that the number of construction workers will decrease by 45% by the year 2000 (Pesonen 1993).

Japan has traditionally been a culture of isolationism from outside ideas and people. Consumers in Japan, however, increasingly prefer the look of western-style houses (JETRO, 1996a). This is especially true of the younger generation. A greater proportion of the population has lived or traveled overseas. The strong yen and the bubble economy of the 1980's allowed many Japanese to travel overseas and experience other cultures and lifestyles. In addition, there are significant numbers of people who have lived overseas as a result of business transfers within multinational corporations, and overseas study and home stays. These Japanese have seen the quality of housing in

other cultures and are now demanding this same high quality for their own houses in Japan.

There is strong dissatisfaction among Japanese people with their houses. A 1993 Ministry of Construction (MOC) survey showed that 49.4% of households are not satisfied with their current housing condition. Among the more commonly cited reasons are an inadequacy of space, inferior layout of rooms and facilities, poor noise and inadequate thermal insulation, and general wear and tear of their houses (JETRO, 1996a). There is great interest in matching the quality of their housing with their wealth and consumer spending power.

Differences in Housing Costs between Japan and US

Construction Requirements: In a study conducted at Stanford University, Okimoto *et al*. (1996) suggest that Japan's non-traded sectors such as agriculture, housing, construction and others tend to be high-priced, inefficient, and non-competitive vis-à-vis foreign firms. These non-traded sectors, which account for upwards of 70% of Japan's GDP, have long suffered the ill effects of protection, political clientelism, cozy cartels, rigged bidding, and excessive regulation. They suggest that the onerous weight of government regulatory controls must be lifted and international competition must be embraced in order to increase performance in these sectors.

Many sources have noted that housing costs in Japan are much higher than in the US. In May 1994, the MOC's North America Housing Cost Study Group found a two-storied 2x4 wooden house built in Japan was between 1.82 to 1.98 times more expensive than comparable houses built in the US (JETRO 1996a). The MOC also found the cost of an average 164 square meter house in Seattle was about $139,000 compared to $255,000 for a comparable house in the Sendai region (Magnier 1994).

The various reasons housing costs are higher in Japan include complex and hard-to-use distribution channels, nonstandardized building methods, reduced competition, higher overhead, more cumbersome regulations, higher material costs, high cost of certifying US wood products, and 2x4 houses being constructed using the same management system used by the post-and-beam industry. Extended distribution channels are typical of the Japanese marketplace. The housing construction industry has a long history, and supply and sales channels for lumber and other building materials are well established (JETRO 1996b). It is very difficult to modify this system without causing severe disruptions.

The MOC study found labor costs composed 65% of the building cost in Japan compared with 35% in the US (EP 1992). The various factors for higher labor costs include no specialization of labor and low labor productivity. Furthermore, Tokyu Home Co. of Japan estimates that US carpenters complete work on one *tsubo* (a common Japanese construction measurement equivalent to 3.3 square meters) in 6.72 hours while the most efficient Japanese carpenter completes one *tsubo* in 9.6 hours (Nakamae 1994). Labor productivity is therefore roughly one-half that of the US. In addition, the Japanese Ministry of International Trade and Industry estimates that labor requirements for residential house construction in the US are approximately 700 hours compared with a traditional Japanese house of equivalent size requiring 2,500 hours (Briggs and Dickens 1984). The Japanese researchers estimate that the overall cost savings resulting from using 2x4 methods is in the range of 20 to 50% of total construction costs. These cost estimates do not include land costs. If land was included, the Japanese price would increase substantially. *The Economist* (1997) did a study that showed that if land cost per m^2 was set at 100 in Japan, then land costs in the US would be 8 and in the UK 4. Therefore, land in Japan is roughly 12 times more expensive than in the US.

Consumer Requirements: For many Japanese consumers, purchasing a house is a once in a lifetime decision (JETRO 1996a). The consumer is ultra-sensitive to small defects in the finish of the house. Consumers care deeply about the appearance and finish of housing components. Prices therefore increase for contractors in order to produce a high level of quality in their houses.

Consumers expect a high degree of after-sales service with most housing companies providing guarantees and regular inspections for 10 years (JETRO 1996c). In addition, Japanese homeowners rarely perform repair and remodeling tasks on their houses, relying instead on the contractor to perform these tasks. As a result, companies increase the price of the house to incorporate the costs associated with the after-sales service and maintenance. This contrasts with the US where there is a large market for do-it-yourself home renovators. Many homeowners repair and

remodel their houses themselves to save money and increase the market value of their property (a concept often referred to as "sweat equity").

Although most cost comparisons are based on comparable houses in Japan and the US, there are significant additions and modifications made to houses built in Japan which increase construction costs. Basically, every Japanese house has an entrance space or *genkan*, where shoes are removed and stored prior to entering the living area of the house. Bathing, toilet and washing facilities must also be made separate from each other. A western style house in Japan usually incorporates a traditional *tatami* room. In addition, central heating is not common in Japan. Instead, individual heaters for each room are typically used. Finally, most houses are designed so they are oriented towards the south in order to maximize exposure to the sunshine (JETRO 1996c).

Imported Housing in Japan

Import housing has been defined by the Imported Housing Industry Council as "housing of basic foreign design concepts that utilize foreign materials in … more than half the materials used" (JETRO 1996a). It excludes housing that imitates foreign design or housing that uses only small quantities of foreign components and materials such as Japanese-style 2x4 houses (3x6 module) and log houses.

Imported houses have been sold in Japan since 1909 when an American businessman first sold a prefabricated 2x4 house in Tokyo (JETRO 1996c). However, it was not until recently that government and related parties have focussed on increasing the import of housing. Imported housing starts has risen rapidly as of late. In 1993, only 1,500 units were constructed, or 0.1% of the total housing market (*Pacific Rim Wood Market Report* 1996). The MOC determined that in 1997, a total of 10,672 units were imported (*Japan Lumber Reports* 1998b). This was a 30.6% increase from 1996. They also determined that the majority of the units imported were of 2x4 or 2x4 panelized construction. Figure 9 shows the most common types of houses imported in Japan.

The Japanese government is actively trying to increase housing imports. MITI announced plans to import 50,000 houses over a five to seven year period starting in 1993 (Nakamae 1993). MITI also reduced the current 4% tariff to 3% on imported housing kits. Furthermore, the Export-Import Bank of Japan will increase the amount of low-interest loans available to companies importing houses. As a result, the Imported Housing Industry Council expects imported houses to reach 30,000 per year.

2x4 Housing Industry in Japan

2x4 Housing Product Life Cycle: 2x4 houses were first constructed in Chicago, during the mid 1830's (Youngquist and Fleischer 1977). They were known then as balloon-frame houses which developed into the combination-frame house and then the platform-frame house. Thus, 2x4 houses have been produced in one format or another for over 160 years in the US.

2x4 housing in Japan is in a growth stage. 2x4 housing was only introduced to the Japanese market in 1974 (JETRO 1993). 2x4 house sales experienced very slow growth due to poor penetration into the market. Many barriers, both tariff and non-tariff, limited sales. It was not until 1995 that 2x4 houses surpassed a 5% market share of all residential construction for the first time. The North American style 2x4 house is now one of the main types of wooden housing in Japan. Even though the total percentage of wood housing has fallen, the 2x4 housing percentage has risen rapidly over the same period. Market share of total housing starts has risen from 0.01% in 1974, when it was first introduced, to 5.7% in 1997 (Figure 10).

In the past five years, the 2x4 market share has been growing at a rate of 5% annually. This makes 2x4 houses one of the fastest growing segments within the Japanese residential housing industry. Not only is it growing quickly, it also has high potential for even greater growth because of a very favorable market environment. The total number of 2x4 houses constructed in 1997 was 79,458 units, down from 93,693 units in 1996 (Figure 11). Even though the total number of 2x4 housing starts decreased in 1997, the overall market share remained the same.

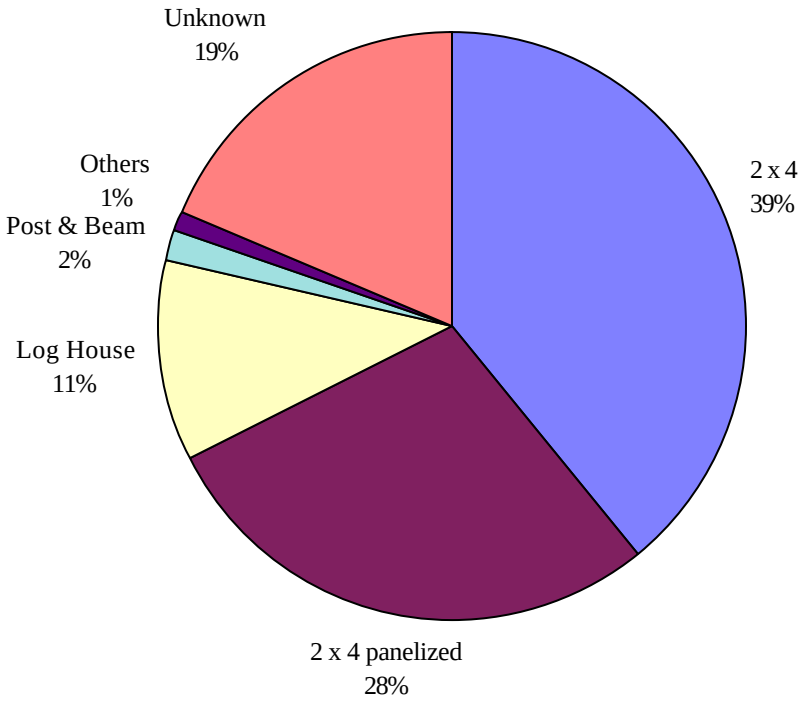

Figure 9. Import housing by type of construction method FY 1996.
Note: "2x4" represents stick-built houses and "2x4 panelized" represents premanufactured, panelized 2x4 houses
Source: *Japan Lumber Reports* 1997.

In a study conducted by the Japan 2x4 Homebuilders Association, it was determined that nearly 50% of their membership companies began building 2x4 houses within 6 years of the official introduction in 1974 (Roos and Eastin 1998). Therefore, many companies have had time to develop their construction techniques and understand the intricacies of constructing 2x4 houses. The Japan 2x4 Homebuilders Association is one of the major forces promoting 2x4 housing in Japan. It is an organization supported by the MOC and is composed of 978 membership companies including homebuilders, general contractors, developers, trading companies, building material suppliers, and other related organizations (WWPA 1994).

The rapid growth rate of three-story wooden houses represents another good market opportunity for 2x4 houses (Figure 12). Although growth rates lag post-and-beam houses, 3 story 2x4 housing starts have been growing at approximately 17.9% per year over the past 5 years. In addition, the *Japan Lumber Journal* (1997d) indicates that the proportion of three-story wooden houses being built in quasi-fire prevention areas has increased continuously from 23.1% in 1990 to 48.2% in 1996. Finally, 2x4 houses are the market leaders in the three-story wooden apartment market. As Figure 13 indicates, 2x4 houses have over 50% of the market share of three-story apartment units.

Factors Restricting The Growth Of 2x4 Housing Starts: One of the main factors for the extended introduction period for 2x4 houses is that Japanese carpenters lack sufficient training in 2x4 construction techniques (Eastin *et al.* 1995). It is a relatively new construction technology which carpenters are still adjusting to. In contrast, traditional post-and-beam houses have been constructed for hundreds of years and are the dominant method of constructing single-family wooden housing. It is a highly appreciated style of housing. Many older carpenters are reluctant to switch from the post-and-beam method because it requires learning an entirely new technique. They tend to stick with the tried and true techniques of post-and-beam houses.

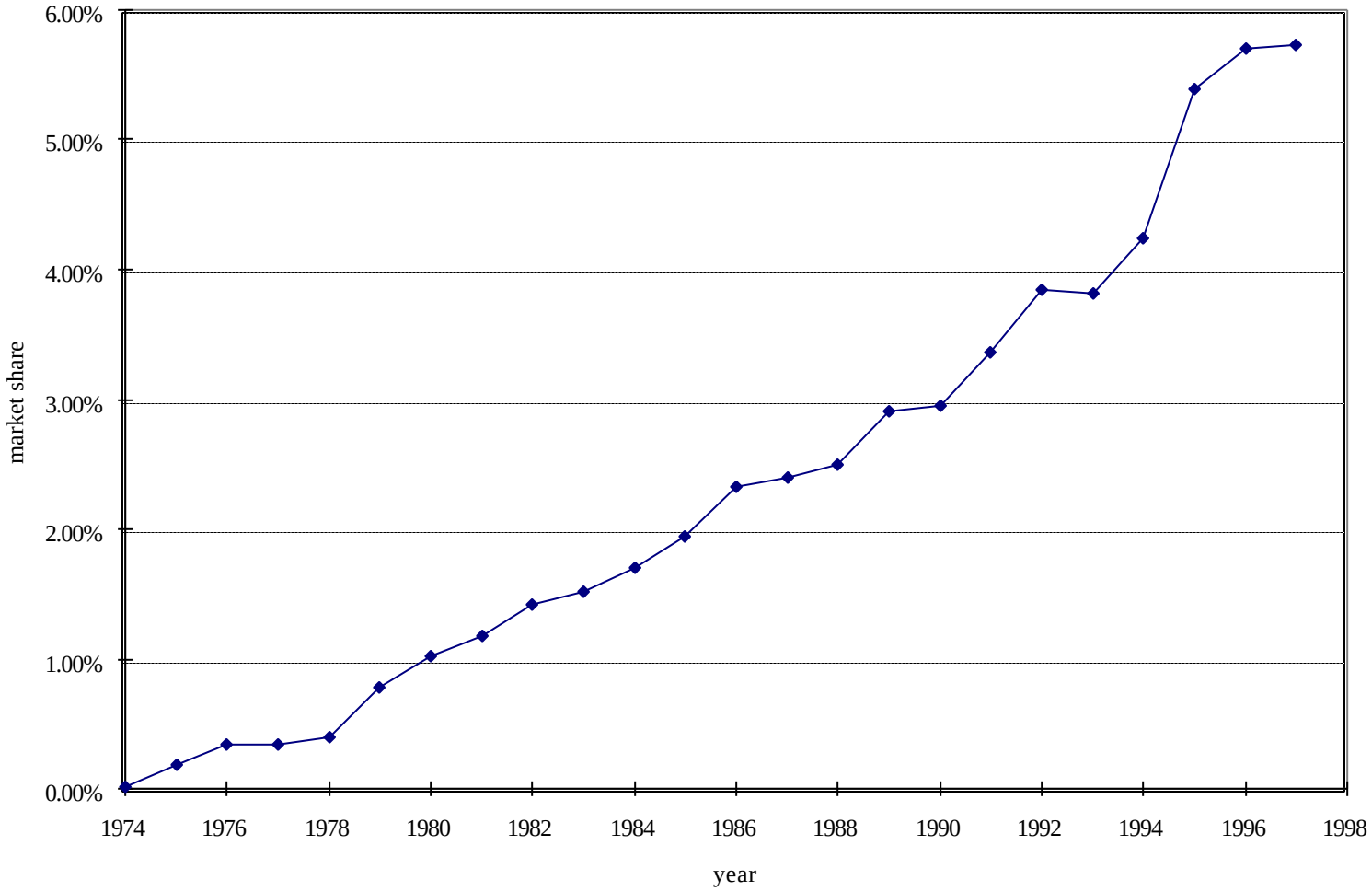

Figure 10. 2x4 housing market share of total residential construction.
Source: derived from data provided in *Japan Lumber Journal.*

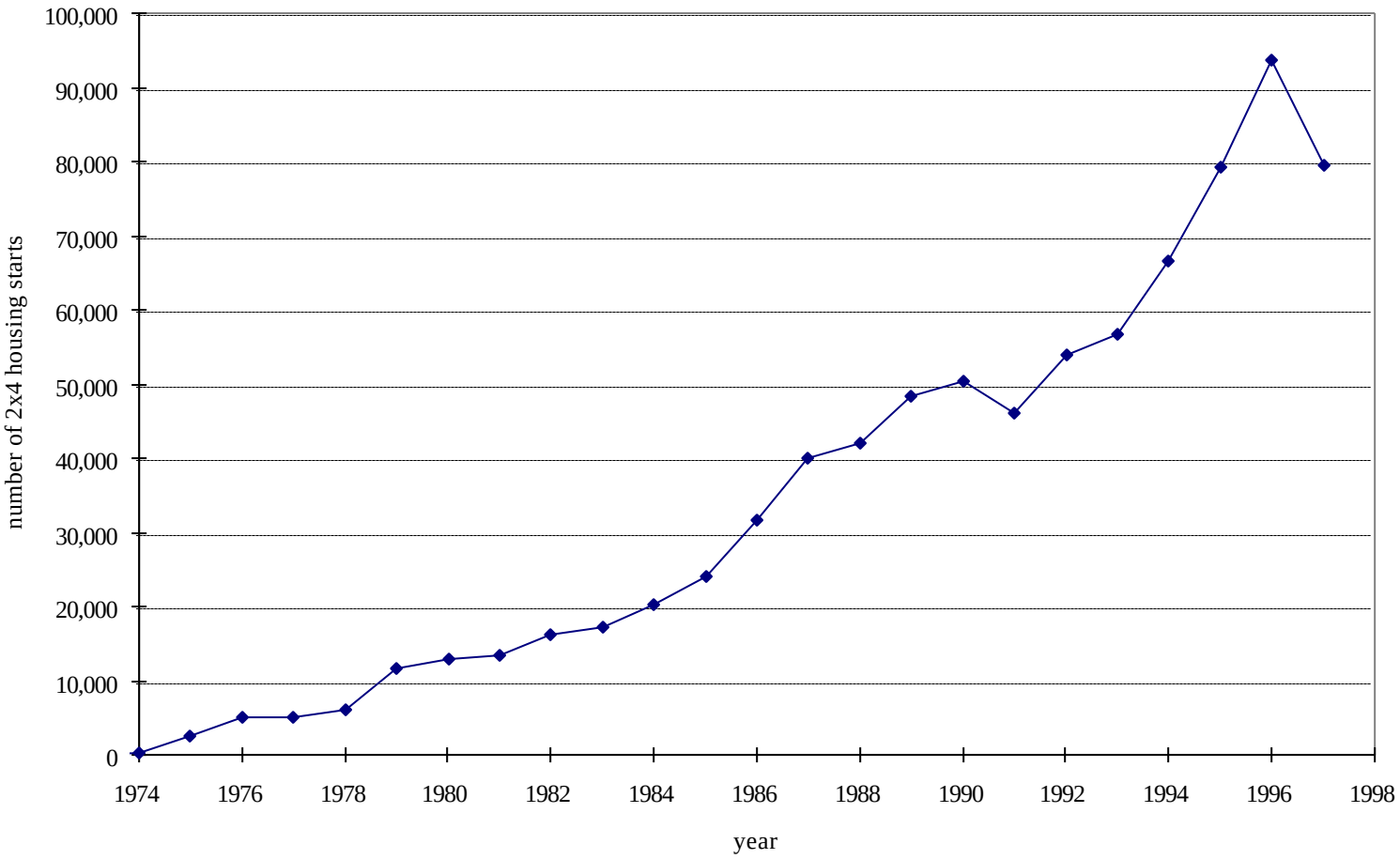

Figure 11. Japanese 2x4 housing starts since its inception in Japan.
Source: *Japan Lumber Journal.*

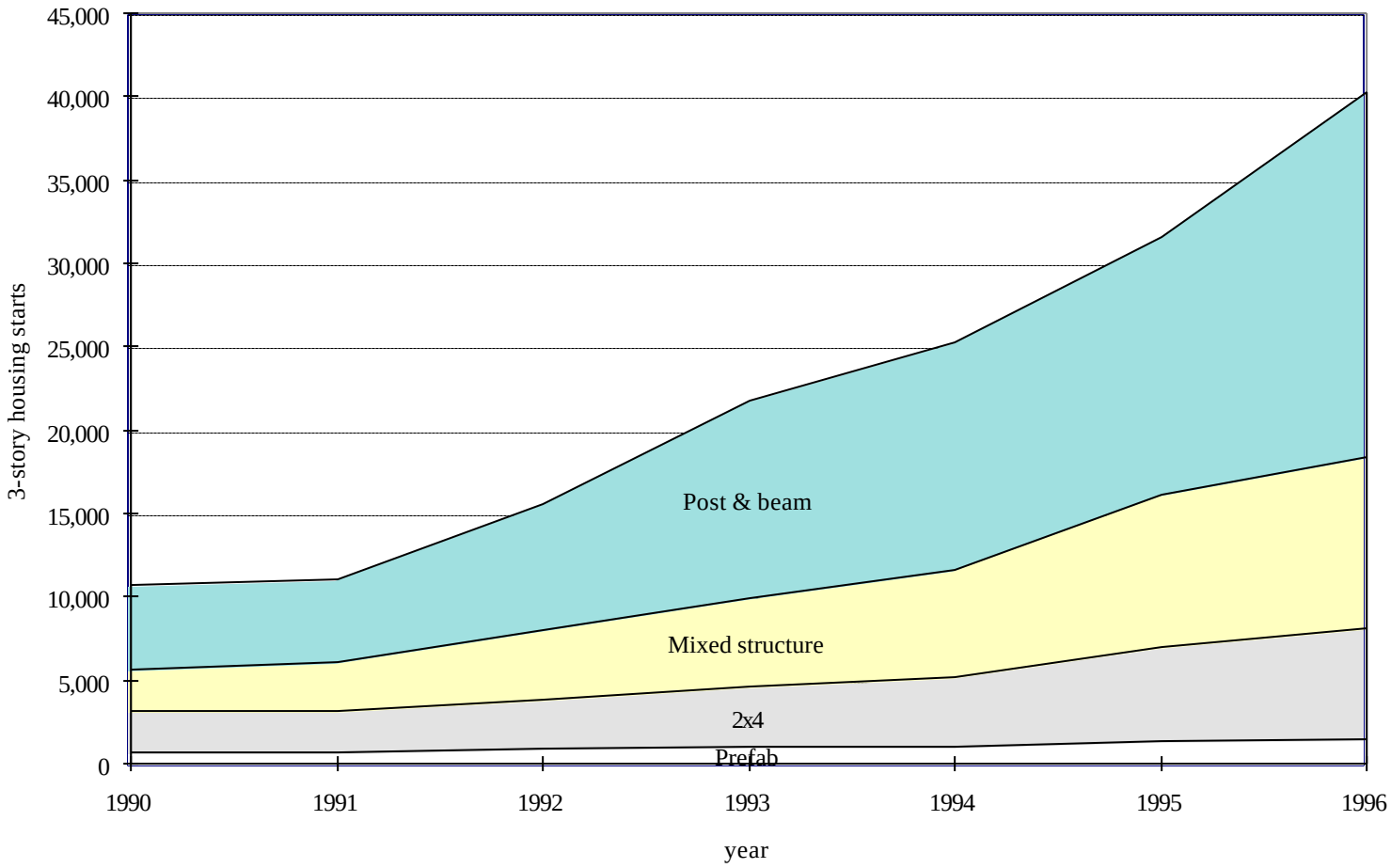

Figure 12. Market share of three-story wooden single-family houses.
Source: *Japan Lumber Journal* 1997d.

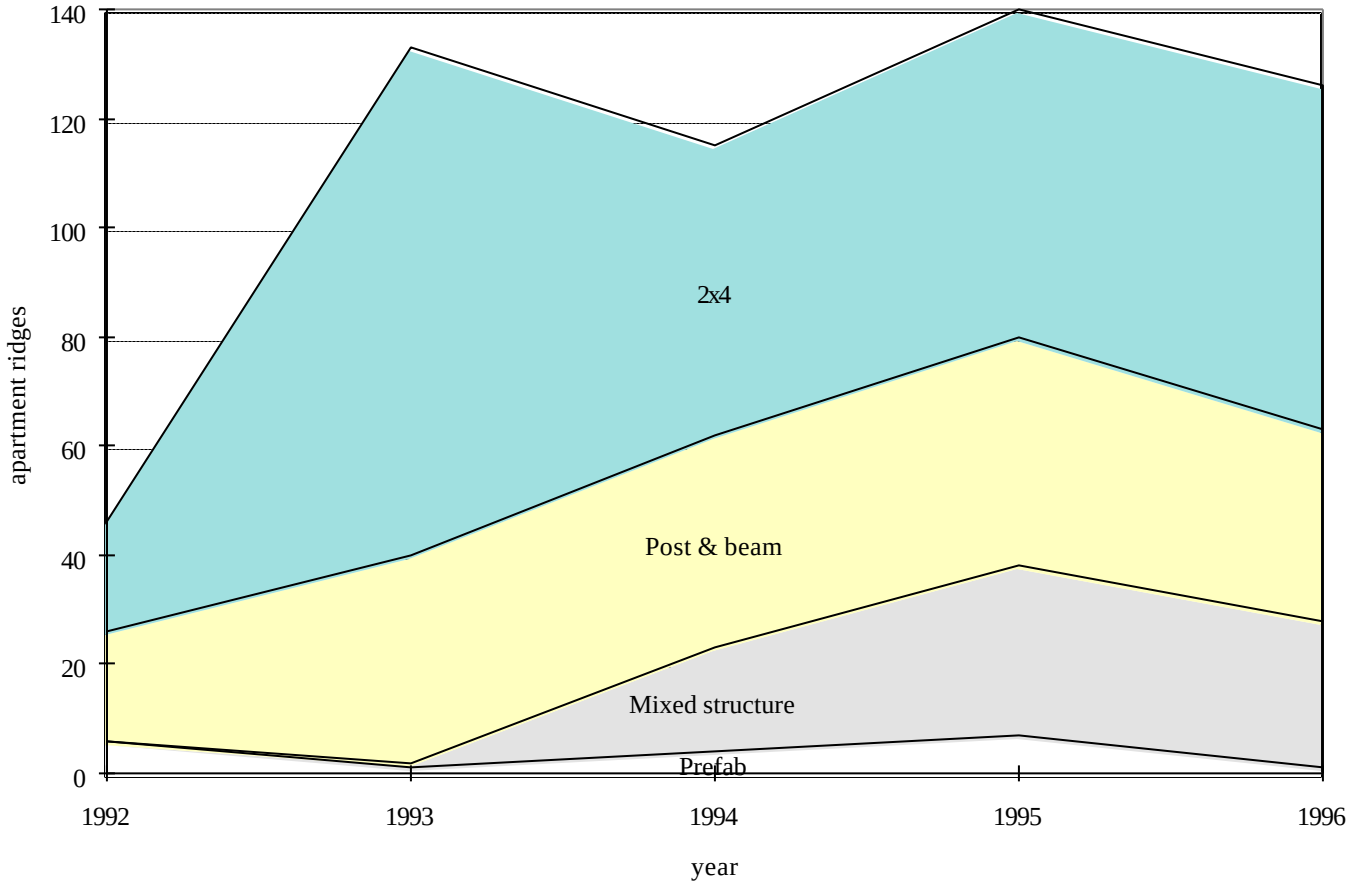

Figure 13. Three-story wooden apartment starts.
Source: Japan Lumber Journal 1997d

Economies of scale are often not available when constructing in Japan. Most single-family homes are built in isolation and in small volumes rather than the large multi-unit subdivision development common in the US. It is more difficult for construction workers to learn the special techniques of 2x4 construction in this manner.

There is a complex and difficult set of building codes that all construction must meet. They are the Japan Agricultural Standards (JAS) for lumber and plywood, and the Japan Industrial Standard (JIS) for nails, gypsum board and related products. Previously, all building products, both domestic and imported, required the standards stamp before use. Therefore, all 2x4 housing products had to be graded or perhaps regraded to meet building codes approval. This was especially a problem for imported packaged housing because every item within the package must be inspected and individually marked. This cost both time and effort on the part of the exporter.

In a related barrier, the Japanese government previously did not recognize foreign lumber grade stamps such as those of APA-The Engineered Wood Association and WWPA (Western Wood Products Association). Even if a product was acceptable for use in a 2x4 house in the US, it had to be graded by Japanese inspectors to be imported into Japan.

Most Japanese 2x4 housing is based on a 3x6 module rather than the North American standard of 4x8 (WWPA 1994). This required exporters to modify their products so they fit within the Japanese module. Finally, JETRO has noted the following apparent disadvantages to 2x4 houses: limitations on the house design, difficulty in creating openings, and its unsuitability to the Japanese climate (JETRO 1996c).

Government Commitment to Import 2x4 Housing: The Japanese government has implemented many programs to increase the production of lower cost, high quality housing including imported 2x4 housing. Promotion of 2x4 housing has been initiated by the Ministry of International Trade and Industry (MITI), the Ministry of Construction (MOC), and the Government Housing Loan Corporation (GHLC).

The MOC has proposed a plan to reduce housing costs to roughly five times the average annual salary for Japanese salaried workers (Yamakoshi 1994). This would be equivalent to reducing housing costs by 33%. They want to achieve this goal by fiscal year 2000. This was introduced by past Prime Minister Miyazawa in the "Five-Year Economic Plan: Sharing Better Quality of Life." This plan aimed to provide quality housing suitable for Japan's economic consumer power. They also want to import more low cost building materials (*Pacific Rim Wood Market Report* 1996). These goals were reinforced in the government's Action Plan announced in 1994.

The Hashimoto administration implemented widespread deregulation by revising the MOC's 2x4 standards on March 30, 1997. Building standards are now less restrictive in order to reduce housing costs (Washington State CTED 1997). Some of the issues of study included: reducing the time of issuing work visas for US carpenters entering Japan, providing wider acceptance of US lumber grade marks, and moving towards performance based-building codes.

Reducing the time of issuing work visas will enable US workers to enter Japan more easily to build houses and educate Japanese construction workers on North American-style 2x4 construction techniques. Wider acceptance of US lumber grades will reduce the non-tariff barriers imposed on US lumber. A performance-based Construction Standard Law allows various designs and building products to be used (*Japan Lumber Journal* 1997c). The MOC anticipates that new products will be developed, new technologies will be used, and foreign products will be introduced into the marketplace. These will reduce the construction time of large wooden buildings which are currently hampered by cumbersome regulations. The current Construction Standard Law is considered cumbersome mostly because of the non-performance based specifications of engineering methods, materials, and sizes. Overall construction costs will be reduced with increased competition.

The MOC has made many revisions to the Buildings Standards Law in order to allow easier market access for import housing companies. In 1987, MOC first allowed the construction of a three-story wooden house which met certain technical standards within the quasi-fire prevention area. Then in 1992, the MOC allowed three-story wooden apartments outside of the fire prevention area and the quasi-fire prevention area (*Japan Lumber Journal* 1995). In

1993, the Building Standards Law was again modified by increasing the maximum allowable floor space for wooden houses from 2,000 m^2 to 3,000 m^2. These changes encouraged the building of three-story, multi-family wooden houses. These apartments are very attractive for Japan's aging population because the elder parents can live with their children in a less expensive and more convenient manner. It is predicted that the percentage of people over age 65 will increase from 14.5% in 1995 to 20% in 2010 (Kodansha International 1995). This is higher than the estimated percentage in the US and Germany of 16% and 18% respectively (Jahraus and Cohen 1997).

The MOC also allowed all North American wood products used in 2x4 construction, including lumber and plywood, to enter the Japanese market as they are without being graded to JAS standards as of January 9, 1997 (*Japan Lumber Journal* 1997a). Both the American Lumber Standards Committee and Canadian Standards Accreditation Board lumber grades are recognized. These include grading agencies such as APA, WWPA, and NLGA. This reduces the cost of lumber and increases the speed of delivery.

The Government Housing and Loan Corporation has also increased the income ceiling for their programs to ¥13.225 million (JETRO, 1993). This allows a larger proportion of the population to qualify for inexpensive government mortgages. In addition, financing has been expanded so that houses up to 240 m^2 floor space can obtain financing. These changes have increased the percentage of people who can afford housing.

MITI officially promotes import housing directly through its Housing Industry Division and indirectly through JETRO. JETRO is an international organization promoting trade with Japan's partners. They have a large budget to support information gathering and construction of model home parks. These activities promote 2x4 housing as a high quality, less expensive type of housing.

Factors Which Will Increase 2x4 Housing Starts: The current chairman of the Japan 2x4 Homebuilders Association lauds the beneficial qualities of 2x4 housing as being superior structural integrity, insulation, and builder productivity (Roos and Eastin 1998). Japanese consumers are now aware that 2x4 housing is structurally sound and highly resistant to earthquake damage. Government testing done in 1991 first demonstrated this feature. The Hanshin earthquake in 1995 reinforced the structural qualities of 2x4 housing. Of the 147,600 houses damaged by the earthquake, 111,100 units or 75% were non-wood framed (*Japan Lumber Reports* 1995). In addition, the Japan 2x4 Homebuilders Association verified the status of 8,948 North American style 2x4 homes and found that only two suffered serious damage from the earthquake (1996). Jahraus and Cohen (1997) believe that the Hanshin earthquake was a turning point for post-and-beam construction and imported housing. The earthquake pointed out that older style post-and-beam houses do not fare well in earthquakes, primarily due to a lack of cross bracing

Japanese consumers also are attracted to 2x4 style of housing because it makes extensive use of wood in both the structural and aesthetic components of a house. Both the frame and structure of the house are wood. In addition, kitchen components, doors, window sashes and other components make extensive use of wood.

Finally, 2x4 housing construction workers requires less training time than post-and-beam construction workers. This allows more people to enter the 2x4 construction trade and almost immediately start building (Briggs and Dickens 1984). As mentioned earlier, the post-and-beam labor force is aging and decreasing in number. A smaller post-and-beam labor force will make this style of housing more expensive to build.

Efforts To Transfer 2x4 Technology To Japan

Misunderstandings Of The North American 2x4 Housing Technology: Ossinger (1998) of US Construction Link K.K. suggests that the Japanese have the most misunderstanding with the 2x4 house being an overall "system." The 2x4 house needs to be viewed as a system in order to maximize both design and construction efficiency.

Ossinger believes that the system mentality is missing in Japanese construction industry professionals. Some observations include piecemeal implementation by mixing traditional post-and-beam technology with North American technology; design details and structural systems being modified to produce a less desirable finished product; and only implementing parts of the 2x4 system such as framing and drywall but skipping the efficient techniques developed for the installation of other subsystems such as plumbing, electrical and interior finishes.

In addition, in a study conducted by Eastin *et al*. (1995), differences between US and Japanese 2x4 construction practices were identified in the areas of construction technology, labor specialization and project management. The differences in construction technology were in foundations, structural framing, drywalling and finish carpentry. A lack of labor specialization reduces production efficiencies of Japanese construction industry professionals. Project management inefficiencies are found in mobilization, procurement, scheduling, cost control and value engineering. It was determined that if refinements were made to the Japanese 2x4 construction methods, there would be both cost and production efficiencies.

In a recent study conducted by the Japan 2x4 Home Builders' Association and translated by Roos and Eastin (1998), 390 companies within the Association membership were surveyed regarding their experiences with imported 2x4 housing. It was found that imported houses are generally lower in cost than traditional post-and-beam houses. However, the cost could not be reduced as much as expected due primarily to a lack of experienced carpenters and engineers. It was expected, though, that cost reductions would be achieved through building large quantities of houses and experiential learning.

In terms of the training of workers, the study indicates that 40% of the companies surveyed have some sort of regular 2x4 worker training program with large companies having a formal in-house training program. The majority are without training programs however, so it was suggested that there be a third party organization to provide training classes.

Schools And Training Centers: The Bates Technical College in Tacoma, WA, regularly offers classes and training sessions for Japanese construction industry professionals. In addition, the Royal Oak College in Burnaby, BC, offers two- and three-year, post-secondary diploma programs in residential design, interior design, and 2x4 construction. This college's curriculum is targeted mostly to young students from Japan and other countries who wish to have a career in the 2x4 housing industry. The curriculum is conducted in English and offers hands-on classes and seminars.

The *Japan Lumber Journal* (1997e) reports that Pacific Housing International Co., Ltd., operates a school for builders in Urawa, Saitama. This school teaches construction techniques for 2x4 houses at its Pacific Housing Center. The center offers one- or two-day technical courses in framing, furnishing windows and doors, molding, drywalling, and other housing components of a 2x4 house.

In addition, the Washington State government launched a 12-month technical training program in Kobe and Tokyo in March 1996 (Washington State CTED 1997). The program offered professional classes once per month taught by design, construction and building materials experts from the Seattle area.

RESEARCH OBJECTIVES

This project assesses companies' efforts in transferring North American 2x4 construction technology to Japanese construction industry professionals. The objectives of this study were to: 1) analyse companies in the US and Canada which have designed or constructed North American 2x4 houses in Japan; 2) identify those components of the North American 2x4 system that are poorly understood by Japanese construction industry professionals; 3) identify the strategies that are being used to promote the transfer of the North American 2x4 construction technology into Japan; and 4) identify those technology transfer strategies that are perceived to be the most effective in transferring the North American 2x4 technology to Japanese construction industry professionals.

The specific research questions addressed in this study include:

- What are the housing components that companies focus on when providing technical support for Japanese construction industry professionals?
- What strategies are North American companies employing to transfer the North American 2x4 construction system?
- What are perceived to be the most effective methods of transferring North American 2x4 construction technology to Japanese construction industry professionals?
- What factors are most inhibiting the transfer of technology?

- ? Are there any differences in technology transfer programs between Canadian and US companies?
- ? Does the size of the company have an impact on the transfer of technology?
- ? Does the volume of business that the company does with Japan have an impact on the transfer of technology?

These research questions were based on the results of two previous projects. The first project consisted of collecting construction cost data from the Evergreen Chiyo project in Fukuoka, Japan. This data was collected during February, 1997, and was provided by Bay Pacific Construction, Inc. The cost data was based on a 16-unit subdivision completed by various teams of US and Japanese work crews. The differences in construction costs were compared between houses built in Japan and the US.

The second project consisted of visits to 2x4 construction projects in Japan during March, 1997. The inspections were conducted by a team of professional US architects, contractors, trade officials and University researchers. Visits to 21 sites provided a first-hand inspection of Japanese 2x4 construction techniques regarding construction inefficiencies and errors. However, it was felt that a more comprehensive survey was required to obtain more complete information regarding how to effectively transfer North American technology to Japanese professionals.

SURVEY DESIGN AND METHODOLOGY

Survey Population

The population targeted for this study included individuals and companies based in North America which had experience in 2x4 residential construction projects in Japan. The target population included trading companies, consolidators, manufacturing companies, architects, and wholesalers.

The sample population was gathered through various methods. Industry associations, trade databases and personal contacts in the industry provided the bulk of company names, contacts and addresses. US contacts were obtained from directories and lists provided by The Evergreen Building Products Association; State of Washington Department of Community, Trade and Economic Development (CTED) (English and Japanese versions); Oregon Economic Development Department; Pacific NorthWest Economic Region CATALIST; US Department of Agriculture Foreign Agricultural Service's 1997 Directory of US Home Suppliers (Japanese version); Bates Technical College; CINTRAFOR; and industry sources. Canadian contacts were obtained from directories and lists provided by Canada Comfort Direct; TRADE WORKS International Ventures, Ltd.; Council of Forest Industries (COFI); and BC Wood Specialties Group.

A total of 176 companies were based in the western US with Washington State being the most common location. In Canada, the majority of the surveyed companies were located in British Columbia (Table 2).

Table 2. Survey population segmented by country and state of operation.

	# of Companies	%	Cumulative %
US, state			
Washington	136	71.2	71.2
Oregon	27	14.1	85.3
California	13	6.8	92.1
Arizona	2	1.0	93.2
New York	2	1.0	94.2
Pennsylvania	2	1.0	95.3
Other States	9	4.7	100.0
Canada, province			
British Columbia	67	84.8	84.8
Alberta	5	6.3	91.1
Ontario	5	6.3	97.5
Other	2	2.5	100.0

Survey Instrument

Due to time and budget constraints, a mail census was determined to be the most effective and cost efficient method of collecting data (Dillman 1978). The target population was also spread coast-to-coast throughout both the US and Canada, which made a mail survey more practical than other methods. The survey was pre-tested by several university faculty members, three industry managers involved in the Japanese 2x4 market, and 2 laypersons who checked mostly for grammar and readability.

There were two mailings sent to survey participants. Each mailing consisted of an envelope containing a personalized cover letter, survey, and self-addressed, stamped return envelope. The first mailing went out on February 25, 1998. The second mailing went out one month later to companies that did not respond to the first mailing. The second mailing was used because one of the single most important techniques for producing high response rates is to send out reminders (Kanuck and Berenson 1975).

A $1 bill was inserted in the second mailing to provide more incentive to the respondents to return the questionnaire. Providing monetary incentive is an excellent method of increasing response rates (Brennan *et al*., 1991). In addition, prepaid monetary incentives are considered more effective than promised monetary rewards (O'Keefe and Homer 1987)

Also, the respondents had the option of receiving the results of the completed study. This was done to further thank the respondent for completing the survey. This type of non-monetary reward provides improvements in response rates to the extent that the offer is viewed as valuable by respondents (Dommeyer 1985).

Response Rates

A total of 270 surveys were mailed out. There were a total of 191 and 79 companies based in the US and Canada respectively. The fact that there are more companies based in the US is confirmed by Takabatake (1995) who suggests that the US is the largest supplier of imported houses and building materials to Japan, with a market share of 50%, followed by Canada and the Scandinavian countries. A total of 29 US companies and 12 Canadian companies were declared unusable because they indicated that they were not involved in the 2x4 industry in Japan or they could not be contacted by mail. A total of 116 surveys were completed and returned, with 77 responses from US firms and 39 responses from Canadian firms. The overall response rate for the project was 51.5%, with the US response rate being 47.5% and the Canadian response rate being slightly higher at 58.2%.

Non-response Bias

Since 48.5% of the companies did not respond, non-response bias was a concern because companies that do not respond may differ from companies that do respond. The data was therefore analyzed to evaluate whether non-response bias was a factor. The Armstrong and Overton (1977) test which uses late respondents as a proxy for non-respondents, was used to determine whether non-response bias was a factor. An ANOVA test was done to compare the information provided by late respondents versus the information provided by early respondents. Only 2 of the 87 variables or 2.3% of the variables were significantly different between the two groups. Therefore, no statistical difference was observed between the two groups at a 95% confidence level. This indicates that non-response bias was most likely not a factor in this study.

RESULTS

Company Demographic Profile

Out of 116 returned surveys, the owners and primary managers of companies (CEO's, Presidents, and Principals) made up the majority (64%) of the respondents (Table 3). There were 8 major categories of businesses that returned the surveys. The most common line of business was building products consolidators (32%) (Table 4). The next most common types of businesses were manufacturers, construction companies, and export trading companies. Architects, wholesalers, general contractors and other companies (consultants, diversified companies, *etc*.) made up the remaining companies.

As Table 4 indicates, the sample population could be segmented into builders and non-builders. Builders are those companies that are actually involved in building houses and include construction companies, general contractors, manufacturers and companies listed as "other" that build houses in some way (for example, building consultant). Non-builders are those companies not involved in the actual building of houses and include architects, building products consolidators, export trading companies, and wholesalers. There were a total of 43 builders, and 73 non-

Table 3. Job titles of survey respondents.

Title	# of firms	% of firms
Owner	12	10.3
CEO	2	1.7
President	56	48.3
Principal	4	3.4
Vice President	5	4.3
Manager	27	23.3
Sales	8	6.9
Other	2	1.7

Table 4. Types of businesses responding to survey.

Line of business	Frequency	%
Building products consolidator	37	31.9
Manufacturer	18	15.5
Construction company	15	12.9
Export trading company	11	9.5
Architect	9	7.8
Wholesaler	9	7.8
General contractor	8	8
Other	9	9

builders. Most of the companies had sales under $5 million in 1997 (Figure 14). The companies which had sales over $50 million were mostly trading companies, wholesalers, and manufacturers.

Table 5 shows a number of other demographic characteristics segmented between Canadian and US companies. The Canadian demographics are skewed by a very large housing manufacturer whose parent company is based in Japan. This company provided very high "total 2x4 housing projects built" numbers and "total employees in Japan." Sales to Japan made up more than half of company sales for the majority of the respondents. In addition, the number of years companies have been in the Japanese 2x4 market averaged 6.96 and 7.37 years for US and Canadian companies respectively.

Table 5. Comparison of demographic factors between the US and Canada.

	US		Canada	
Demographic factor	**Mean**	**SD**	**Mean**	**SD**
Sales derived from Japan (%)	58.79	38.30	62.53	39.51
Years involved in 2x4 industry	18.36	18.85	15.11	11.32
Years involved in 2x4 industry in Japan	6.96	5.09	7.37	5.49
Total 2x4 housing projects in 1997	210.09	684.84	380.91	1767.70
Total 2x4 housing projects in Japan in 1997	48.04	127.36	326.89	1663.60
Total employees	59.89	244.16	20.84	31.08
Total employees in Japan	1.11	2.98	66.68	405.41
Total Japanese speaking employees	2.49	3.36	68.47	401.00
Employees who have worked in Japan	4.67	8.34	7.68	22.22

Analysis of Technology Transfer Factors

As mentioned in the Survey Design and Methodology section, scales ranging from 1 to 7 were used with 4 being a neutral rating. The use of this type of scale allows the Hotelling T^2 statistic to be utilized. This test measures whether the mean response is significantly different than a neutral value of 4. If the mean value is significantly less than the neutral value of 4, then the factor is considered to be significantly low in rating. If the mean value is significantly greater than the neutral value of 4, then the factor is considered to be significantly high in rating. If there was no significance, then the factor is not significantly different from the neutral rating of 4. Significance tests, where applicable, were always tested at a 95% confidence level.

Quality Of 2x4 Houses Built By Japanese Construction Industry Professionals: The first question in the survey asked respondents about the quality of 2x4 houses built by Japanese construction industry professionals compared

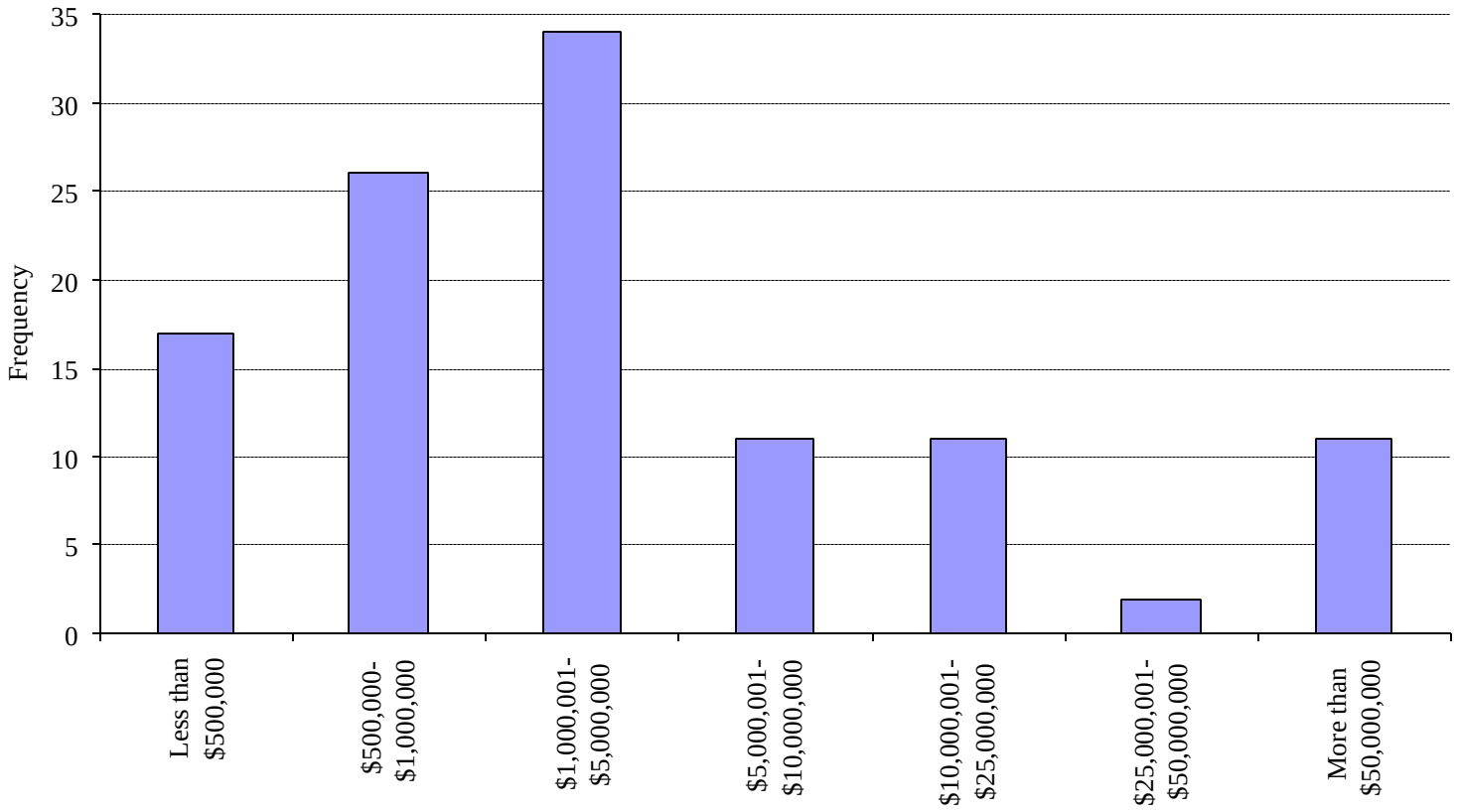
35
30
25
20
15
10
5
0
Frequency
Less than $500,000
$500,000-$1,000,000
$1,000,001-$5,000,000
$5,000,001-$10,000,000
$10,000,001-$25,000,000
$25,000,001-$50,000,000
More than $50,000,000

Figure 14. Annual sales revenue of survey respondents.

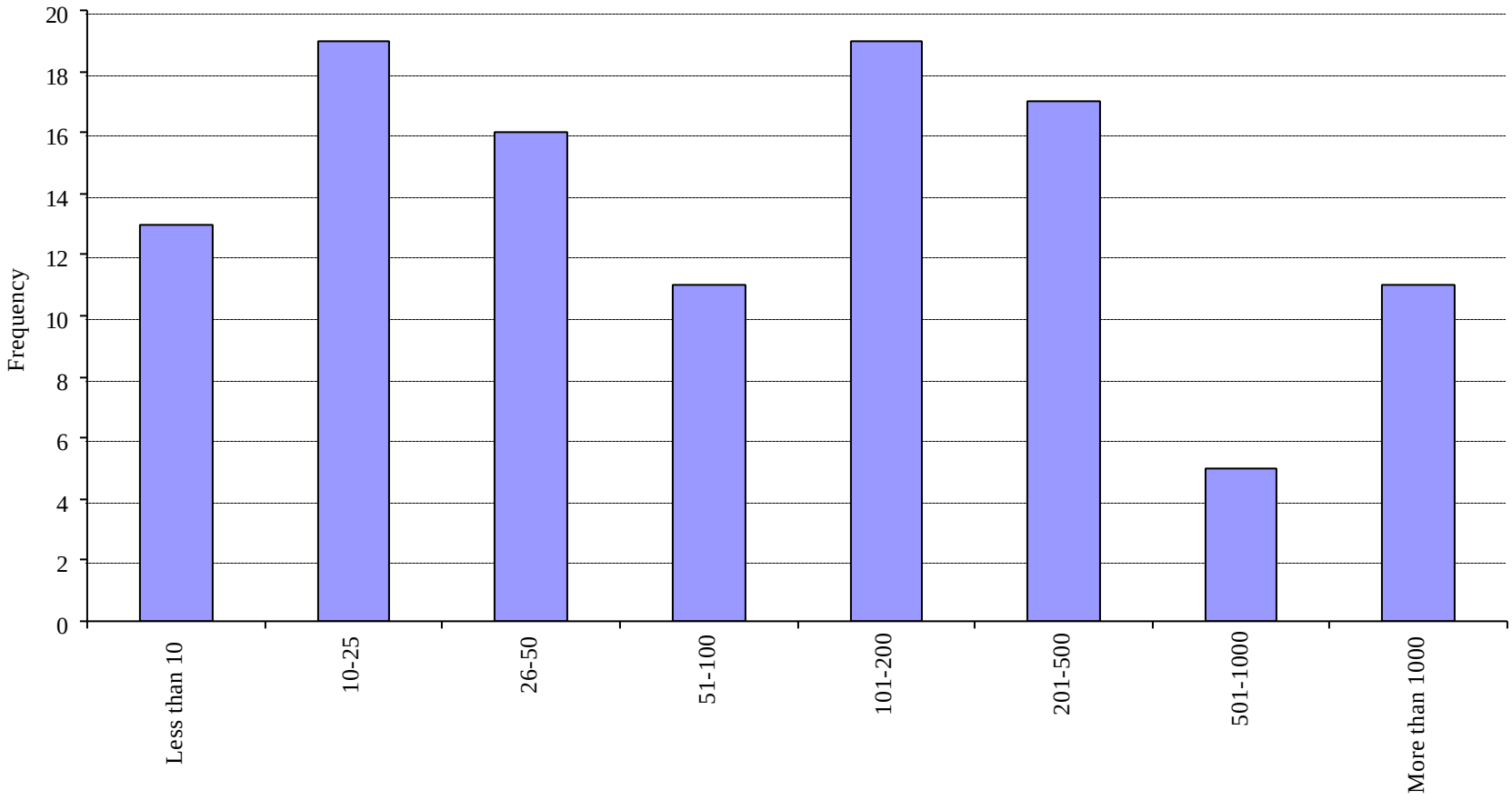

Figure 15. Total 2x4 housing units built in company history in Japan.

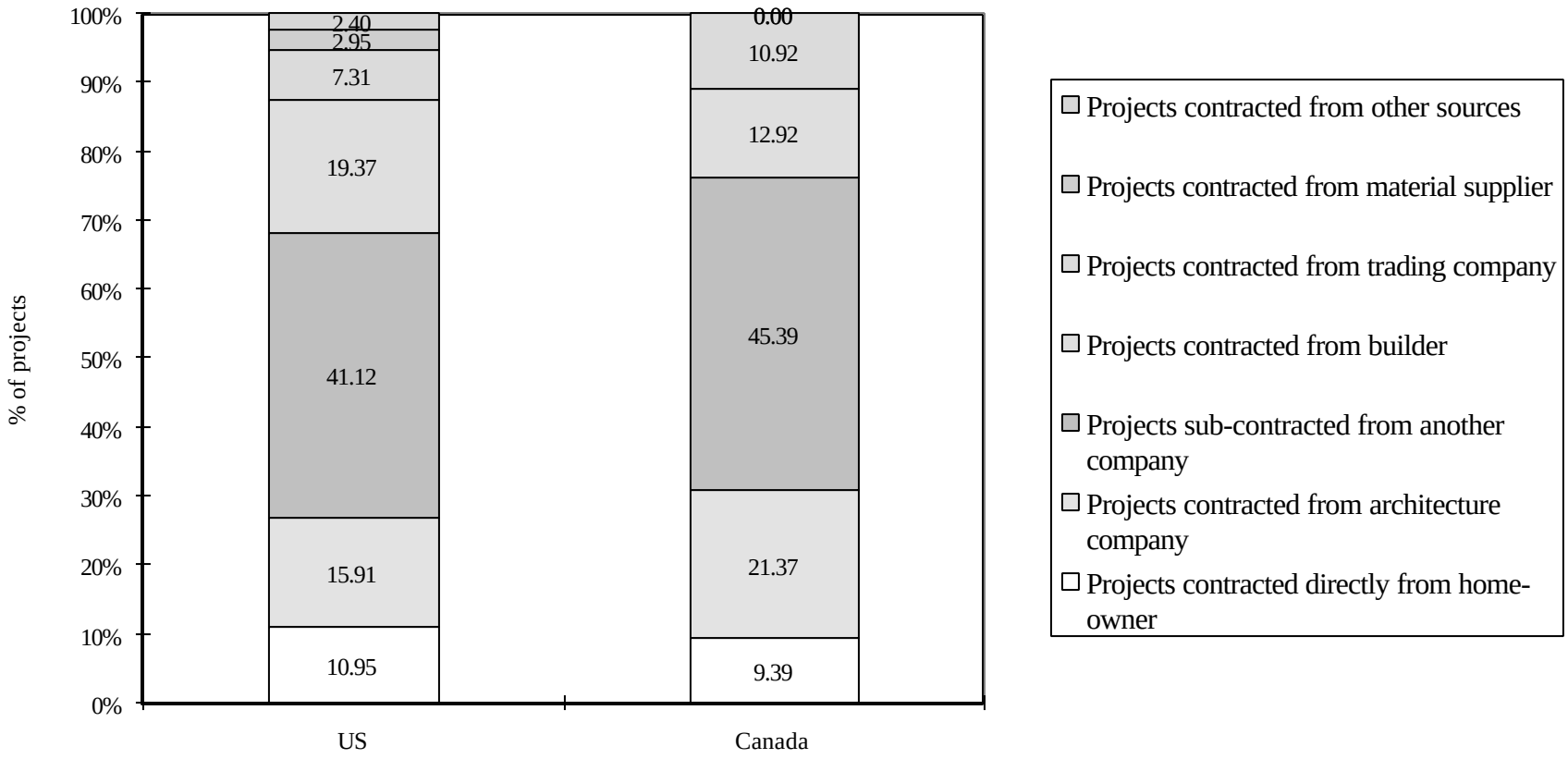

Figure 16. A comparison of US and Canadian companies and the source of projects contracted in Japan.

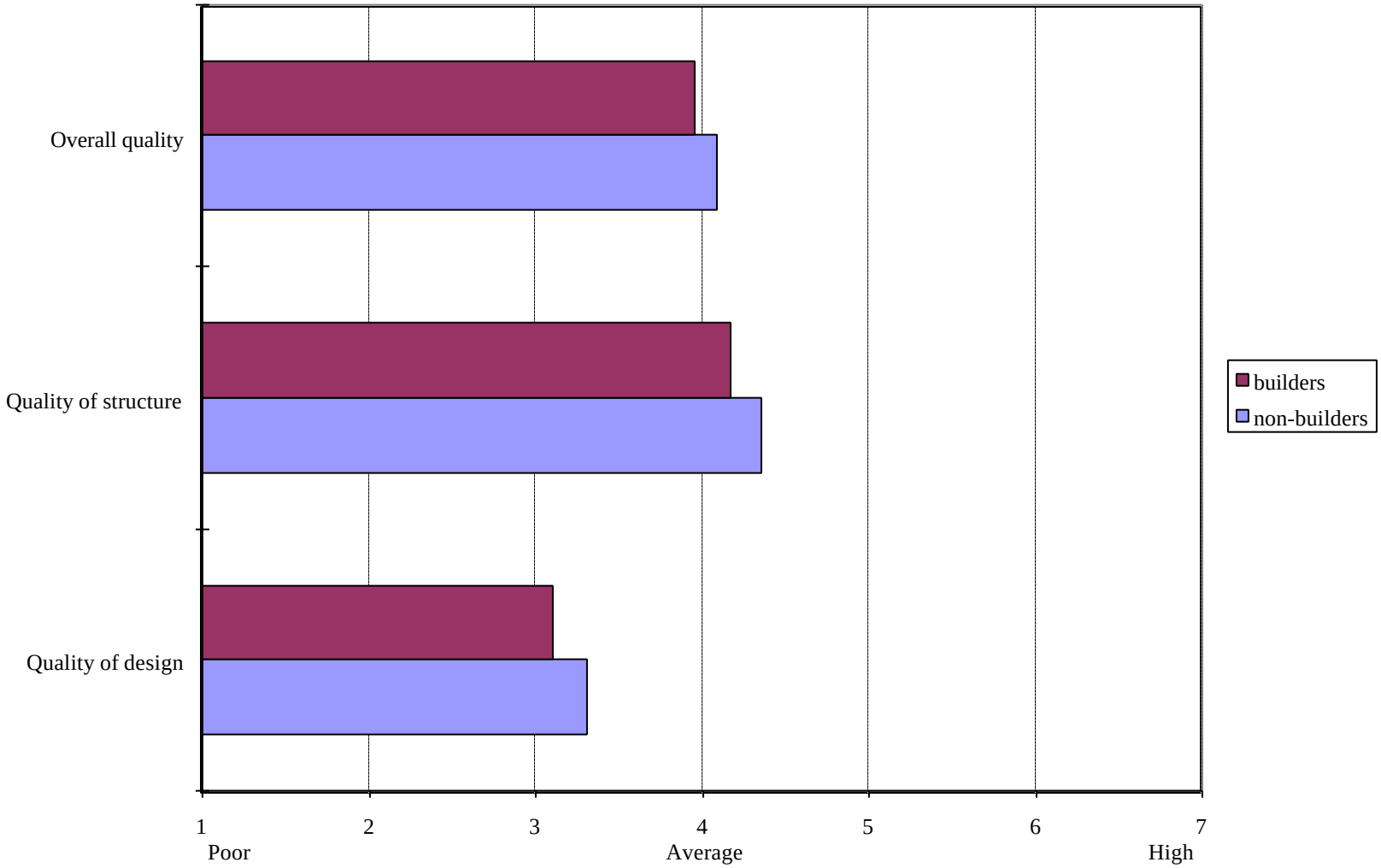

Figure 17. Difference in quality opinion between builders and non-builders.

with North American standards. The overall quality rating of a 2x4 house built in Japan was 4.04, which is considered to be an average rating. The quality of the structure received a rating of 4.29, which was significantly above average. The quality of the design however had a low rating of 3.23, which is significantly below average. Since none of the quality ratings exceeded a score of 5, there is much potential for improving the quality of 2x4 houses built in Japan.

Figure 17 outlines the differences in opinion between builders and non-builders regarding quality. Although none of the differences in opinion were significant, it should be noted that builders provide a slightly lower rating of the quality of a 2x4 house built in Japan than non-builders. The builders would probably have a more intimate understanding of the quality ratings because they have first-hand experience with 2x4 construction projects in Japan.

Aregression model was developed with overall quality being the dependent variable and quality of structure being the independent variable. Table 6 outlines the model.

Table 6. Regression model of overall quality versus quality of structure.

Model	**SS**	**df**	**MS**	**F**	**Sig**	**r**	**r^2**
Regression	93.323	1	93.323	126.311	0.000	.733	.537
Residual	80.533	109	.739				
Total	173.856	110					
	Unstandardized Coefficients			**Standardized Coefficients**			
	B	**Std.Error**		**Beta**	**t**	**Sig**	
Intercept	1.419	.247			5.751	.000	
Structure	.614	.055		.733	11.239	.000	

There is a positive linear relationship between overall quality and the quality of structure. Therefore, when there is a high rating of quality of structure, there is a corresponding high rating of overall quality.

The regression model which best explains the relationship between these two quality measures is:

$$E(Q) = 1.419 + 0.614\ S$$

where E(Q) is the expected overall quality rating
S is the quality of structure rating

A regression model was also developed with overall quality being the dependent variable and quality of design being the independent variable. Table 7 outlines the model.

Table 7. Regression model of overall quality versus quality of design.

	SS	**Df**	**MS**	**F**	**Sig**	**r**	**r^2**
Regression	62.995	1	62.995	61.938	0.000	.602	.362
Residual	110.861	109	1.017				
Total	173.856	110					
	UnstandardizedCoefficients			**StandardizedCoefficients**			
	B	**Std.Error**		**Beta**	**t**	**Sig**	
Intercept	2.297	.241			9.538	.000	
Design	.542	.069		.602	7.870	.000	

There is also a positive linear relationship between overall quality and the quality of design. Therefore, when there is a high rating of quality of design, there is a corresponding high rating of overall quality.

The regression model which best explains the relationship between these two quality measures is:

$E(Q) = 2.297 + 0.542\ D$

where E(Q) is the expected overall quality rating
D is the quality of design rating

The r^2 value for the regression model of overall quality versus quality of structure is higher. This suggests that the quality of structure explains the variance in overall quality to a greater degree than quality of design. 53.7% of the variance in overall quality is explained by its relationship with quality of structure. However, only 36.2% of the variance in overall quality is explained by its relationship with quality of design. Therefore, there is a stronger linear relationship between overall quality and quality of structure.

Finally, a multiple regression model was developed with overall quality being the dependent variable and quality of structure and quality of design being the independent variables. Table 8 outlines the regression model.

Table 8. Regression model of overall quality versus quality of structure and quality of design.

	SS	**Df**	**MS**	**F**	**Sig**	**r**	**r^2**
Regression	113.430	2	56.715	101.368	0.000	.808	.652
Residual	60.426	108	.559				
Total	173.856	110					

	UnstandardizedCoefficients		**StandardizedCoefficients**		
	B	**Std.Error**	**Beta**	**t**	**Sig**
Intercept	.872	.233		3.738	.000
Structure	.492	.052	.586	9.494	.000
Design	.334	.056	.370	5.995	.000

As the R^2 value of .652 indicates, this regression model explains the variance in overall quality to a greater extent than the individual regressional models. The multiple regression model yields a substantially larger reduction in error than using either of the bivariate models. Therefore, this model should be used in order to predict the overall quality based on company rating of quality of structure and design.

The regression which best explains the relationship between these three quality measures is:

$E(Q) = .872 + .492S + .334D$

where E(Q) is the expected overall quality rating
S is the quality of structure rating
D is the quality of design rating

A high rating of the structural or design quality would lead to a corresponding high overall quality.

Japanese Contractors' Understanding Of North American 2x4 Construction Technology: Respondents were asked to indicate how well Japanese contractors understand 14 different components of the North American-style 2x4 construction system (Table 9). Respondents used a scale on which a score of 1 = No Understanding, 4 = Average Understanding, and 7 = Complete Understanding. Overall, the survey respondents felt that none of the components were fully understood by Japanese construction professionals. The components that were least understood included drywall, ventilation and architectural design. The Hotelling T^2 test indicated that these components were significantly lower than the mid-scale score of 4. The components that were best understood by Japanese construction professionals included interior carpentry, roofing, flooring, doors, windows, exterior finishing, and weatherproofing. Note that while 7 of the components were rated significantly higher than the mid-point of the rating scale, none received a score higher than 5. This would suggest that while Japanese construction professionals have acquired a basic working knowledge of the various components that make up the 2x4 construction technology, they are still far from having a strong understanding of them. This indicates that technical transfer programs involving all

of the components of the 2x4 construction system should be considered.

Table 9. Mean understanding rating for 14 components of 2x4 construction technology.

Component	Average Understanding Score
Interior carpentry	5.01
Roofing	4.96
Flooring	4.88
Doors	4.70
Windows	4.66
Exterior finishing	4.61
Weatherproofing	4.43
Stairs	4.19
Foundation	4.10
Framing	4.03
Insulation	4.01
Architectural Design	3.58
Ventilation	3.31
Drywall	3.16

A factor analysis was performed to try to understand a subset of areas of 2x4 housing components that could be used to represent the concept of Japanese contractor understanding (Table 10). The 14 components were reduced to four general factors: non-structural components, structural components, finish details, and exterior envelope. The factor analysis explains 65% of the total variance of the original data using just four factors. So instead of trying to use the 14 components of 2x4 construction technology, we can simplify the discussion by considering only four factors.

The mean understanding ratings were calculated for each factor utilizing the understanding scores summarized in Table 9. It appears obvious that all of the factors, with the exception of structural components, had understanding ratings that were substantially higher than 4. The structural component factor, with a mean understanding score of 3.63, was the lowest rated factor. This should be a cause of great concern because one of the strongest advantages of the 2x4 construction system is its structural integrity. These results would seem to suggest that Japanese construction professionals need substantial training to improve their knowledge and understanding of the 2x4 structural framing system.

Table 10. Summary of factor analysis solution and the factor loading scores for Japanese carpenter understanding of 2x4 housing components.

2x4 House Component	Mean Score	Rotated Discriminant Function Loading Scores			
		Factor 1 Non-structural Components	Factor 2 Structural Components	Factor 3 Finish Details	Factor 4 Exterior Envelope
Windows	4.66	**0.825**	0.200	0.261	-0.071
Stairs	4.19	**0.786**	0.118	0.069	0.170
Doors	4.70	**0.746**	0.275	0.373	-0.144
Flooring	4.88	**0.682**	0.221	0.221	0.264
Architectural design	3.58	**0.410**	0.397	-0.021	0.381
Framing	4.03	0.218	**0.703**	0.146	0.150
Ventilation	3.31	0.062	**0.680**	0.338	0.284
Insulation	4.01	0.103	**0.669**	0.380	0.014
Drywall	3.16	0.345	**0.636**	-0.024	0.039
Interior carpentry	5.01	0.184	0.088	**0.808**	-0.077
Exterior finishing	4.61	0.128	0.263	**0.731**	0.327
Roofing	4.96	0.143	-0.110	0.323	**0.823**
Foundation	4.10	-0.205	0.218	-0.324	**0.659**
Weatherproofing	4.43	0.207	0.280	0.447	**0.468**

Mean Score	**4.26**	**4.40**	**3.63**	**4.81**	**4.50**

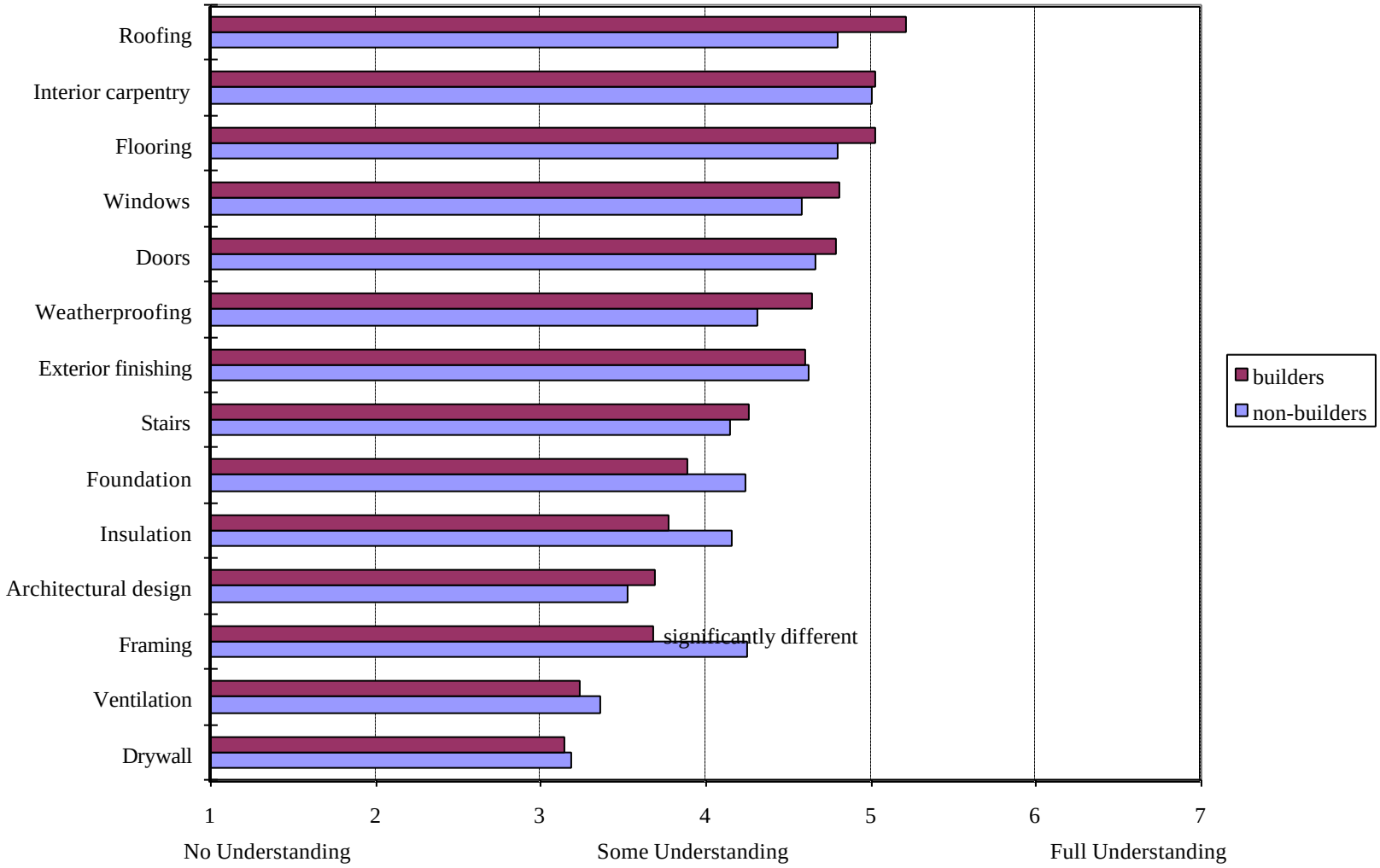

Figure 18. Difference in opinion in mean understanding rating for 14 components between builders and non-builders.

Figure 18 summarizes the differences in understanding scores provided by builders and non-builders. Among the 14 components assessed it was found that, while opinions differed between the two groups regarding the understanding of framing by Japanese construction industry professionals, few of these differences were statistically different. Unfortunately, one of the components that was rated significantly lower by builders was Japanese construction professionals' understanding of the 2x4 structural framing technology. This is an important difference to note, and combined with the low rating (3.7), suggests that technology transfer programs should strongly emphasize 2x4 framing techniques.

Technical Transfer Areas Emphasized By Companies When Providing Technical Assistance: Most companies provide some type of training or technical assistance to their customers in Japan. Survey respondents were asked which components of 2x4 construction technology they emphasize when providing technical assistance to Japanese construction industry professionals (Table 11). All 14 of the components except roofing and foundation were significant areas of emphasis for technical transfer programs.

Table 11. Mean emphasis rating for 14 components by companies providing technical assistance.

Component	Mean rating	SD	Rating significantly: None (-), Some (=), or Much (+)
Framing	5.75	1.62	+
Windows	5.18	1.63	+
Architectural Design	5.08	2.00	+
Doors	4.97	1.61	+
Insulation	4.94	1.74	+
Stairs	4.77	1.63	+
Ventilation	4.70	2.05	+
Drywall	4.67	2.00	+
Weatherproofing	4.66	1.91	+
Exterior finishing	4.59	1.58	+
Flooring	4.53	1.74	+
Interior carpentry	4.47	1.80	+
Roofing	3.72	1.74	=
Foundation	3.25	2.12	-

The two areas receiving the least emphasis in technical transfer activities were roofing and foundations. A comparison of framing versus foundations is interesting because in most cases concrete foundations are put in place by Japanese crews prior to the active involvement of North American firms, thus the low rating for foundations. In contrast, North American firms are much more involved in incorporating framing technology in their technical transfer programs. However, given the fact that framing was identified earlier as one of the areas where Japanese construction professionals need further training, this focus should be continued, and most likely increased. Finally, it should be noted that respondents reported that they provide some level of technical training for all of the construction areas included in the survey, including foundations.

The topic of foundations is an important one because the foundation provides support for the entire structure. An uneven surface or out-of-level foundation leads to differential settling of the entire structure over time resulting in cracked walls and sloping floors. It also causes door and window frames to shift, making them difficult to work and, in some cases, can prevent doors from closing tightly in their frames and can cause windows to crack. Japanese carpenters have indicated that they utilize the two step system of pouring the rough foundation followed by the application of a thin (1-2 cm) topping layer of mortar to level off the foundation in order to ensure that the foundation is both flat and smooth. Thus the foundation looks better than if it had been formed in a single pour. During discussions with Japanese contractors it was rare that they expressed the opinion that wall cracks and uneven floors caused by cracking and disintegration of the topping layer were a concern. However, given the serious impact that this problem can have on the long-term performance of 2x4 homes, it is a critical area for future technical transfer programs to emphasize.

Another factor analysis was performed to reduce the 14 house components into a more manageable number of subgroups (Table 12). The results of the factor analysis suggest that the original 14 technical components can be reduced to 3 factors: non-structural elements, living comfort, and structural framework. These three factors explain 69% of the variation of the original data. To help describe the relationship between the three factors and current technical transfer programs, the mean emphasis ratings were calculated. The results of this suggest that North

Table 12. Summary of factor analysis solution and the factor loading scores for 2x4 house components emphasized when providing technical assistance to Japanese construction industry professionals.

2x4 House Component	Rotated Discriminant Function Loading Scores		
	Factor 1 Non-structural Elements	**Factor 2 Living Comfort**	**Factor 3 Structural Framework**
Doors	**0.895**	0.186	-0.059
Stairs	**0.877**	0.074	0.221
Flooring	**0.876**	0.232	0.001
Windows	**0.862**	0.223	0.042
Interior carpentry	**0.680**	0.241	0.406
Ventilation	0.124	**0.821**	0.301
Architectural design	0.044	**0.776**	-0.005
Insulation	0.272	**0.728**	0.294
Weatherproofing	0.267	**0.715**	0.352
Drywall	0.288	**0.587**	0.348
Foundation	0.003	0.180	**0.813**
Framing	-0.032	0.135	**0.756**
Exterior finishing	0.422	0.432	**0.468**
Roofing	0.349	0.493	**0.428**
Mean	**4.78**	**4.64**	**4.53**

American exporters and builders emphasize each of the factors to about the same extent, with aggregate scores ranging from 4.53 (structural framework) to 4.78 (non-structural elements).

The survey data was segmented to compare the relative level of emphasis that builders place on each area of construction technology relative to non-builders. The results of this exercise suggest there were no significant differences between the two groups with the exception of framing. In this case, builders reported that they place significantly more emphasis on providing their Japanese customers with training in framing techniques than did non-builders. The difference between builders' (6.5) and non-builders' scores (5.3) was very large and suggests that most builders incorporate training on framing technology as a standard component of virtually all of their training programs.

Table 13. Regression model of overall quality versus contractor understanding.

	SS	**df**	**MS**	**F**	**Sig**	**R**	**R^2**
Regression	52.621	3	18.874	18.660	0.000	.601	.361
Residual	100.136	99	1.011				
Total	156.757	102					
	UnstandardizedCoefficients			**StandardizedCoefficients**			
	B	**Std.Error**		**Beta**	**t**	**Sig**	
Intercept	1.529	.383			3.990	.000	
Architecturaldesign	.308	.075		.368	4.126	.000	
Framing	.221	.096		.210	2.296	.024	
Ventilation	.161	.079		.193	2.045	.044	

A regression model was tested for the overall quality of the house using the understanding ratings of the 14 technical components of the 2x4 house as the independent variables. The step-wise method of selecting variables was used. Table 13 summarizes the regression model for overall quality versus the understanding rating of the 14 components of a 2x4 house. The overall quality of the house was best explained by three of the technical

understanding variables: architectural design, framing, and ventilation. The R^2 value of .361 indicates that these three variables

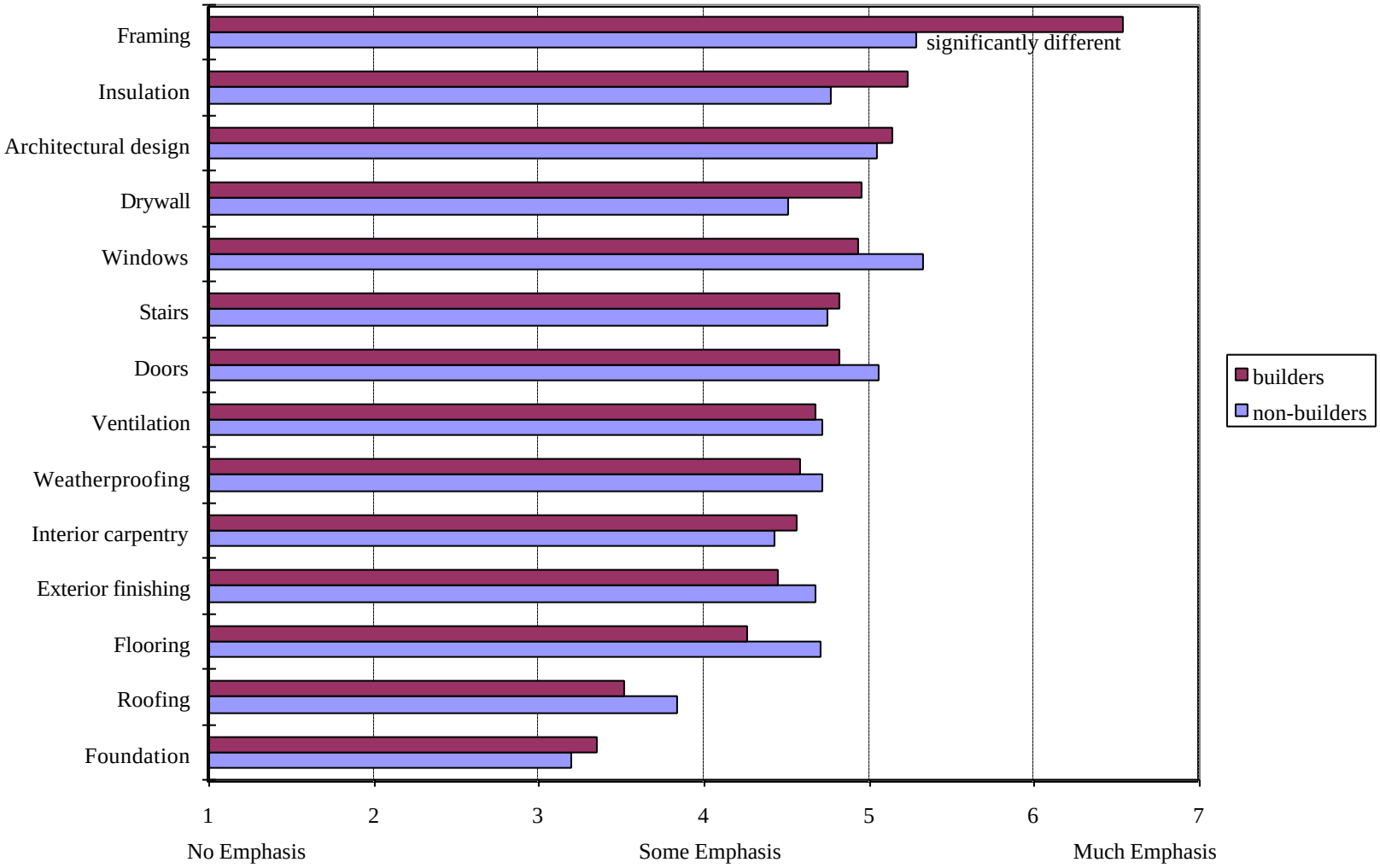

Figure 19. Difference in opinion in mean emphasis rating for 14 components between builders and non-builders.

explain 36.1% of the variance in the overall quality of 2x4 houses built in Japan. However, the R^2 value indicates that other unspecified variables have a substantial impact on the overall quality of 2x4 homes built in Japan.

The regression model is as follows:

$$E(Q) = 1.529 + .308A + .221F + .161V$$

where E(Q) is the expected overall quality rating
A is the understanding of architectural design rating
F is the understanding of framing rating
V is the understanding of ventilation rating

The variables were added in the order of architectural design, framing, and ventilation. Architectural design is the most highly correlated with the overall quality. This means that a company's understanding of 2x4 architectural design concepts would be the most useful for predicting the overall quality of a 2x4 house being built in Japan.

Out of all 14 understanding variables, understanding of architectural design, framing techniques, and ventilation best predict the overall quality of a 2x4 house built in Japan. All of the variables are positively correlated to overall quality. Therefore, an increase in the rating of any of the three variables would lead to increases in the overall quality (holding the other variables constant). Efforts to develop regression models for the quality of structure and quality of design provided inconsistent results and the final models were not significant.

The 2x4 House Component That Is The Least Understood: Respondents were asked to identify the one component of which Japanese construction industry professionals have the weakest understanding. The respondents were allowed to identify any construction component. The results show that respondents identified 2x4 structural engineering as the area where Japanese construction professionals have the weakest understanding, with 19.1% of all responses. The other areas that generated high response rates were structural framing (16.4%) and architectural design (12.7%).

Importance of Continued Efforts Of Promoting 2x4 Construction Technology: Survey respondents were also asked to indicate how important it was to continue to provide technical transfer programs in North American 2x4 construction technology to Japanese construction professionals. The overwhelming majority of respondents indicated that continued efforts are very important (63%) (Figure 20). On a scale from 1 to 7, where a rating of 1 meant "Not Important" and a rating of 7 meant "Very Important," the mean importance rating was 6.41. There was no significant difference between US and Canadian companies. There was also no significant difference between builders and non-builders. Virtually every group considered it very important to continue promoting North American 2x4 construction technology. So despite double digit growth rate of 2x4 housing starts over the past 10 years, it was still important to promote proper 2x4 construction methods.

Evaluation of Strategies Used By North American Companies To Provide Technical Assistance: Respondents were asked to rank their use of eight different methods of training Japanese construction industry professionals in 2x4 construction technology. Table 14 describes the respondents' rating of the eight methods. The two methods most often used were hands-on construction in Japan and North American site supervisors in Japan. Joint projects with North American and Japanese carpenters and translated training manuals were sometimes used, while instructional videos, hands-on construction in North America, and classroom seminars (in either Japan or North America) were used much less often. It would appear that respondents favor the training methods that emphasize construction activities as a strategy to train Japanese construction industry professionals (average rating of 4.15) rather than training exercises that rely primarily on books or seminars (average rating of 3.52) (Table 14).

However, after segmenting the survey data into builders versus non-builders, it was observed that builders tend to use a different mix of strategies for technical training programs. First of all, builders differ from non-builders in that they are significantly more likely to incorporate hands-on training and North American site supervisors in their technical training programs, while non-builders are significantly more likely to utilize translated training manuals. Further, the survey data suggests that builders are much more likely to provide technical training programs to their

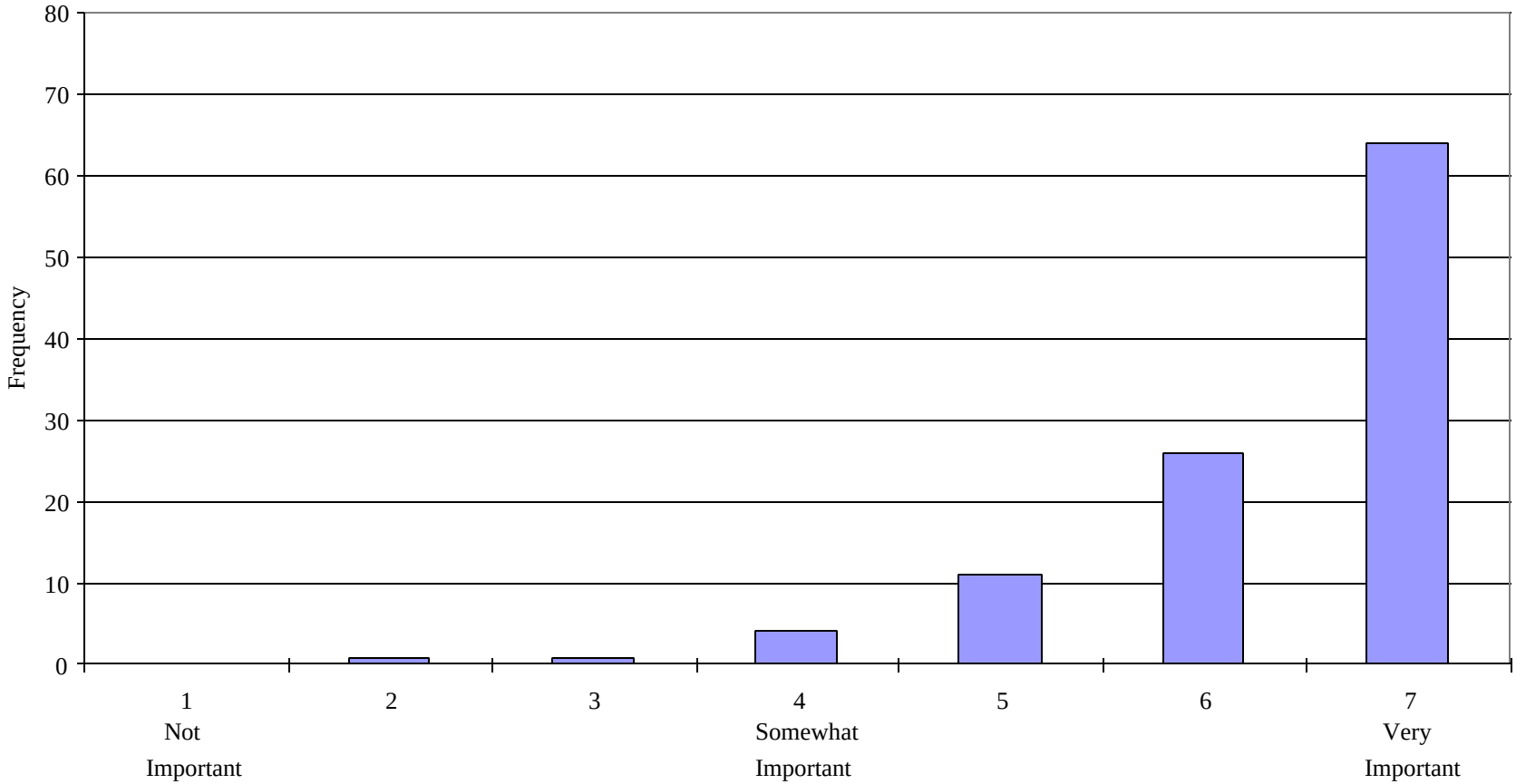

Figure 20. Frequency distribution of companies responding to the importance of continued promotion of 2x4 technology.

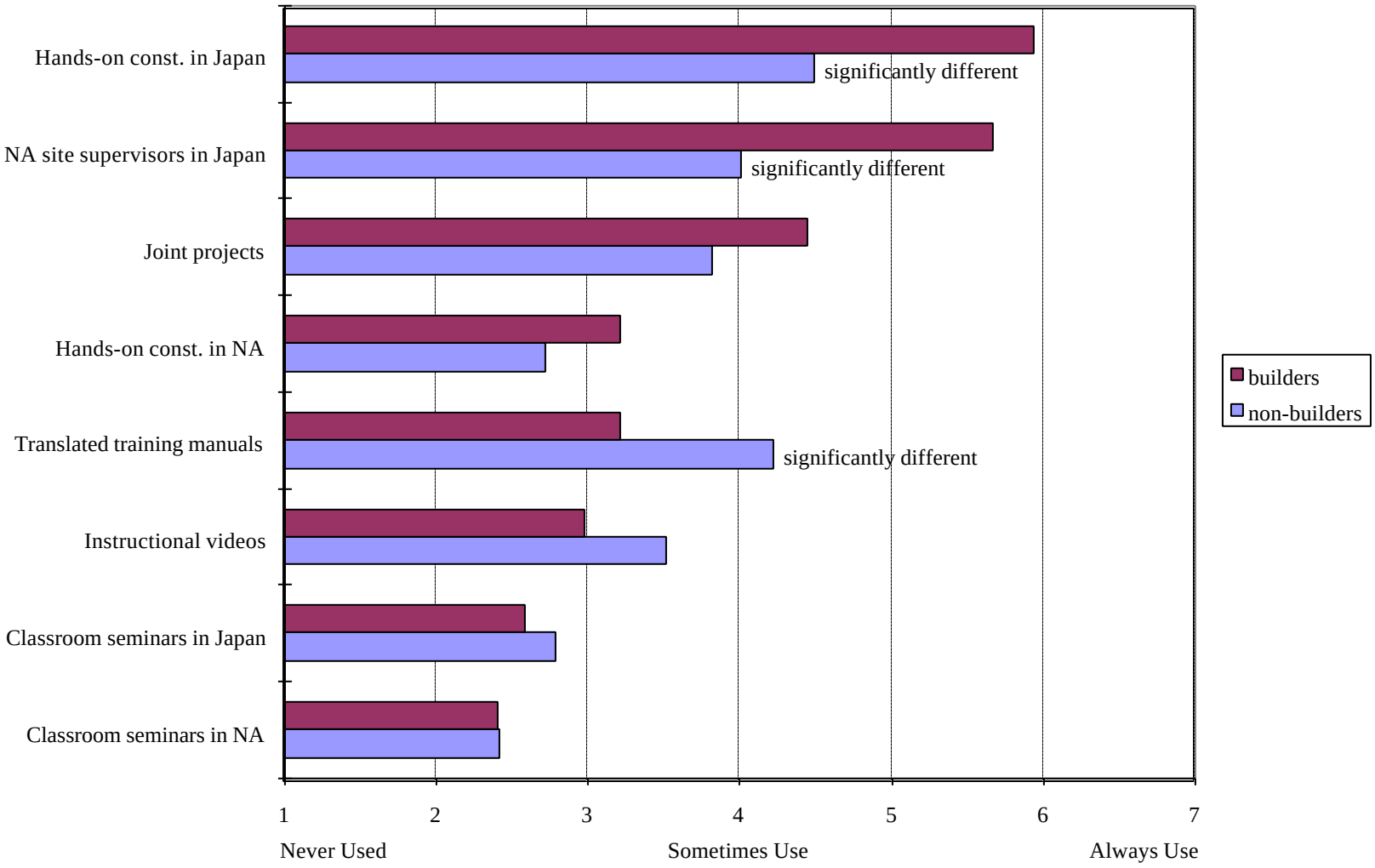

Figure 21. Difference in opinion in mean use rating for technical assistance strategies between builders and non-builders.

Table 14. Mean rating of strategies used by North American companies to provide technical assistance to Japanese construction professionals.

Strategy	Mean rating	Group rating	Rarely (-), Sometimes (=), or Always (+)
Hands-on construction in Japan	5.04		+
NA site supervisors in Japan	4.63	4.15	+
Joint projects with NA and Japanese carpenters	4.05		=
Hands-on construction in NA	2.90		-
Translated training manuals	3.84		=
Instructional videos	3.31	3.52	-
Classroom seminars in Japan	2.71		-
Classroom seminars in NA	2.41		-

Japanese customers in general than are non-builders. Also, builders tend to develop more interactive training programs in comparison to non-builders, who rely more on passive technical training strategies. For example, the use ratings for interactive training strategies differed substantially between builders (4.87) and non-builders (3.78). While much of this difference can probably be attributed to the nature of each group's business activities in Japan, the fact remains that builders appear to be much more involved and active in developing and implementing interactive technical training programs for their Japanese customers.

Survey respondents were then asked to evaluate the effectiveness of their technical training (Table 15). While all of the strategies were considered at least somewhat effective, three strategies were considered to be substantially more effective than the others. The most effective strategies were perceived to be hands-on construction in Japan (6.24), using North American site supervisors in Japan (5.91), and joint projects utilizing both Japanese and North American carpenters (5.89). Interestingly, the four strategies that were perceived to be most effective in providing technical training were all interactive programs, whereas the four strategies receiving the lowest ratings tended to be passive programs (Table 19). In comparing the perceived effectiveness of the interactive versus passive training programs, survey respondents felt that the interactive programs would be much more effective in promoting technical transfer (5.82) than would the passive training methods (4.46).

Table 15. Mean rating of the effectiveness of strategies used for providing technical assistance.

Strategy	Mean rating	Group rating	Not Effective (-), Somewhat (=), or Very (+)
Hands-on construction in Japan	6.24		+
NA site supervisors in Japan	5.91	5.82	+
Joint projects with NA and Japanese carpenters	5.89		+
Hands-on construction in NA	5.23		+
Instructional videos	4.62		+
Translated training manuals	4.58	4.46	+
Classroom seminars in Japan	4.50		+
Classroom seminars in NA	4.15		=

An open-ended question was also asked regarding the single most effective strategy for transferring 2x4 construction technology to Japanese construction industry professionals. The strategy mentioned the most frequently by companies (19.8%) was hands-on construction (Figure 23).

The survey data further suggests that builders and non-builders have similar perceptions regarding the effectiveness of different technical transfer strategies (Figure 22). For example, builders provided interactive training strategies an effectiveness rating of 5.95 relative to an effectiveness rating of 5.72 for non-builders, indicating that both groups perceive action-oriented programs to be very effective. In contrast, both groups felt that more passive programs would be less effective in providing technical training, with builders giving these programs an effectiveness rating of 4.3 relative to a rating of 4.6 for non-builders. When asked to list the single most effective strategy for achieving technical transfer, 71% of the respondents indicated some type of hands-on training (Figure 23). There seems to be a clear perception that technical transfer is most effective when the training activity involves hands on, interactive training in an actual construction environment.

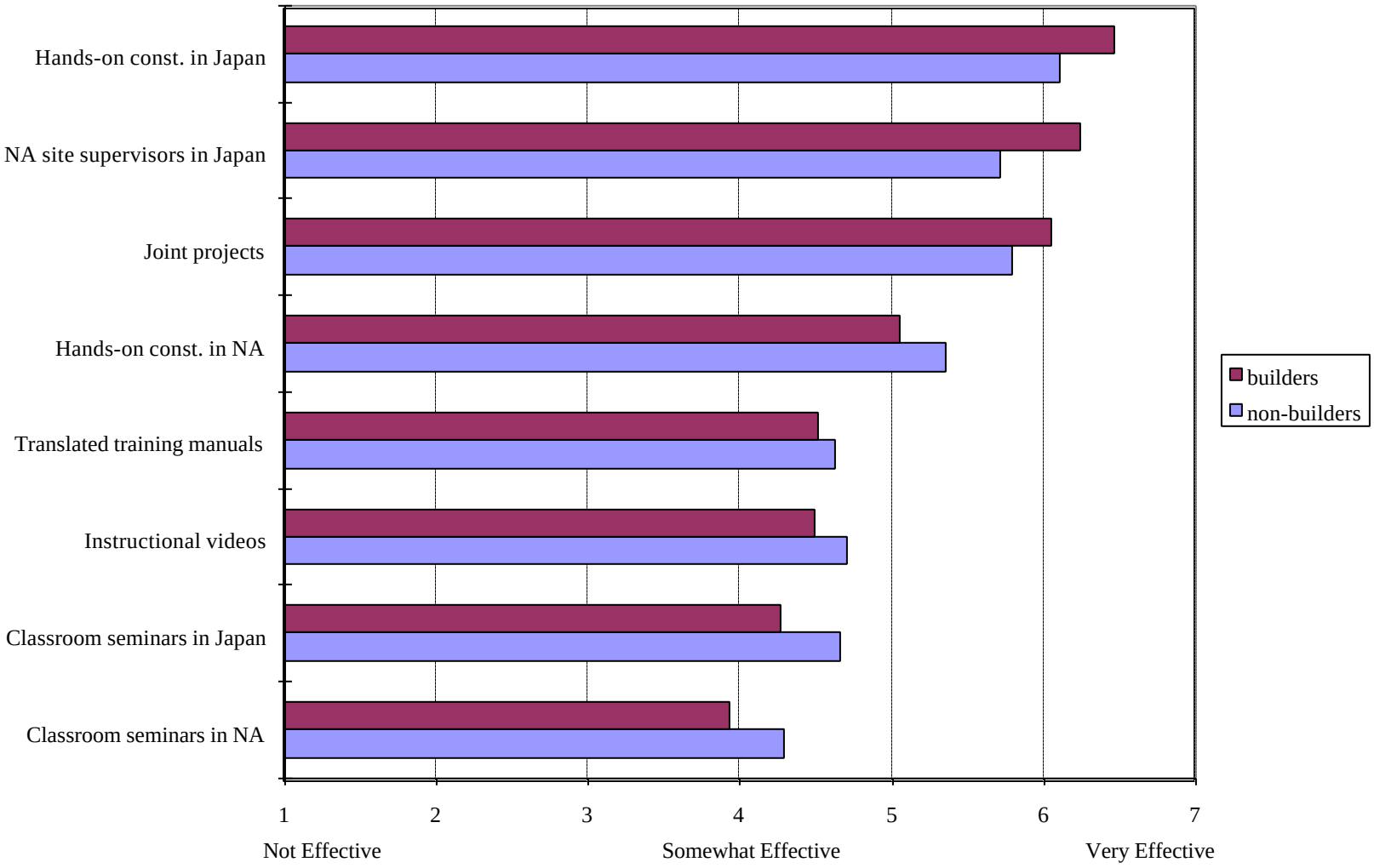

Figure 22. Difference in opinion in mean effectiveness rating for strategies used for providing technical assistance between builders and non-builders.

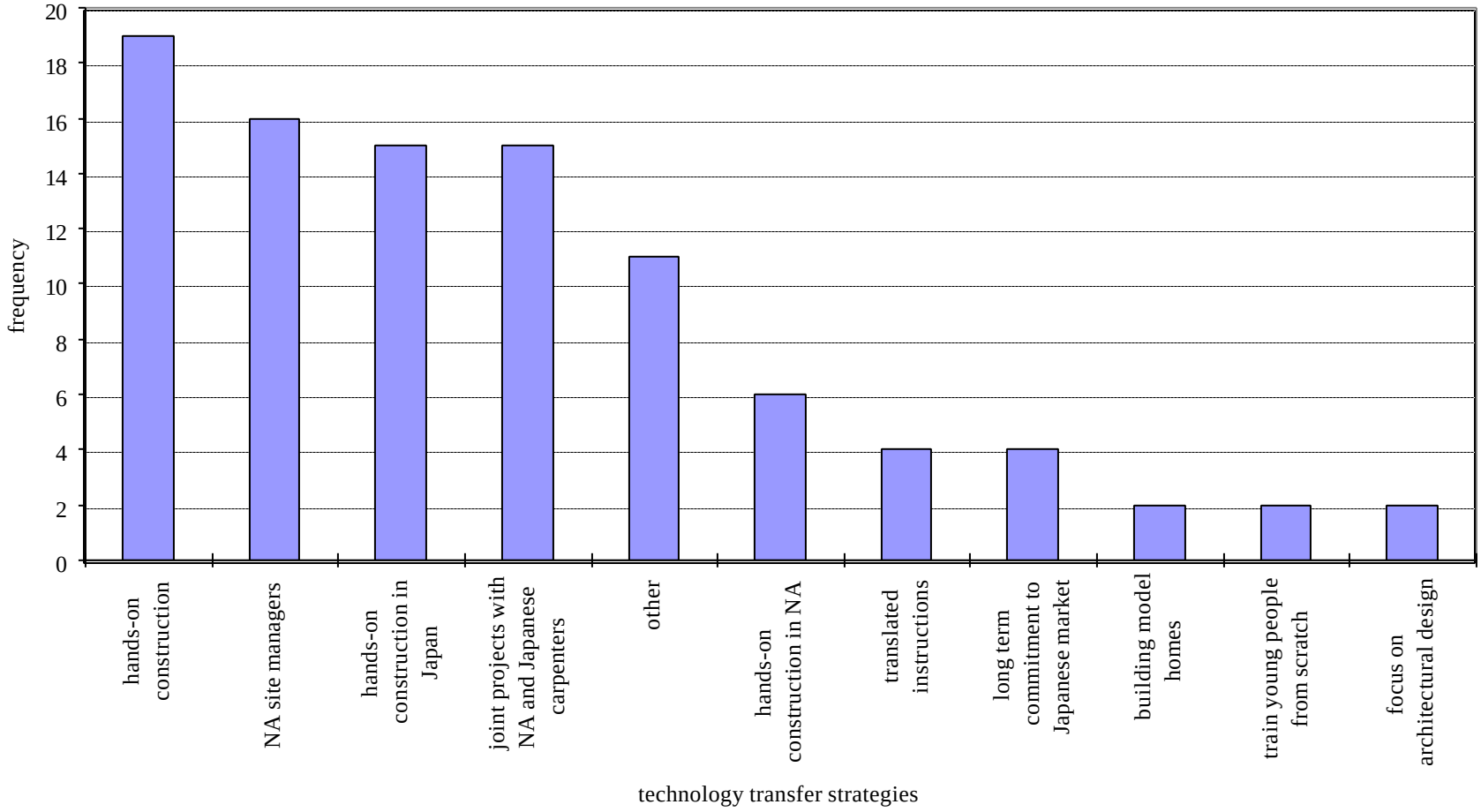

Figure 23. The single most effective strategy for technology transfer to Japanese construction industry professionals.

The Most Important Professionals To Target Technology Transfer Programs: The respondents were asked to identify important Japanese construction industry professionals who should be the focus for technology transfer programs. They ranked the importance of six groups of professionals (Table 16). All the groups had mean ratings which were considered to be significantly higher than the neutral value of 4. It appears that the groups doing the actual construction are the most important. These groups include contractors, carpenters, architects, and home building companies.

Table 16. Mean importance rating of professionals receiving technical assistance.

Professional	Mean	SD	Not Important (-), Somewhat (=), or Very (+)
Contractors	6.30	1.04	+
Carpenters	6.25	1.08	+
Architects	6.07	1.26	+
Home building companies	5.75	1.43	+
MOC officials	4.95	1.94	+
Industry associations	4.63	1.62	+

However, based on the relative values of the mean rankings it would appear that construction professionals who are actively involved in construction activities are considered to be the most important targets of technical training programs. An analysis of the survey data by builders versus non-builders indicates that the rankings are very similar for both groups.

Effectiveness Rating Of Organizations Involved With Transferring 2x4 Construction Technology: Having identified which types of technical transfer strategies are most important, as well as the target recipients of technical training programs, we next sought to identify groups perceived to be most effective in delivering technical transfer programs to Japanese construction professionals. Survey respondents were asked to evaluate the effectiveness of 13 organizations located in both North America and Japan in providing technical transfer programs to Japanese construction professionals (Table 17). The results show that North American construction companies, North American building products suppliers and Japanese construction companies were perceived to be most effective in promoting technology transfer. The organizations that were rated as being least effective in promoting technology transfer were Japanese building products suppliers, North American colleges, and Japanese colleges. The remaining organizations were perceived to be somewhat effective in conducting technical transfer activities.

Table 17. Mean effectiveness rating of organizations involved with 2x4 technology transfer.

Effectiveness rating	Mean rating	Not Effective (-), Somewhat (=), or Very (+)
NA construction companies	5.04	+
NA building products suppliers	4.79	+
Japanese construction companies	4.54	+
NA industry associations	4.26	=
NA State/Provincial government agencies	4.19	=
Japanese architects	3.88	=
NA Federal government agencies	3.87	=
NA architects	3.85	=
Japanese industry associations	3.80	=
Japanese government agencies	3.71	=
Japanese building products suppliers	3.51	-
NA colleges	3.16	-

Respondents also clearly felt that North American organizations would be more effective in conducting technology transfer programs than their Japanese counterparts, with the singular exception of Japanese construction companies. Interestingly, North American architects were the only group of construction professionals who were rated as being less effective in providing technical transfer programs. Finally, respondents clearly felt that universities and colleges in both North America and Japan would not be particularly effective in providing technical training programs to Japanese construction professionals.

Figure 24 presents the differences in opinions between builders and non-builders. Builders rated North American construction companies as being significantly more effective in conducting technology transfer programs relative to

any other group or organization. In contrast, non-builders did not perceive that any single organization was very effective in conducting technical transfer programs. Rather, they felt that a broad range of organizations were somewhat effective. The interesting point here is that builders clearly felt that they would be the single most effective organization for providing technical transfer programs while non-builders favored a broad mix including North American builders, North American building material exporters, and Japanese builders. In addition, an open ended question was asked to identify the single organization that was perceived to be most effective at transferring North American 2x4 construction technology to Japanese construction industry professionals. The organizations mentioned the most frequently were North American construction companies (31.5%) and North American industry associations (19%) (Figure 25).

The Importance Rating Of Various Market Factors In Restricting Exports Of 2x4 Houses to Japan: The respondents were asked to rate the importance of 20 market variables that can influence the competitiveness of North American building materials and imported house exports to Japan. The average importance ratings for each of the 20 factors are presented in Table 18. All but three of the market factor ratings were found to be significantly different from the scale midpoint, so they were all perceived to be important in restricting the export potential of 2x4 houses and building materials from North America. A lack of builder and carpenter familiarity with imported building materials and 2x4 construction technology were the highest rated factors. In fact, all seven of the factors related to Japanese construction professionals familiarity with, and understanding of, North American-style 2x4 construction technology and building materials received the highest importance ratings. This is a strong indication that North American builders and consolidators perceive technology transfer to be a critical factor restricting the future growth of the industry in Japan. In comparing the mean responses for builders and non-builders, few new trends were observed. We can conclude that the two groups are quite similar in their responses (Figure 22).

Table 18. Mean importance rating of market factors restricting the export of 2x4 houses to Japan.

Importance rating	Mean rating	Not Important (-), Somewhat (=), or Very (+)
Lack of builder familiarity with imported building materials	6.00	+
Lack of carpenter familiarity with 2x4 construction technology	5.96	+
Lack of builder familiarity with 2x4 construction technology	5.91	+
Lack of carpenter familiarity with imported building materials	5.90	+
Lack of trained carpenters	5.86	+
Lack of architect familiarity with imported building materials	5.82	+
Lack of architect familiarity with 2x4 construction technology	5.77	+
Fluctuating exchange rates	5.54	+
Japanese building codes	5.41	+
Difficulty of obtaining spare parts for imported products	5.29	+
High transportation costs within Japan	5.23	+
Difficulty of obtaining work visas for NA workers	4.95	+
Complex distribution channels for imported building materials	4.87	+
Well-established Japanese post and beam construction industry	4.76	+
High labor costs	4.53	+
Lack of lifetime warranty	4.53	+
Lack of local suppliers for imported building materials	4.52	+
Japanese consumer perception that 2x4 houses are poor quality	4.30	=
2x4 houses not meeting cultural needs of Japanese homeowner	3.74	=
2x4 housing is just a trend that will fade	2.99	-

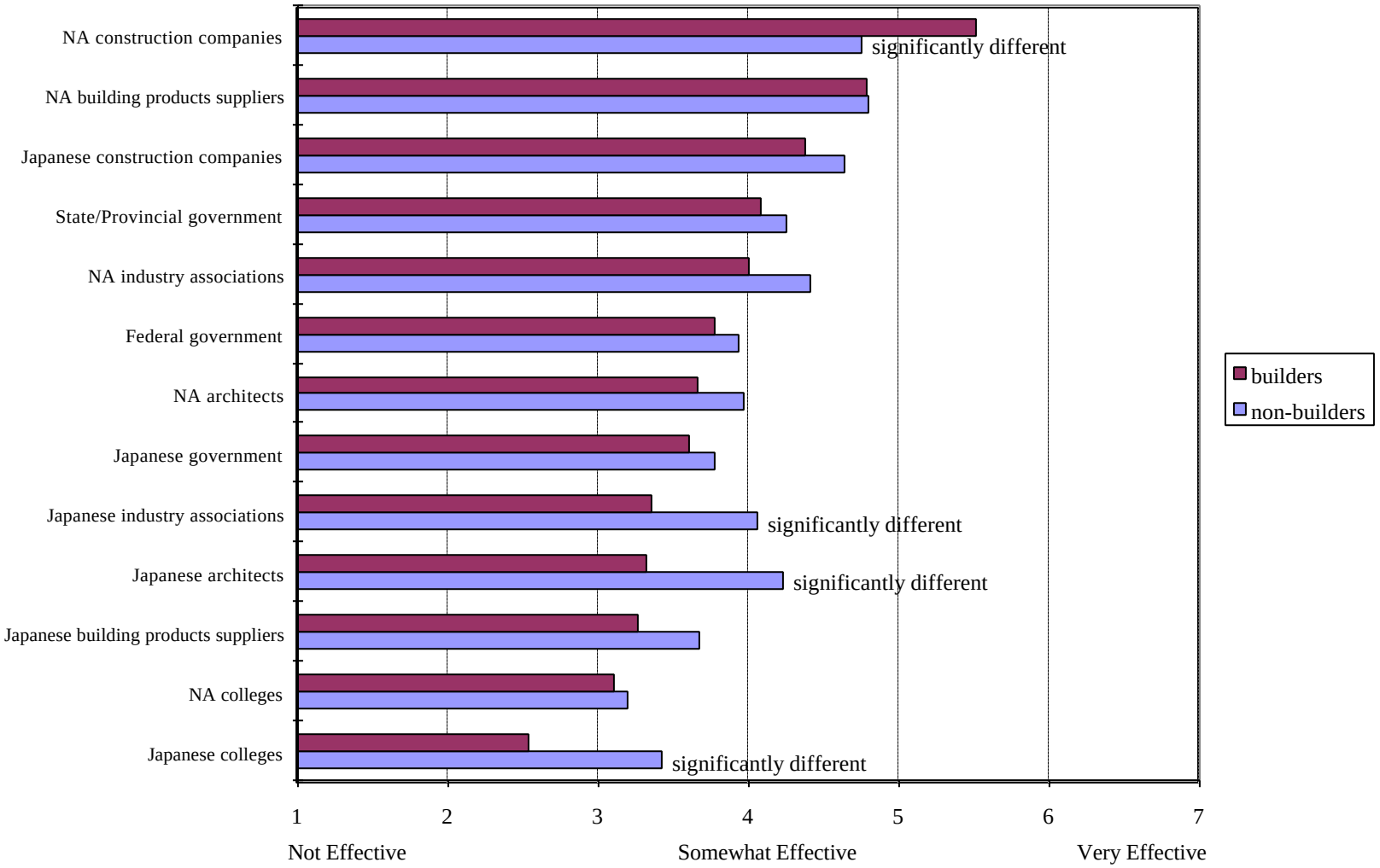

Figure 24. Difference in opinion in effectiveness of organizations involved with 2x4 technology transfer between builders and non-builders.

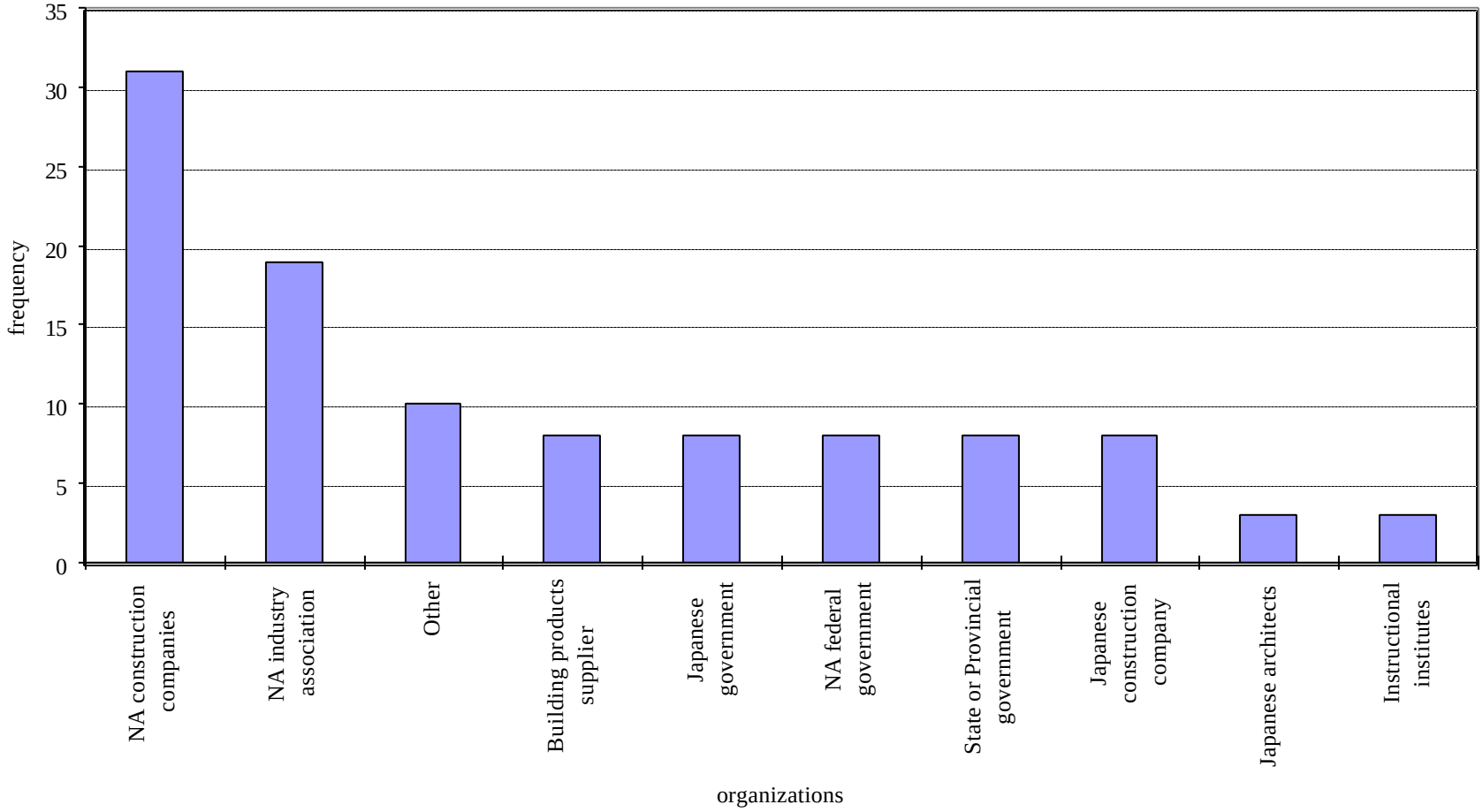

Figure 25. Which organization would be most effective at transferring NA 2x4 technology.

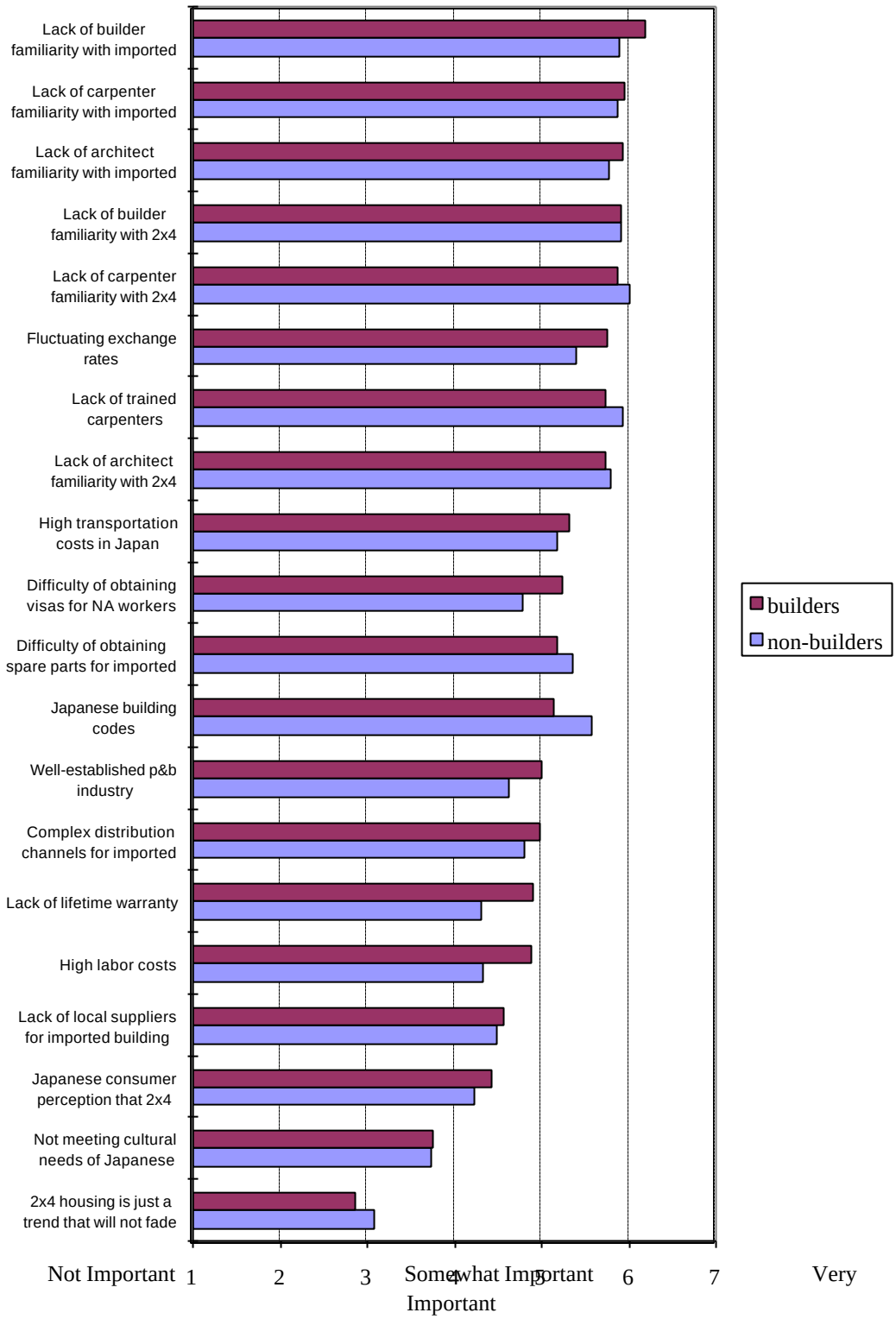

Figure 26. Difference in opinion in importance of market factors restricting the export of 2x4 houses to Japan between builders and non-builders.

A factor analysis was conducted on the survey data to determine if a smaller number of factors could be used to describe the information represented by the original twenty variables. The factor analysis showed that the original 20 variables can be represented by just 6 factors which account for 65% of the variability contained in the original survey data. The 6 factors, and the variables contained within each, are summarized in Table 19. To help better analyze the relationship between the six factors and the average importance ratings for the individual variables contained within each factor were included as well. The analysis clearly indicates that two factors (poor technical understanding and incomplete architectural training) have a substantially greater impact on restricting the

Table 19. Summary of factor analysis solution and the factor loading scores for market factors restricting the export of 2x4 houses to Japan.

		Rotated Discriminant Function Loading Scores					
Importance rating of restrictive factors	**Mean**	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 5**	**Factor 6**
Lack of carpenter familiarity with imported building materials	5.90	**0.861**	0.096	-0.007	0.193	0.161	-0.141
Lack of builder familiarity with imported building materials	6.00	**0.819**	0.016	0.006	0.186	0.241	-0.131
Lack of carpenter familiarity with 2x4 construction technology	5.96	**0.762**	0.100	0.109	-0.229	0.249	0.159
Lack of builder familiarity with 2x4 construction technology	5.91	**0.739**	0.148	0.106	-0.279	0.332	0.131
Lack of trained carpenters	5.86	**0.588**	-0.085	-0.029	0.173	0.040	0.420
Not meeting cultural needs of Japanese homeowner	3.74	0.136	**0.830**	0.017	0.063	-0.034	0.049
2x4 housing is just a trend that will not fade	2.99	-0.015	**0.763**	0.018	-0.008	0.027	0.149
Japanese consumer perception that 2x4 houses are poor quality	4.30	0.048	**0.753**	0.137	0.253	0.108	-0.063
Lack of lifetime warranty	4.53	-0.008	**0.516**	0.156	0.304	0.259	0.177
Lack of local suppliers for imported building materials	4.52	0.187	0.107	**0.808**	0.053	-0.133	0.043
Difficulty of obtaining spare parts for imported products	5.29	0.132	-0.017	**0.767**	0.067	0.149	-0.001
Complex distribution channels for imported building materials	4.87	-0.063	0.164	**0.733**	0.071	-0.059	0.259
Well-established p&b industry	4.76	-0.303	0.014	**0.526**	0.046	0.261	0.046
High transportation costs in Japan	5.23	0.095	0.261	0.164	**0.698**	-0.062	0.193
Japanese building codes	5.41	-0.125	0.042	0.085	**0.690**	0.197	-0.149
Fluctuating exchange rates	5.54	0.133	0.096	-0.041	**0.577**	-0.133	0.349
Lack of architect familiarity with 2x4 construction technology	5.77	0.252	0.032	0.089	-0.249	**0.815**	0.127
Lack of architect familiarity with imported building materials	5.82	0.232	0.080	-0.071	0.331	**0.787**	0.000
High labor costs	4.53	-0.102	0.254	-0.023	-0.013	0.117	**0.725**
Difficulty of obtaining visas for NA workers	4.95	0.040	-0.064	0.232	0.104	0.025	**0.662**
Mean	**5.09**	**5.93**	**3.89**	**4.86**	**5.39**	**5.80**	**4.74**

competitiveness of North American-style 2x4 housing and building material imports in Japan. The six factors that were derived from the factor analysis were identified as being:

Factor 1: Poor technical training
Factor 2: Cultural bias
Factor 3: Domestic competitive factors
Factor 4: Institutional barriers
Factor 5: Incomplete architectural training
Factor 6: Labor factors

The average importance rating for Factor 1 (poor technical training) was 5.93 while Factor 5 (incomplete architectural training) had an average importance rating of 5.80. Factor 1 included five variables, all related to the fact that Japanese construction professionals are often unfamiliar with North American-style 2x4 construction technology and building materials. The second most important factor (incomplete architectural training) had an average importance rating of 5.80 and included two variables. It is obvious that an effective technical training program for Japanese construction professionals could be critical in overcoming what are perceived to be the two biggest factors restricting the export of North American-style 2x4 homes and building materials into Japan.

CONCLUSIONS AND RECOMMENDATIONS

Several studies conducted by CINTRAFOR have clearly illustrated the fact that many Japanese builders, carpenters and architects do not possess a strong technical understanding of the North American-style 2x4 construction system. As a result, many of the 2x4 homes constructed in Japan, whether using North American or Japanese construction methods, were found to have a wide variety of structural and non-structural deficiencies. These deficiencies seriously reduce both the structural and the long-term performance of 2x4 homes in Japan. This research project was undertaken to develop a better understanding of how North American companies are responding to this problem. The specific objectives of this research were to:

1. identify what types of technical transfer programs are currently being undertaken by North American builders and exporters in Japan,
2. determine what types of programs are perceived to be most effective in promoting understanding of 2x4 construction technology,
3. identify what group would be most effective in conducting technical training programs,
4. identify who should be the target audience for these technical programs, and
5. assess how a lack of technical understanding of the North American construction system has restricted the market growth of 2x4 homes in Japan relative to other non-technical types of barriers.

This study clearly showed that North American builders and export consolidators feel that many Japanese construction professionals (*i.e.*, carpenters, builders, and architects) do not possess a strong technical understanding of the North American-style 2x4 construction system. This perceived lack of technical understanding was corroborated in several areas of the project and was strongly reinforced by the results of the factor analysis. In most cases there was general agreement between firms in different industry segments (*e.g.*, builders and non-builders, and US and Canadian firms) as to the extent of the problem and the effectiveness of specific strategies in addressing the problem.

Survey respondents reported that many Japanese construction professionals have at best an average understanding of the North American-style 2x4 construction technology. The areas where this deficiency in technical knowledge was perceived to be greatest include drywall installation, architectural design, and ventilation. Other areas of concern included structural framing, insulation, and foundations. To a certain extent, this lack of technical knowledge is offset by the fact that North American firms tend to emphasize their technical training programs in those areas where they perceive that Japanese construction professionals have a weak technical understanding (Table 20).

Survey respondents felt that the most effective strategies for achieving technology transfer in Japan consisted of hands-on, interactive construction-related activities. The survey data showed these types of activities were not only

Table 20. Respondents' perception of Japanese construction professionals' understanding of 2x4 construction technology relative to the types of information emphasized in their technical training programs.

	Japanese Understanding (average rating)	Technical Program Emphasis (average rating)
Framing	4.03	5.75
Windows	4.66	5.18
Architectural design	3.58	5.08
Doors	4.70	4.97
Insulation	4.01	4.94
Stairs	4.19	4.77
Ventilation	3.31	4.70
Drywall	3.16	4.67
Weatherproofing	4.43	4.66
Exterior finish	4.61	4.59
Flooring	4.88	4.53
Interior carpentry	5.01	4.47
Roofing	4.96	3.72
Foundation	4.10	3.25

perceived to be more effective than more passive programs, but respondents reported that they tended to use these types of programs more often than more passive programs. This was particularly true for those respondents who fell into the builder classification and who are actively involved in construction projects in Japan. The types of technical training programs that were perceived to be most effective included: hands-on construction in Japan, using North American site supervisors in Japan, and joint projects that involved US and Japanese carpenters. Classroom seminars, translated technical manuals, and instructional videos were perceived to be less effective types of activities. While the perceived effectiveness of the group of interactive, hands-on programs was significantly higher than the group of passive programs, this difference was relative and the overall rating for the passive programs suggests that they are perceived as being somewhat effective. Thus we can conclude that passive training programs provide useful support to interactive, hands-on activities.

Survey respondents also had clear preferences on what groups would be most effective in delivering technical transfer programs and who the audience for these programs should be. With respect to what group would be most effective in delivering technical transfer training programs, two groups (North American builders and building material exporters) received substantially higher ratings than the other 11 groups evaluated. While survey respondents felt that technical transfer training programs should be directed to all industry related groups in Japan, they provided substantially higher scores for Japanese construction professionals (builders, carpenters, and architects). These results clearly show that North American builders and exporters feel that the most effective strategy for achieving technical transfer of the North American 2x4 construction system is through hands-on training programs delivered by North American builders and targeted towards Japanese construction professionals.

Finally, survey respondents were asked to evaluate the impact that twenty different variables had on restricting the market growth of the North American-style 2x4 construction system in Japan. The variables included in the survey ranged from technical knowledge of the 2x4 construction system to non-tariff barriers. The seven highest rated variables all related to a lack of understanding of North American construction methods or building materials on the part of many Japanese construction professionals. These variables collectively received an importance rating that was substantially higher than all other factors (5.88); individually their importance rating ranged between 5.77 and 6.00

A factor analysis reduced the original 20 variables to just 6 factors, of which the two most important were found to consist entirely of variables related to technology transfer. These two factors were rated by respondents as having the greatest adverse impact on market opportunities for North American-style 2x4 homes and building materials in Japan. While the other factors were also perceived to restrict market opportunities, the average importance rating for the two technical transfer factors (5.93 for builder training and 5.80 for architect training) were significantly higher than the average importance ratings of the other factors.

North American builders and building material exporters perceive that many Japanese construction professionals do not have strong technical understanding of the North American-style 2x4 construction technology. The vast majority of respondents indicated that they have developed technical training programs for their Japanese customers.

However, several recent technical assessments of 2x4 construction projects in Japan suggest that this lack of technical understanding and the extent of technical deficiencies in 2x4 homes built in Japan is much greater than North American builders and building material exporters are aware. It is time for North American builders and building materials exporters to work with the Japanese construction associations to develop a comprehensive technical training program to ensure that 2x4 homes are built correctly in Japan. The recently-passed Housing Quality Assurance and House Inspection Laws further emphasize the need for a comprehensive and effective 2x4 technology transfer training program. The alternative, sporadic and uncoordinated technical transfer programs provided by individual companies, will not lead to the effective and widespread transfer of the North American-style 2x4 construction technology in Japan. Ultimately, it is in the best interest of North American and Japanese companies to ensure that 2x4 homes are built properly in Japan. Otherwise, consumer perceptions that 2x4 homes in Japan are inferior in terms of overall quality or long-term performance, relative to other types of housing technologies, will lead to the decline of this important segment of the residential construction market in Japan.

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APPENDIX A: SURVEY QUESTIONNAIRE AND COVER LETTERS

Survey for US companies

Center for International Trade in Forest Products

JAPAN 2x4 RESIDENTIAL HOUSING TECH TRANSFER SURVEY

1. Have you ever been involved in a North American-style 2x4 construction project in Japan that employed Japanese construction industry professionals?

   ☐ **Yes** **Please continue to question 2 and complete the survey**
   ☐ **No** **Please return the blank survey in the enclosed envelope. Thank you.**

2. How would you rate the **quality** of a 2x4 house built by Japanese construction industry professionals compared with North American standards? (*please choose the quality level from 1 to 7*)

	Poor			Average			High
Quality of structure	1	2	3	4	5	6	7
Quality of design	1	2	3	4	5	6	7
Overall quality	1	2	3	4	5	6	7

3. In your opinion, how well do Japanese contractors **understand** the following components of **North American** 2x4 construction technology? (*please circle only one number for each component*)

	No Understanding			Some Understanding			Full Understanding
Foundation	1	2	3	4	5	6	7
Framing	1	2	3	4	5	6	7
Insulation	1	2	3	4	5	6	7
Drywall	1	2	3	4	5	6	7
Doors	1	2	3	4	5	6	7
Windows	1	2	3	4	5	6	7
Stairs	1	2	3	4	5	6	7
Flooring	1	2	3	4	5	6	7
Interior carpentry	1	2	3	4	5	6	7
Exterior finishing	1	2	3	4	5	6	7
Weatherproofing	1	2	3	4	5	6	7
Ventilation	1	2	3	4	5	6	7
Roofing	1	2	3	4	5	6	7
Architectural Design	1	2	3	4	5	6	7
Other (*please specify*): _____	1	2	3	4	5	6	7

4. Which components does your company **emphasize** when providing technical assistance to Japanese construction industry professionals? (*please circle only one number for each component*)

	No Emphasis			Some Emphasis			Much Emphasis
Foundation	1	2	3	4	5	6	7
Framing	1	2	3	4	5	6	7
Insulation	1	2	3	4	5	6	7
Drywall	1	2	3	4	5	6	7
Doors	1	2	3	4	5	6	7
Windows	1	2	3	4	5	6	7
Stairs	1	2	3	4	5	6	7
Flooring	1	2	3	4	5	6	7
Interior carpentry	1	2	3	4	5	6	7
Exterior finishing	1	2	3	4	5	6	7
Weatherproofing	1	2	3	4	5	6	7
Ventilation	1	2	3	4	5	6	7
Roofing	1	2	3	4	5	6	7
Architectural Design	1	2	3	4	5	6	7

Other (*please specify*): _____	1	2	3	4	5	6	7

5. In your opinion, what is the **one component** that Japanese construction industry professionals have the **weakest understanding** of: _____

6. North American 2x4 houses were first introduced to Japan in 1974. In your opinion, how **important** are **continued efforts** of promoting North American 2x4 construction technology? (*please choose the importance from 1 to 7*)

Not Important						Somewhat Important	Very Important
1	2	3	4	5	6	7	

7. Which of the following strategies has your company **used** for providing technical assistance in 2x4 construction technology to Japanese construction industry professionals? (*please circle only one number for each strategy*)

	Never Used			Sometimes Use			Always Use
Translated training manuals	1	2	3	4	5	6	7
Instructional videos	1	2	3	4	5	6	7
Classroom seminars in Japan	1	2	3	4	5	6	7
Classroom seminars in US	1	2	3	4	5	6	7
Hands-on construction in Japan	1	2	3	4	5	6	7
Hands-on construction in US	1	2	3	4	5	6	7
Joint projects with US and Japanese carpenters	1	2	3	4	5	6	7
US site supervisors in Japan	1	2	3	4	5	6	7
Other (*please specify*): _____	1	2	3	4	5	6	7

8. In your opinion, how **effective** are the following strategies for providing technical assistance in 2x4 construction technology to Japanese construction industry professionals? (*please circle only one number for each strategy*)

	Not Effective			Somewhat Effective			Very Effective
Translated training manuals	1	2	3	4	5	6	7
Instructional videos	1	2	3	4	5	6	7
Classroom seminars in Japan	1	2	3	4	5	6	7
Classroom seminars in US	1	2	3	4	5	6	7
Hands-on construction in Japan	1	2	3	4	5	6	7
Hands-on construction in US	1	2	3	4	5	6	7
Joint projects with US and Japanese carpenters	1	2	3	4	5	6	7
US site supervisors in Japan	1	2	3	4	5	6	7
Other (*please specify*): _____	1	2	3	4	5	6	7

9. In your opinion, what is the **single** most effective strategy for transferring North American 2x4 construction technology to Japanese construction industry professionals?

_____

10. In your opinion, how **important** is it for 2x4 technology transfer training programs to focus on the following Japanese construction industry professionals? (*please circle only one number per group)*

	Not Important				Somewhat Important		Very Important
Carpenters	1	2	3	4	5	6	7
Contractors	1	2	3	4	5	6	7
Architects	1	2	3	4	5	6	7
Home building companies	1	2	3	4	5	6	7
Industry associations	1	2	3	4	5	6	7

MOC officials	1 2 3 4 5 6 7
Other (*please specify*): _____	1 2 3 4 5 6 7

11. In your opinion, how **effective** are each of the following organizations in transferring North American 2x4 construction technology to Japanese construction industry professionals. (*please circle one number for each organization*)

	Not Effective			Somewhat Effective			Very Effective
US Federal government agencies	1	2	3	4	5	6	7
US State government agencies	1	2	3	4	5	6	7
Japanese government agencies	1	2	3	4	5	6	7
US industry associations	1	2	3	4	5	6	7
Japanese industry associations	1	2	3	4	5	6	7
US construction companies	1	2	3	4	5	6	7
Japanese construction companies	1	2	3	4	5	6	7
US building products suppliers	1	2	3	4	5	6	7
Japanese building products suppliers	1	2	3	4	5	6	7
US architects	1	2	3	4	5	6	7
Japanese architects	1	2	3	4	5	6	7
US colleges	1	2	3	4	5	6	7
Japanese colleges	1	2	3	4	5	6	7
Other (*please specify*): _____	1	2	3	4	5	6	7

12. In your opinion, which 2 organizations would be **most effective** at **transferring** North American 2x4 construction technology to Japanese construction industry professionals?

1) _____
2) _____

13. How **important** are the following factors in restricting the export potential of North American 2x4 houses and building materials in the Japanese residential construction market? (*please circle only one number per factor)*

	Not Important			Somewhat Important			Very Important
Lack of carpenter familiarity with imported building materials	1	2	3	4	5	6	7
Lack of builder familiarity with imported building materials	1	2	3	4	5	6	7
Lack of architect familiarity with imported building materials	1	2	3	4	5	6	7
Lack of carpenter familiarity with 2x4 construction technology	1	2	3	4	5	6	7
Lack of builder familiarity with 2x4 construction technology	1	2	3	4	5	6	7
Lack of architect familiarity with 2x4 construction technology	1	2	3	4	5	6	7
Lack of trained carpenters	1	2	3	4	5	6	7
High labor costs	1	2	3	4	5	6	7
Difficulty of obtaining work visas for US workers	1	2	3	4	5	6	7
Well-established Japanese post and beam construction industry	1	2	3	4	5	6	7
Japanese building codes	1	2	3	4	5	6	7
High transportation costs within Japan	1	2	3	4	5	6	7
Complex distribution channels for imported building materials	1	2	3	4	5	6	7
Lack of local suppliers for imported building materials	1	2	3	4	5	6	7
Difficulty of obtaining spare parts for imported products	1	2	3	4	5	6	7
Japanese consumer perception that 2x4 houses are poor quality	1	2	3	4	5	6	7
Lack of lifetime warranty	1	2	3	4	5	6	7
2x4 houses not meeting cultural needs of Japanese homeowner	1	2	3	4	5	6	7
2x4 housing is just a trend that will fade	1	2	3	4	5	6	7
Fluctuating exchange rates	1	2	3	4	5	6	7
Other (*please specify*): _____	1	2	3	4	5	6	7

14. In your opinion, what is the **single** most important factor restricting the continued growth of the North American 2x4 house segment of the Japanese residential construction market?

_____

COMPANY DEMOGRAPHICS (USED FOR STATISTICAL PURPOSES ONLY)

15. What is your job title (or position) within your company? _____

16. What is your company's primary line of business? (*please check only one box*)

☐ Construction company
☐ General contractor
☐ Architect
☐ Manufacturer
☐ Building products consolidator
☐ Export trading company
☐ Wholesaler
☐ Other (*please specify*): _____

17. Please estimate your company's total sales revenue for 1997 in ☐ US $ or ☐ Canadian $

☐ Less than $500,000
☐ $500,000 - $1,000,000
☐ $1,000,001 - $5,000,000
☐ $5,000,001 - $10,000,000
☐ $10,000,001 - $25,000,000
☐ $25,000,001 - $50,000,000
☐ More than $50,000,000

18. What percentage of your total sales revenue is derived from business in Japan? ____ %

19. How long has your company been involved in the 2x4 housing industry? ____ Years

20. How long has your company been involved in the 2x4 housing industry in Japan? ____ Years

21. In 1997, how many 2x4 housing projects were your company involved in? ____ Total # ____ Total # in Japan

22. How many 2x4 housing units **in total** has your company been involved with **in Japan**?

☐ Less than 10
☐ 10 - 25
☐ 26 - 50
☐ 51 - 100
☐ 101 - 200
☐ 201 - 500
☐ 501 - 1000
☐ More than 1000

23. How many employees are at your company? ____ Total
____ In Japan office
____ Japanese speaking employees

24. How many employees have experience **working in Japan** on 2x4 housing projects? ____ Employees

25. Approximately what percentage of your projects in Japan are contracted using the following sources? (*total should add up to 100%*)

_____ % Directly from home-owner
_____ % From architecture company
_____ % Sub-contracted from another company
_____ % Other (*please specify*): _____
100 % Total

THANK YOU VERY MUCH *for participating in this CINTRAFOR Research Study!* Please return the survey in the stamped addressed envelope provided. If you would like to receive a summary of the research results, please check the box and print your name and address on the back of the return envelope. ☐ **Please send me a copy of the research results.**

Survey for Canadian companies

Center for International Trade in Forest Products

JAPAN 2x4 RESIDENTIAL HOUSING TECH TRANSFER SURVEY

1. Have you ever been involved in a North American-style 2x4 construction project in Japan that employed Japanese construction industry professionals?

   ☐ **Yes** **Please continue to question 2 and complete the survey**
   ☐ **No** **Please return the blank survey in the enclosed envelope. Thank you.**

2. How would you rate the **quality** of a 2x4 house built by Japanese construction industry professionals compared with North American standards? (*please choose the quality level from 1 to 7*)

	Poor			Average			High
Quality of structure	1	2	3	4	5	6	7
Quality of design	1	2	3	4	5	6	7
Overall quality	1	2	3	4	5	6	7

3. In your opinion, how well do Japanese contractors **understand** the following components of **North American** 2x4 construction technology? (*please circle only one number for each component*)

	No Understanding			Some Understanding			Full Understanding
Foundation	1	2	3	4	5	6	7
Framing	1	2	3	4	5	6	7
Insulation	1	2	3	4	5	6	7
Drywall	1	2	3	4	5	6	7
Doors	1	2	3	4	5	6	7
Windows	1	2	3	4	5	6	7
Stairs	1	2	3	4	5	6	7
Flooring	1	2	3	4	5	6	7
Interior carpentry	1	2	3	4	5	6	7
Exterior finishing	1	2	3	4	5	6	7
Weatherproofing	1	2	3	4	5	6	7
Ventilation	1	2	3	4	5	6	7
Roofing	1	2	3	4	5	6	7
Architectural Design	1	2	3	4	5	6	7
Other (*please specify*): _____	1	2	3	4	5	6	7

4. Which components does your company **emphasize** when providing technical assistance to Japanese construction industry professionals? (*please circle only one number for each component*)

	No Emphasis			Some Emphasis			Much Emphasis
Foundation	1	2	3	4	5	6	7
Framing	1	2	3	4	5	6	7
Insulation	1	2	3	4	5	6	7
Drywall	1	2	3	4	5	6	7
Doors	1	2	3	4	5	6	7
Windows	1	2	3	4	5	6	7
Stairs	1	2	3	4	5	6	7
Flooring	1	2	3	4	5	6	7
Interior carpentry	1	2	3	4	5	6	7
Exterior finishing	1	2	3	4	5	6	7
Weatherproofing	1	2	3	4	5	6	7
Ventilation	1	2	3	4	5	6	7
Roofing	1	2	3	4	5	6	7
Architectural Design	1	2	3	4	5	6	7
Other (*please specify*): _____	1	2	3	4	5	6	7

5. In your opinion, what is the **one component** that Japanese construction industry professionals have the **weakest understanding** of: _____

6. North American 2x4 houses were first introduced to Japan in 1974. In your opinion, how **important** are **continued efforts** of promoting North American 2x4 construction technology? (*please choose the importance from 1 to 7*)

Not Important						Somewhat Important	Very Important
1	2	3	4	5	6	7	

7. Which of the following strategies has your company **used** for providing technical assistance in 2x4 construction technology to Japanese construction industry professionals? (*please circle only one number for each strategy*)

	Never Used			Sometimes Use			Always Use
Translated training manuals	1	2	3	4	5	6	7
Instructional videos	1	2	3	4	5	6	7
Classroom seminars in Japan	1	2	3	4	5	6	7
Classroom seminars in Canada	1	2	3	4	5	6	7
Hands-on construction in Japan	1	2	3	4	5	6	7
Hands-on construction in Canada	1	2	3	4	5	6	7
Joint projects with Canadian and Japanese carpenters	1	2	3	4	5	6	7
Canadian site supervisors in Japan	1	2	3	4	5	6	7
Other (*please specify*): _____	1	2	3	4	5	6	7

8. In your opinion, how **effective** are the following strategies for providing technical assistance in 2x4 construction technology to Japanese construction industry professionals? (*please circle only one number for each strategy*)

	Not Effective			Somewhat Effective			Very Effective
Translated training manuals	1	2	3	4	5	6	7
Instructional videos	1	2	3	4	5	6	7
Classroom seminars in Japan	1	2	3	4	5	6	7
Classroom seminars in Canada	1	2	3	4	5	6	7
Hands-on construction in Japan	1	2	3	4	5	6	7
Hands-on construction in Canada	1	2	3	4	5	6	7
Joint projects with Canadian and Japanese carpenters	1	2	3	4	5	6	7
Canadian site supervisors in Japan	1	2	3	4	5	6	7
Other (*please specify*): _____	1	2	3	4	5	6	7

9. In your opinion, what is the **single** most effective strategy for transferring North American 2x4 construction technology to Japanese construction industry professionals?

_____

10. In your opinion, how **important** is it for 2x4 technology transfer training programs to focus on the following Japanese construction industry professionals? (*please circle only one number per group)*

	Not Important				Somewhat Important		Very Important
Carpenters	1	2	3	4	5	6	7
Contractors	1	2	3	4	5	6	7
Architects	1	2	3	4	5	6	7
Home building companies	1	2	3	4	5	6	7
Industry associations	1	2	3	4	5	6	7

MOC officials	1 2 3 4 5 6 7
Other (*please specify*): _____	1 2 3 4 5 6 7

11. In your opinion, how **effective** are each of the following organizations in transferring North American 2x4 construction technology to Japanese construction industry professionals. (*please circle one number for each organization*)

	Not Effective			Somewhat Effective			Very Effective
Canadian federal government agencies	1	2	3	4	5	6	7
Provincial government agencies	1	2	3	4	5	6	7
Japanese government agencies	1	2	3	4	5	6	7
Canadian industry associations	1	2	3	4	5	6	7
Japanese industry associations	1	2	3	4	5	6	7
Canadian construction companies	1	2	3	4	5	6	7
Japanese construction companies	1	2	3	4	5	6	7
Canadian building products suppliers	1	2	3	4	5	6	7
Japanese building products suppliers	1	2	3	4	5	6	7
Canadian architects	1	2	3	4	5	6	7
Japanese architects	1	2	3	4	5	6	7
Canadian colleges	1	2	3	4	5	6	7
Japanese colleges	1	2	3	4	5	6	7
Other (*please specify*): _____	1	2	3	4	5	6	7

12. In your opinion, which 2 organizations would be **most effective** at **transferring** North American 2x4 construction technology to Japanese construction industry professionals?

1) _____
2) _____

13. How **important** are the following factors in restricting the export potential of North American 2x4 houses and building materials in the Japanese residential construction market? (*please circle only one number per factor)*

	Not Important			Somewhat Important			Very Important
Lack of carpenter familiarity with imported building materials	1	2	3	4	5	6	7
Lack of builder familiarity with imported building materials	1	2	3	4	5	6	7
Lack of architect familiarity with imported building materials	1	2	3	4	5	6	7
Lack of carpenter familiarity with 2x4 construction technology	1	2	3	4	5	6	7
Lack of builder familiarity with 2x4 construction technology	1	2	3	4	5	6	7
Lack of architect familiarity with 2x4 construction technology	1	2	3	4	5	6	7
Lack of trained carpenters	1	2	3	4	5	6	7
High labor costs	1	2	3	4	5	6	7
Difficulty of obtaining work visas for Canadian workers	1	2	3	4	5	6	7
Well-established Japanese post and beam construction industry	1	2	3	4	5	6	7
Japanese building codes	1	2	3	4	5	6	7
High transportation costs within Japan	1	2	3	4	5	6	7
Complex distribution channels for imported building materials	1	2	3	4	5	6	7
Lack of local suppliers for imported building materials	1	2	3	4	5	6	7
Difficulty of obtaining spare parts for imported products	1	2	3	4	5	6	7
Japanese consumer perception that 2x4 houses are poor quality	1	2	3	4	5	6	7
Lack of lifetime warranty	1	2	3	4	5	6	7
2x4 houses not meeting cultural needs of Japanese homeowner	1	2	3	4	5	6	7
2x4 housing is just a trend that will fade	1	2	3	4	5	6	7
Fluctuating exchange rates	1	2	3	4	5	6	7
Other (*please specify*): _____	1	2	3	4	5	6	7

14. In your opinion, what is the **single** most important factor restricting the continued growth of the North American 2x4 house segment of the Japanese residential construction market?

_____

COMPANY DEMOGRAPHICS (USED FOR STATISTICAL PURPOSES ONLY)

15. What is your job title (or position) within your company? _____

16. What is your company's primary line of business? (*please check only one box*)

☐ Construction company
☐ General contractor
☐ Architect
☐ Manufacturer
☐ Building products consolidator
☐ Export trading company
☐ Wholesaler
☐ Other (*please specify*): _____

17. Please estimate your company's total sales revenue for 1997 in ☐ US $ or ☐ Canadian $

☐ Less than $500,000
☐ $500,000 - $1,000,000
☐ $1,000,001 - $5,000,000
☐ $5,000,001 - $10,000,000
☐ $10,000,001 - $25,000,000
☐ $25,000,001 - $50,000,000
☐ More than $50,000,000

18. What percentage of your total sales revenue is derived from business in Japan? ____ %

19. How long has your company been involved in the 2x4 housing industry? ____ Years

20. How long has your company been involved in the 2x4 housing industry in Japan? ____ Years

21. In 1997, how many 2x4 housing projects were your company involved in? ____ Total # ____ Total # in Japan

22. How many 2x4 housing units **in total** has your company been involved with **in Japan**?

☐ Less than 10
☐ 10 - 25
☐ 26 - 50
☐ 51 - 100
☐ 101 - 200
☐ 201 - 500
☐ 501 - 1000
☐ More than 1000

23. How many employees are at your company? ____ Total
____ In Japan office
____ Japanese speaking employees

24. How many employees have experience **working in Japan** on 2x4 housing projects? ____ Employees

25. Approximately what percentage of your projects in Japan are contracted using the following sources? (*total should add up to 100%*)

_____ % Directly from home-owner
_____ % From architecture company
_____ % Sub-contracted from another company
_____ % Other (*please specify*): _____
100 % Total

THANK YOU VERY MUCH *for participating in this CINTRAFOR Research Study!* Please return the survey in the stamped addressed envelope provided. If you would like to receive a summary of the research results, please check the box and print your name and address on the back of the return envelope. ☐ **Please send me a copy of the research results.**

Cover letter for first mailing
February 23, 1998
«FirstName» «LastName»
«Title»
«OrganizationName»
«Address»
«City»

Dear Mr. «LastName»:

I am requesting your assistance in a research project being conducted at the University of Washington's *Center for International Trade in Forest Products* (CINTRAFOR). The goal of this project is to assess industry efforts in transferring North American 2x4 housing technology to the Japanese residential housing market. The results of this project should help companies, such as yours, better understand the constraints and opportunities in the Japanese 2x4 housing market.

Please take 10 minutes of your valuable time to complete the enclosed survey. Your participation is very important to the success and accuracy of this project since *«OrganizationName»* has been identified as one of a small group of companies who has experience with 2x4 housing projects in Japan.

Of course, ALL information provided by your company will be held in the strictest confidence and will be used for statistical and academic purposes only.

For participating in this project, you are entitled to receive a complimentary copy of the research results. Please contact me if you have any questions about the project. Information regarding CINTRAFOR international trade research is also located on the Internet at: http://weber.u.washington.edu/~blippke/

Thank you very much for responding to this survey!

Sincerely,

Robert Hashizume
Market Researcher
Center for International Trade in Forest Products
University of Washington

Tel: (206) 685-4778
Email: rhashizu@u.washington.edu

Cover letter for second mailing
March 23, 1998
«FirstName» «LastName»
«Title»
«OrganizationName»
«Address»
«City»

Dear Mr. «LastName»:

A few weeks ago, I sent you the *CINTRAFOR Japan 2x4 Residential Housing Tech Transfer Survey*. If you have already returned the survey, thank you for your help!

I realize you may have been very busy. However, I encourage you to complete the survey because of the importance of this market factor. Your participation is vital to the success of this study since *«OrganizationName»* is only one of a small number of companies being asked to provide their opinions on 2x4 tech transfer. The results of this project should also help companies, such as yours, better understand the constraints and opportunities in the Japanese 2x4 housing market.

The survey takes only 10 minutes to complete and you do not have to identify yourself nor your company. I have included another survey in case you required another copy. **Again, ALL information provided by your company will be held in the strictest confidence and will be used for statistical purposes only.**

For participating in this project, I have included a token of appreciation so you may perhaps purchase a cup of coffee. You are also entitled to receive a complimentary copy of the research results. Please contact me with any questions.

Thank you very much for your assistance and hope to hear from you soon!
Sincerely,

Robert Hashizume
Market Researcher
Center for International Trade in Forest Products
University of Washington

Tel: (206) 685-4778
Email: rhashizu@u.washington.edu