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The goal of this study is to provide a better understanding of new product adoption by single family homebuilders. Information from this study will be useful to producers of new and existing engineered wood products in targeting their market development efforts.

Homebuilders are studied with the goal of segmenting them into groups based on their openness to new products, or innovativeness. This study evaluates three methods of measuring this trait. A hybrid innovativeness measure based on the time of adoption of multiple products was chosen as the best measure. It captures both the time element, and the degree of adoption element of innovativeness.

Adopter group segments are then profiled based on demographics and communication characteristics. Innovative firms were found to be larger firms with higher revenues. They were also more likely to build higher end homes and to work primarily in new home construction rather than remodeling or commercial construction. Most early adopters come from counties of medium sized populations, while later adopters are more likely to be from large counties.

Early adopters scored higher than later adopters on a measure of opinion leadership. They also were more likely to indicate that the use of new products was a part of their firm's competitive premise.

Segmenting Single-family Homebuilders on a Measure of Innovativeness

by

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David R. Fell, Author

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DEDICATION

To the Fell, Pongracz, and Wade families.

Segmenting Single-family Homebuilders on a Measure of Innovativeness

1. INTRODUCTION

1.1 Problem Statement

Engineered wood products require marketing and market development efforts that have not been used for traditional products in the forest products industry. Little research has been done to identify the adoption tendencies of single-family homebuilders, the largest consumers in the product segment. This information will help in targeting marketing in developing the markets for these new products.

1.2 Objectives Statement

This study will evaluate three measures of innovativeness with respect to single-family homebuilders. It will identify the innovation adoption characteristics of builders, and provide insight into how change agent efforts to develop engineered wood product markets may be most effectively targeted.

1.2.1 Adopter Classification

Respondents will be classified into adopter groups based on pre-existing theories of innovativeness. Each theory will then be evaluated based on its ability to capture two separate innovativeness constructs: adoption and diffusion. Group differences in demographic and communication variables will be examined for each theory of innovativeness. This will allow us to identify the characteristics of respondents in different adopter groups. By comparing three methods of measuring innovativeness on the same variables we will be able to comment on whether the innovativeness measures are indeed measuring the same construct.

1.2.2 Adopter Group Profiles

The second objective of this study is to profile each adopter group based on their demographic and communications characteristics. By profiling each adopter segment, marketing messages can be targeted at specific adopters, rather than all potential adopters.

2. LITERATURE REVIEW

2.1 State Of the Engineered Wood Products Industry

2.1.1 Definition of Engineered Wood Products.

Engineered wood is a relatively new category of products in the forest industry. These composite products of wood and glue have allowed the industry to move beyond the limitations of using solid wood.

One of the earliest examples of engineered wood was the advent of plywood panels in the early part of this century. Since the invention of plywood, the wood panel has been re-engineered continuously for cost savings, increased performance, and changing wood resources.

Houses are typically constructed from two classes of structural wood products, panels and non-panel structural products. The physical dimensions of panels require them to be engineered composite wood products. However, the nature of non-panel structural products is such that they have traditionally been comprised of solid wood. It is only recently that engineered structural products have made inroads into the structural wood market.

2.1.2 Why the Move to Engineered Wood Products?

Engineered wood products (EWP's) have become increasingly prevalent in structural, non-panel applications based on two factors. First, they have arisen as innovative solutions to a changing forest resource base. Second, in many applications structural engineered wood products provide superior performance to solid wood.

Today's forest resource is much different than the one the forest products industry has traditionally utilized. The industry developed around the use of old growth timber, while trees used today are typically from second or third growth stands. The wood of the young part of a tree stem has different characteristics from the mature wood that will follow in thickening the stem. This wood is called juvenile wood. Trees from second and third growth stands often have a higher percentage of juvenile wood as they are harvested much earlier than old growth.

Juvenile wood is undesirable in structural products because of its lower density and higher microfibril angle. Density is highly correlated with the strength properties of wood, denser wood being stronger. Microfibril angle effects the shrinkage characteristics of wood. A lower microfibril angle (<10degrees) results in very little longitudinal swelling. The microfibril angle of wood near the pith (juvenile wood) has been found to be greater than 35 degrees in some instances. Wood 20 years from the pith in the same study had a microfibril angle below 10 degrees (Jozsa and Middleton 1994). Lower density and high microfibral angle make juvenile wood less suitable for structural uses.

In addition to the changing characteristics of the wood, the volume of wood for commercial use has seen a decrease. Harvests from public lands have been severely curtailed, leading to a supply crunch for wood inputs, especially in the Northwestern U.S.

Engineered wood products help address the issue of the changing wood resource. EWP's have a higher conversion rate than solid lumber (Nelson 1997),[1] allowing producers to get more structural product from a given volume of wood. Some types of engineered wood can also be made from previously non-commercial wood species such as aspen and poplar. This acts to increase the volume of commercial wood in a given area, especially from mixed stands.

Engineered wood has many performance advantages to solid wood. Since it is a composite and does not rely on continuous solid wood, it can be made in sizes and spans that do not exist, or are very expensive, in solid wood. Solid wood is a non-uniform material plagued with great variability in strength properties. This is due to knots, juvenile wood and other defects. Engineered wood is a much more homogeneous product with any wood defects distributed evenly throughout the member, effectively averaging out wood defects. Some products are engineered to allow for the use of lower quality wood in places where they least effect the performance of the composite, while using higher quality wood in where it is needed for strength. This practice increases the structural value of lower quality wood. Across the range of different engineered wood products increased performance with respect to solid wood is a common characteristic.

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[1] When comparing the volume of a log going into solid wood versus the volume of a log that can be utilized by producing structural composite lumber.

2.1.3 The Products

2.1.3.1 Laminated Veneer Lumber (LVL)

Laminated veneer lumber is a very strong and consistent solid wood substitute. It is made similarly to plywood by gluing a series of veneers together. However, in LVL the grain direction of all the veneers is longitudinal to give the product performance characteristics similar to solid lumber. The strength properties of LVL are very predictable because any wood defect such as a knot is only in one veneer and does not continue through the width of the board. Further, each veneer going into LVL is ultrasonically graded for strength and stiffness ensuring consistence performance.

LVL is used as beams and headers for its strength over long spans. This application makes up about 55% of the market for LVL, mostly in residential building (Adair 1997b). A large portion of LVL used goes into the production of another EWP, wood I-joists. LVL is used as flange material for 70-75% of I-joists produced (Adair 1997b). This was estimated at about 45% of the market for LVL (Adair 1997b). Up to 5% is used in the manufacture of wood trusses (Guss 1995). LVL is also used in other applications such as scaffolding where its strength over long spans is of benefit.

North American production of LVL is expected to nearly double between 1995 and 1999. In 1995 LVL production was approximately 34.6 million cubic feet. This is expected to grow to 64 million cubic feet in 1999 (Adair 1997b). The continued acceptance of LVL as a structural product combined with the growth of the I-joist market will account for this growth. Adair (1997b) expects that in five to seven years the use of LVL for beams and headers will equal the use for wood I-joists, both accounting for about half of LVL demand. Table 2.1 compares the usage of LVL in single-family and multifamily construction.

Table 2.1 LVL Use By Application 1995 (US). (Million Cubic Feet)

	Single-family	Multifamily	Total
Floor Beam	3.5	0.00	3.5
Window and Door Header	.5	.07	.57
Garage Door Header	.9	.2	1.1
Roof Beam	.49	.02	.51
Total	5.39	.29	5.68

Source: Adair, 1996

A recent Center for International Trade in Forest Products (CINTRAFOR) study surveyed solid wood substitute use across the four US census regions. It was found that LVL had been trialed[2] by a low of 37% of homebuilders in the Southeast to a high of 51% in the Southwest. Of all builders surveyed, only 5.3% indicated that their firm had at least one employee trained in the use of LVL (Eastin et al. 1996).

Trus Joist Corporation commercially developed LVL in the 1970's. The product was called Micro-Lam® and today it has the largest market share in LVL (Vlosky et al. 1994). Market shares for US LVL production in 1992 were as follows; Trus Joist MacMillan 55.9%, Boise Cascade 17.9%, Tecton Laminates11.5%, Louisiana Pacific 10.2%, Willamette Industries 3.1%, and TemLam 1.5%(Leonard Guss and Associates 1993).

In 1994 Vlosky et al. wrote that the adoption of LVL into the marketplace was moving slowly. In fact, in 1993 industry capacity was roughly double that of production

[2] Trialing a product means that it has been used at least once by a builder.

(Guss and Associates 1993). Vlosky et al. (1994) identify the perception of higher costs and lack of product information for lagging market development. However, they believe that as other solid wood substitutes, especially I-joists, gain market share LVL markets will expand as well.

2.1.3.2 Wood I-joists.

Wood I-joists are a composite product used primarily to replace solid wood in floor and roof joist applications. I-joists are stronger, and lighter than solid wood, and are commonly available in longer lengths. They consist of an oriented strand board (OSB) or plywood web with machine stress rated (MSR) solid wood or LVL flanges. The 'I' shape is very strong and cuts down on the wood fiber needed for a given length of joist. Further, the strong, predictable strength properties of I-joists allow for greater spacing than solid wood, giving further wood savings as well as cost savings.[3]

The performance advantages of prefabricated I-joists are many. They can be fabricated to lengths and depths unavailable in solid wood. They are light, easy to handle, and produce little job site waste. Wood I-joists are less susceptible to shrinkage and swelling than is solid wood. This property, plus their installation methods, have all but eliminated the creaking floor.

[3] Wood I-joists typically cost more than solid wood per linear foot. Greater spacing compared to solid wood brings the overall costs of the two products closer together.

Current production (1997) of wood I -joists in North America is 615 million linear feet. This is up from 1995 production of 397 million linear feet. By 1999 this is expected to reach 965 million linear feet (Adair 1997b), and 1230 million linear feet by the year 2001 (Adair 1997a). About 70% of wood I-beams produced in 1996 were used in new residential construction (Adair 1997b). Table 2.2 displays the 1995 usage of I-joists by application for single-family and multifamily construction. Of all the structural engineered wood products, wood I-joists have made the greatest impact on the market. This is due to performance benefits, decreasing availability of solid wood suitable for joists, and effective marketing (Nelson 1997).

Table 2.2 I-joist Use By Application 1995. (MMlf)

	Single-family	Multifamily	Total
Floor Joists	182.0	55.9	237.9
Window and Door Headers	.4	.04	.44
Garage Door Header	.2	0.0	0.2
Exterior Wall Stud	6.2	3.2	9.4
Roof System	10.5	3.1	13.6
Total	199.3	62.2	261.5

Source: Adair, 1996

Thus far I-joists have not become a commodity product. Producers provide technical and engineering support to users as well a field service not provided for solid wood (Nelson 1997). Until recently no standard existed for engineered wood products. Each company's products were proprietary and therefore each had to be tested for performance, and then applied in the field according to company specifications and literature. Recently, APA-The Engineered Wood Association, introduced a set of standards for wood I-joists known as APA AWS PRI-400. This is intended to reduce the effort in specifying wood I-joists, provide for universal practices in installation, and allow for interchangeability between manufacturers (APA, Summer 1997). There is much debate over whether this standard will turn wood I-joists into a commodity product.

Again, Trus Joist MacMillan has the largest market share in I-joists. Other major producers are Boise Cascade, Georgia-Pacific, Louisiana-Pacific, and Willamette Industries. As such a high percentage of LVL production goes into the manufacture of I-joists, many companies take advantage of vertical integration and produce both.

A 1996 survey of single-family homebuilders estimated that 33% of new residential wood floors were built with wood I-joists (Hansen and Adair 1996). Other APA estimates put this figure at about 20% for the US market in 1995 and 23% by the end of 1997 (Adair 1997a). A National Association of Home Builders, Builders Practices Survey found that wood I-joists accounted for 21% of residential floors in 1994 and 25% of floors in 1996 (Biddle 1997). Adair (1997b) estimates that wood I-joists will be used in 50-60% of residential floors within the next 5-7 years.

Eastin et al. (1996) found that I-joists were trialed by a low of 41% of homebuilders in the Southwest and a high of 68% of homebuilders in the Northwest. Of the builders surveyed 22.5% reported having at least one employee trained in the use of I-joists. Of all engineered wood products, I-joists are reported to have the most employees trained in their use. This is probably the result of the technical demands of installation and the market penetration of wood I-joists.

2.1.3.3 *Other Structural Composite Lumber*

Today there is a new generation of structural composite lumber products of a more proprietary nature. They have the same general characteristics and uses of LVL but do not require large veneers for their production. This means that they have an even higher conversion factor than LVL.

The first type of product is parallel strand lumber (PSL). PSL is made of strands of clipped veneer bonded together to form a densified wood/glue composite. PSL utilizes approximately 64% of the volume of a log as compared to the 52% of LVL and 40% of solid sawn lumber (Nelson 1997). The only PSL product on the market at this time is Parallam®, a product of Trus Joist MacMillan.

Eastin et al. (1996) found that in the Northwest 64% of builders had trialed PSL. Between 37% an 41% of homebuilders in the other US regions trialed PSL. Of all homebuilders surveyed 5.9% reported having an employee trained in the use of PSL.

Table 2.3 Parallel Strand Lumber Use By Application 1995. (Million Cubic Feet)

	Single-family	Multifamily	Total
Floor Beam	1.3	0.00	1.30
Window and Door Header	.3	.01	.31
Garage Door Header	.6	.20	.80
Total	2.2	.21	2.41

Source: Adair, 1996

A structural engineered product with an even higher utilization value is Laminated Strand Lumber (LSL). This product is made of wood strands from the solid log. As the veneer peeling process is skipped in making the strands, recovery is even higher at up to

76% (Nelson 1997). Trus Joist MacMillan markets this product under the trade name Timberstrand®. At the current time they are the only company producing PSL and LSL in North America.

2.1.3.4 Glue-Laminated Timber

Of the structural engineered wood products, glue-laminated timber (Glulam) is the oldest. Glulam is constructed by gluing lengths of solid lumber together with a longitudinal orientation to create a large structural product without the size limitations of solid sawn wood. Glulams can also be manufactured in curves to create arches.

The first known application of glue-laminated timber was for an auditorium in Basel, Switzerland in 1893 (Moody et al. 1997). Glulams are commonly used in buildings and bridges requiring large wooden members. At present the total North American production of Glulam is approximately 300 MMbf (Moody et al. 1997). Most of this is consumed for commercial construction, a market for which glulam sales are stagnant (Leonard Guss and Associates 1993). Table 2.4 displays the glulam usage in US residential construction in 1995.

Table 2.4 U.S. Glulam Use By Application 1995 (MMBF)

	Single-family	Multifamily	Total	
Floor Beam	88.2	0.0	88.2	76%
Garage Door Header	11.7	4.5	16.2	3
Roof Beam	5.8	1.7	7.5	14
Window and Door Header	2.8	1.1	3.9	7
Total	108.5	7.3	115.8	100%

Source: Adair, 1996

Although the primary advantage of glulam is its size possibilities, it also has other advantages. First, glulam can be manufactured to have a varying depth, allowing for greater engineering and architectural freedom (Moody et al. 1997). Aesthetically, glulam is the most natural looking of the engineered wood products and is often sought for this quality.

Glulam can be manufactured from lumber of lower grades in all except the bottom outer layer where lumber of high strength is most needed (Guss 1993). This production practice is well suited to the second growth resource being used. A recent development at Oregon State University is the kevlar reinforced glulam beam. This technology developed by Tingley and Leichti significantly reduced the depth of beam needed to carry a given load.

Although the market for glulam is currently mostly commercial, it is expected that homebuilders will use increasingly more of this product in the coming years. The supply of solid sawn timbers is ever shrinking with the changing forest resource. Glulam production (North American) is expected to increase from 337 MMbf in 1997 to 480 MMbf in 2001 (Adair 1997).[4] The use of glulam, thus, is of interest as it is adopted by single-family homebuilders.

Eastin et al. (1996) reported that a the percentage of homebuilders having trialed glulam beams is between 58% (Southeast) and 85% (Northwest). Of all respondents 7.1% reported having at least one employee trained in the use of glulam beams.

Glulam beams have gained a certain degree of acceptance in the Japanese market. Homes in Japan are traditionally built of wood with much more emphasis put on the

[4] It must be noted that a portion of this growth will be due to Japanese demand.

appearance of the wood. Because glulams have an appearance very similar to solid wood they are being imported from North America and Scandinavia. Exports to Japan accounted for 73 MMbf of the 309 MMbf or 24% of glulams produced in the US in 1996 (Random Lengths Export, August 20, 1997). The APA expects US glulam exports to Japan will represent 33% of US production in 2001.[5]

2.1.3.5 Oriented Strand Board

Oriented strand board (OSB) is a structural panel product that competes directly with traditional plywood in sheathing applications. OSB is made up of thin strands or wafers of wood glued together in a manner that gives the resulting board properties similar to plywood. These strands can be produced from traditional North American softwood species, or from less traditional hardwood species such as aspen and birch.

Plants producing waferboard, an early form of OSB, were first built in the 1970's. It was not until 1982 that the first true OSB plant was built (Lowood 1997, from Smulski 1997). It is estimated that the 1997 U.S. production of OSB was 18,470 million square feet (3/8" basis)(Adair 1997a). OSB enjoyed a fairly quick diffusion through the building industry as a low cost commodity substitute for plywood.

2.1.3.6 Finger-jointed Studs

Finger-jointed studs consist of short solid wood pieces glued end-to-end with an interlocking finger-joint. This product utilizes trim ends from solid sawn dimensional

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[5] based on an increase of production of 41% between 1996 and 2001

lumber. Trim ends are most often created when defects are cut off of a board. Trim ends can have their defects cut out, then be joined with other trim ends to create a defect free stud. The resulting stud is more resistant to warping and other moisture cycling defects than regular studs. These are often used in applications where warping cannot be tolerated.

2.1.3.7 Steel Studs

Steel studs are another substitute material for solid wood studs. Though used primarily in commercial construction, they are used in specialty applications for single-family homes. The steel industry has aggressively pursued the single-family market in recent years, especially with recent volatility in lumber prices. Though not a wood product, steel studs were included in this study as they are a new product in homebuilding.

2.1.3.8 Structural Insulated Panels

Structural insulated panels (SIP's) are a prefabricated wall system product. They consist of a foam core sandwiched between two OSB panels. This product is very new to the market and few builders have heard of it. SIP's are included in this study because as they are so new to the market they may help identify innovative builders.

2.1.4 Single-family Homebuilders

Single-family home construction is the largest market for structural wood products. In 1997 an estimated 1,120,000 single-family homes were built as opposed to only 300,000 multifamily homes (Adair 1997b). The average size of a single-family home in the first quarter of 1997 was 2150 square feet, the largest ever recorded (Adair 1997b). In 1950 the average floor size of homes built in the US was 983 square feet. This increased to 1700 square feet in 1979 (Marcin 1987). This is still growing as the average square footage of 1995 houses was 2095 (Mogelonsky 1997), 55 square feet less than the first quarter of 1997.

With the ever increasing size of single-family homes and the relative size of the market when compared to multifamily starts, this segment is identified to be very important for producers of engineered wood products.

Below are a series of tables that give a perspective on the market penetration and market potential of engineered wood in the single-family home market. Table 2.5 summarizes the average amount of materials used in a housing start. Softwood lumber usage dwarfs the use of engineered wood products.

Table 2.5 Summary of Wood Products Used In Residential Construction Per Housing Start, and total Consumption 1995

	Per Single-family start[6]	Total Demand from Single-family Starts[7]
Softwood Lumber (BF)	13171.0	14,172,000,000
Glulam (BF)	112	120,000,000
I-joist (lf)	205	220,580,000
LVL (cubic feet)[8]	5.5	5,900,000
Structural Composite Lumber (cubic feet)	2.3	2,474,800

Source: Adair, 1996

Tables 2.6 through 2.8 give the percent market share for individual products for different applications. This is a fairer representation of the market share of EWP's as they are used in specific applications. Even in applications that are suited to engineered wood products, solid wood still captures most of the market.

Table 2.6 Window & Door Header Market Shares 1995

	MMBF	
Glulam	3.9	1.2%
LVL	9.2	2.8
Parallam	6.7	2.1
I-Joists	6.2	1.9
Solid sawn & Built Up Lumber	297.8	92.0
Total	323.8	100%

Source: Adair, 1996

[6] from, Adair, Craig. 1996. Structural Panels and Engineered Wood Products Used In residential Construction 1988 and 1995. APA publication. page 18

[7] based on 1,072,000 single-family homestarts in 1995

[8] not including LVL used in the production of wood I-joists

Table 2.7 Garage Door Header Market Shares 1995

	MMBF	
Glulam	16.2	18.3%
LVL	3.7	4.2
Parallam	3.9	4.4
I-Joists	.4	.5
Solid sawn & Built Up Lumber	64.2	72.6
Total	88.4	100%

Source: Adair, 1996

Table 2.8 Roof System Market Shares 1995

	MMBF	
Glulam	7.5	.9%
I-Joists	27.2	3.3
LVL	8.2	1.0
Solid Sawn Beams	3.9	.5
Solid sawn 2X10 Lumber	775.0	94.3
Total	821.8	100%

Source: Adair, 1996

2.1.5 Summary

Engineered wood products will play an increasing role in single-family home construction in the future. This is due to a changing wood resource, increasing demand for wood, and performance advantages. EWP's make better utilization of wood and provide more uniform performance than solid wood. Because of their composite nature, the size of EWP's is not tied to the size of logs available, it is only limited by transportation and production restrictions.

The nine engineered wood products examined in this study differ in their newness and their market acceptance. Glulams are the oldest product but have yet to make a large impact on the single-family home market. Composite wood I-joists have gained a substantial degree of market acceptance as floor joists but they have yet to gain acceptance as roof joists or headers. LVL is a major component of wood I-joists and thus is riding the market expansion with them. However, LVL by itself can be used in place of lumber where strength, predictability or long spans are needed. The market for LVL as a building product of its own has yet to significantly develop. Other structural lumber products, parallel strand lumber and laminated strand lumber, have made little impact in the market thus far. Currently they are only made by one producer. These products will some day be important as they make very efficient use of the wood resource.

What all these EWP's have in common is that they are non-tradition building products that are in the introduction or growth phases of their product life cycle. To develop their markets one must look at single-family homebuilders as they are the largest consumers of this class of building products.

2.2. Introduction to Adoption and Diffusion

The design and launch of innovative new products is of central importance to most manufacturing firms to maintain or expand market share (Cooper and Kleinschidt, 1987). Until recently in the forest products industry, the rate of introduction of innovative products has been quite slow. The emerging field of engineered wood products has changed this with the continual development of new wood/glue composites. Markets for these new products have shown continual growth since the mid-1980's. However, most of the engineered products discussed above have not yet captured significant shares of their respective markets. Has the market development of these products been fast or slow? Could the market be better addressed to speed up the adoption of these products? These, among others, are questions that should be asked when marketing a new product. With the increased rate of product innovation in the forest products industry it will be important for companies and industry organizations to evaluate such questions and plan for effective product introduction.

To answer these questions a manager must understand the process through which an innovative product is adopted into a market. A great body of literature exists on the diffusion of innovations. One of the early researchers in the subject, Everett Rogers, was a rural sociologist. He authored a book titled “The Diffusion of Innovations”. His theoretical frameworks on diffusion are widely applicable and form the basis for this study.

Many of the concepts used to discuss adoption and diffusion are interlocking, so a quick discussion of the terms used will follow. Those with an interest in changing the behavior or consumption of a group from its status quo are concerned with adoption and diffusion. Those appointed to bring about the changes are called change agents. For example, the AIDS epidemic was discovered to be spread easily through shared hypodermic needles. It was quickly realized that an effort must be made to encourage the use of clean needles. Because community workers had the best contact with the population of drug users at risk they assumed the role of change agents in promoting the use of clean needles.

In the business world, marketers are the change agents. It is their job to identify the structure of their target market and develop the best way to bring about change. The initial goal of change agents is to bring about awareness of an innovation. However, the ultimate goal is to bring about adoption.

It has been found that within any population, people or organizations differ in their openness to new innovations and propensity to adopt. Rogers (1995) divided the population of adopters into distinct groups based on their adoption characteristics. In looking at the characteristics of each group it was found that there was a certain group of people that was open to new ideas and well respected in their communities. These people are referred to as opinion leaders as their adoption of ideas or products convinces others to follow suit. It is thus very important that change agents identify opinion leaders to bring about effective change.

2.2.1 Adopter Categories.

Rogers provides a framework which studies on the classification of adopters have followed since the first edition of his book, "Diffusion of Innovations", in 1962. He begins the section of his book on adopter categorization with the following statement. "The individuals of a social system do not adopt an innovation at the same time. Rather, they adopt in an over-time sequence, so that individuals can be classified into adopter categories on the basis of when they first begin using an idea." (Rogers 1995, p.252) This excerpt hints at the goal of this study, the segmentation of a market based on the timing of new product adoption.

2.2.1.1 Innovativeness

Rogers created adopter categories to group individuals by their degree of innovativeness. Innovativeness is defined as "the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of a system"(Rogers 1995, p.252).

Midgely and Dowling (1978) criticize this definition because it relies on explicitly observable adoption behavior. This makes any measure of innovativeness based on relative time of adoption innovation specific. Further, they cite the importance of interpersonal communication in time of adoption as another problem. This line of criticism is based on the fact that an individual cannot adopt until the innovation is communicated to them. Therefore, the time and innovation dependent definition of innovativeness may rely more on timing of communication than actual innovative tendencies. Instead, Midgely (1977) defines innovativeness as the "degree to which an individual makes innovation decisions independently of the communicated experience of others"(p.49). This definition takes explicit behavior out of innovativeness, instead relying on the assumption that every individual is predisposed to a certain degree of innovativeness. Midgely (1977) labels this definition of innovativeness as "innate innovativeness", and refers to Rogers behavior based definition as "actualized innovativeness".

According to Midgely and Dowling (1978) it is a mistake to extrapolate a person's innate innovativeness from their more observable actualized innovativeness. They give the example of an innate later adopter learning of an innovation early and through adopting relatively early, being classified as an early adopter.

Rogers (1995) refutes this argument simply by pointing out that the primary goal of a change agent in innovation diffusion is to increase the innovativeness of individuals. To a change agent overt behavioral change is the goal, rather than cognitive change. Further, in defining adopter categories Rogers uses communication channels and timing as indicators of the innovativeness of an individual. Innovative people put themselves in the proper situations and company to be innovative. A innately innovative person that is not exposed to interpersonal communication is not of benefit to a change agent.

For the purposes of this paper the actualized definition of innovativeness is best. In gauging the innovativeness of a specified population towards a specified innovation or group of innovations actualized rather than innate innovativeness is of interest. A measure of the innate innovativeness of the population of homebuilders is not relevant to this study and in fact would take away from the predictive power of the results. We are interested in studying their behavior within the limits of home building and as such, their communications and timing with respect to engineered products only adds to the practicality of the study.

2.2.1.2 The Normal Distribution of Adopters

One of the primary attributes of Rogers's model is the assumption of a normal distribution of adopters when plotted over time on a frequency basis (Rogers 1995). When plotted on a cumulative basis this adoption curve takes on an S-shape, rising slowly at first, then rising rapidly before tapering off. In the diffusion tradition this curve is often called the Bass Curve. Bass (1969) developed a new product growth model for forecasting the diffusion of innovations which produces the S-shaped Bass Curve.

The normality of adoptions over time is a fundamental assumption of Rogers's theory of adopter categories. It is, therefore, important to understand the justifications behind such an assumption. Firstly, he likens the diffusion of an idea through a social system to the individual learning process (Rogers 1995). Instead of a person learning cumulative amounts of information, the system learns by creating cumulatively more adopters. The learning curve is normally distributed, thus the adoption curve is expected to be.

An explanation of the mechanics of diffusion and adoption of an innovation makes the discussion on normality of distribution easier to picture. It was stated earlier in this discussion that it is interpersonal communications that lead to adoption. The hypothetical situation starts likes this. One person adopts a product. Happy with this product they tell two of their friends. They in turn tell two of their friends, and so on. The multiplicative effect of this, if each adopter induces two more adoptions, will yield 1024 adoptions on the tenth iteration, a total of 2047 adopters cumulatively. If each adopter tells three people the number of adopters in the tenth iteration will be 59,049 for a cumulative total of 88,753 adopters!

However, this multiplicative effect does not go on forever as the hypothesized S-shaped cumulative adoptions curve suggests. This is because the population of potential adopters is finite. Rogers (1995) states that once the cumulative adoption curve reaches 50% of the potential adopter population, it becomes increasingly more difficult to find a non-adopter to communicate with. Barriers to communication dictate who learns about an innovation and when. Rogers points out two such barriers could be social status and geography.

By assuming that the distribution of adopters follows the standard normal distribution, Rogers (1995) could apply simple statistical definitions to split the population of adopters into groups. He defines the first group, innovators, to be those who adopt more than two standard deviations before the mean time of adoption. This means they comprise roughly 2.5% of the population of adopters. Those that adopt after the innovators but that still adopt prior to one standard deviation of the mean are termed early adopters, a further 13.5% of the population. The early majority is the next group adopting within one standard deviation before the average (34%). The late majority is the group on the other side of the average up to one standard deviation out. Finally, laggards are those that adopt an innovation more than one standard deviation after the average time of adoption

There are two problems with the above classification scheme, identified by Rogers himself. First, it does not classify non-adopters. Therefore, Rogers's normal distribution is not of potential adopters, but for eventual adopters. The consideration of non-adopters may be a very important for a sociologist or marketer. Change agents would logically want to minimize the population of non-adopters so information regarding them in relation to other adopter categories can be valuable.

The second shortcoming of adopter categorization on the basis of innovativeness is its failure to address partial adoption. Some individuals or units of adoption take a extended time to, or may never, reach a point where they exclusively use an innovation. The problem comes in when and if you classify these people as adopters.

For this study partial adoption is a valid issue. This is because the use of engineered wood may depend on more than just builder preference. Market economics between solid and engineered wood may come into play when either product can be substituted for the other. Further, home plans or consumers may specify a product in which case use of engineered wood may be mandatory but the builder may revert back to solid wood when given free choice.

2.2.1.3 A Discussion of Rogers's Five Adopter Categories

Innovators

Innovators are the first to adopt new ideas and are described by Rogers as 'venturesome'. These people or organizations are motivated by innovations. Innovators expose themselves to new ideas by communicating outside of their local peer networks, having more cosmopolite social relationships with other innovators (Rogers 1995). Innovators are responsible for bringing innovations into a social system. However, Rogers points out that these people may not get the respect and recognition for their role in the local social system.

This group has three primary attributes that allow them to carry out their innovative behavior. The first is financial resources. Innovations can be very expensive or unprofitable when they first hit the market. Further, there is the chance that the innovation will fail. This calls for deep pockets on the part of the innovator. The second attribute of an innovator is the ability to comprehend abstract or technical ideas and information. These people likely have a high degree of education. The final attribute Rogers identifies is a tolerance of risk and uncertainty. Deep pockets and technical competence help to reduce their uncertainty but innovators still take higher risks than other adopters.

Early Adopters.

Early adopters are the opinion leaders of local social systems. They are well respected and later adopters often seek their advice. The role of the early adopter is to decrease the uncertainty for other members of the system by making "judicious innovation-decisions" (Rogers 1995). The single word that Rogers uses to describe early adopters is 'respect'.

Early Majority

The early majority consists of one third of the eventual adopters of an innovation. These people often take a longer period to fully adopt an innovation when compared to innovators or early adopters (Rogers 1995). This group is open to innovation but they move very cautiously and deliberately.

Late Majority

This group constitutes another third of the population of adopters, those who adopt just after the mean time. The late majority is characterized by Rogers as being skeptical of innovation. At this point economic necessity may play a strong part in the motivation for this group to adopt. The late majority is a part of the local social networks and as such faces a great deal of pressure to adopt from their peers. This is because by this point in an innovation's diffusion, half of the system has adopted and is communicating the innovation to the half that has not. This group must feel it is safe to adopt an innovation as it must be cautious with its scarce resources (Rogers 1995).

Laggards

Laggards are very traditional in their thinking and actions. They also communicate primarily with other like-minded individuals. Their communications with others in the local system are limited. When communicating outside of their conservative network they are suspicious of innovations and change agents. Of all the adopter categories, those classified as laggards have the most limited financial resources and must be sure an innovation will be successful before they adopt (Rogers 1995).

2.2.1.4 The Components of Innovativeness

Innovativeness is a product of individual firm characteristics and industry characteristics (see figure 2.1). Industry characteristics are important when comparing studies across industries, or when comparing industries themselves. Shook (1997) studies some of the industry structure components of innovativeness for single-family homebuilders. However, this study aims to segment individual firms within one industry. Therefore, we are concerned with individual firm characteristics.

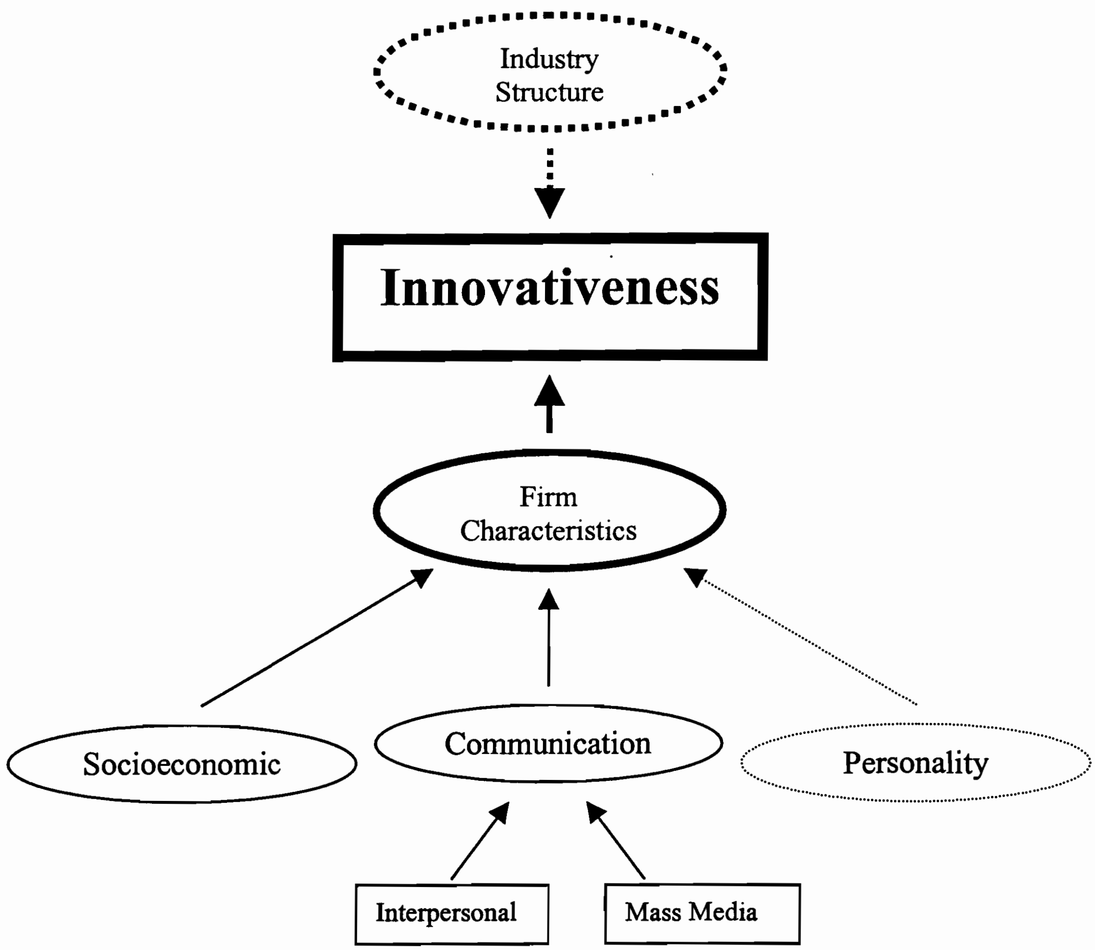

Figure 2.1 The Components of Innovativeness

Rogers makes a series of generalizations about adopters at the individual level in three broad categories; sociometric characteristics, personality variables, and communication behavior. Of these three categories, personality variables were not measured. As this study concerns firms, not individuals, many of the personality variables are not applicable. In addition, personality variables are not readily observable, making them of little use in segmenting a market.

With respect to socioeconomic status, innovativeness tends to be greater in those of greater status. Rogers questions the cause and effect relationship of this finding. "Do innovators innovate because they are richer, or are they richer because they innovate"(Rogers 1995, p.269). Those of higher status tend to control more resources and therefore the innovativeness of larger units is greater than smaller units. More resources allow these people to take more risks. When these risks pay off they are rewarded with control over even more resources.

Innovative people or organizations are calculated risk takers. They believe they have control over their outcomes and strive for high goals. Their rational approach to problems is a product of their intelligence and their understanding of science and scientific thinking.

Innovative people tend to expose themselves to more communication sources than do less innovative people. They actively seek information about innovations from media sources, those within their social system, and those outside of their social system. This exposure to information from diverse sources makes an innovative person knowledgeable of new innovations. This knowledge combined with their tendency to communicate with others makes these people opinion leaders in their social systems.

Rogers's work, though widely accepted as a basis for adopter categorization, it is often criticized for its normality assumption and rigid structure. Peterson (1973) identifies several common situations where we would not expect the adoption of an innovation to be normally distributed with respect to time. Further, he criticizes the traditional approach of Rogers in forcing adopters into five categories.

Peterson suggests a situational approach he calls optimal adopter categorization. This method categorizes adopters using a clustering procedure based on the time of adoption. The researcher must prespecify a maximum number of groups, but the size of these groups is determined by the data. The procedure can be repeated for more or less groups and a least squares F-test can be performed to determine the optimum number of categories. This procedure produces adopter categories that are "homogenous within and heterogeneous among, such that they are extremely distinct from each other" (Peterson 1973, p.328).

Optimal adopter categorization is a powerful situation specific tool. It can make sense of abnormalities in the distribution of times of adoption brought about by situational variables such as marketing efforts and product availability, among other factors. However, this detracts from its usefulness in comparing across situations or extrapolating for future situations. Indeed, Peterson begins his article by identifying the benefits of Rogers's framework.

The benefits of this scheme are obvious. "It is easy to apply in widely divergent investigations, and category standardization permits inter study comparisons, generalizations, and independent replications" (Peterson 1973, p.325). The traditional Rogers method of categorization was chosen for this project as to allow us to compare our results with previous works.

2.2.1.5 Opinion Leadership

Opinion leaders are those who have the ability to informally influence the attitudes and behaviors of others in their social system (Rogers 1995). These people are well connected through interpersonal channels and are respected in their social systems. They usually fall into Rogers's category of early adopters. Rogers's innovators may adopt an innovation earlier than these people but they are not well respected in their social systems, and therefore do not significantly influence opinion.

In trying to promote the adoption of an innovation the identification of opinion leaders is critical. If these people can be identified, change agents can put their efforts into winning over the opinion leaders. Once opinion leaders adopt an innovation the diffusion process can be self-perpetuating. This is because the opinion leaders will influence others in the system to adopt.

Leonard-Barton (1985) points out that sometimes opinion leaders are not adopters, as they can form a credible opinion about an innovation from "some other credential other than personal experience"(p.915). Similar to this, Hirshman (1980) states that an individual can adopt the concept of an idea or product without actual adoption of the product. She terms this vicarious innovativeness. In essence, vicarious innovativeness is a form of knowledge acquisition without the risk associated with actual trial and adoption. Opinion leaders may vicariously adopt an innovation and pass the ideas to others in a social system without their actual adoption. For example, a football coach may suggest a new type of helmet to his team, yet never personally use that type of helmet. The coach is seen as an authority in football, and is therefore an opinion leader.

Opinion leaders influence adoption in two ways. The first is word of mouth. This is simply relaying experiences and opinions of an innovation onto others through interpersonal communications. In marketing, word of mouth is known to be a very powerful medium. This is because information from an opinion leader is seen as more genuine and unbiased than information from an individual or firm with an economic stake in another's decision.

In a recent article in American Demographics, Walker (1995) discusses the importance of word of mouth communications for services and consumer products in the US. Citing a study conducted by the White House Office of Consumer Affairs, Walker writes that about half of Americans admit they often seek advice before purchasing goods or services. Those they seek advice from he calls the "influentials." Influentials make up about 10% of the population and are usually among the first to try new products. Influentials are well connected and active in their communities and social groups. Walker points out that these influentials see it as their role to try out new products and pass the word. Walker's description of influentials fits Rogers profile of the early adopter quite well. Both are describing opinion leaders.

The report cited by Walker indicates the importance of word of mouth communication. Influentials were found to give on average about five recommendations for products if they recommended the product at all. Even more impressive is the magnitude of negative word of mouth. Unhappy customers share their experiences with nine other people on average. Further, 13% of unhappy customers will share their experiences with twenty others.

Opinion leaders use word of mouth not only to pass on their opinions, they also use word of mouth to learn others opinions and to pass them on too. This supports Leonard-Barton's claim that not all opinion leaders need be adopters (1985).

The second way in which opinion leaders influence adoption is through behavior modeling (Leonard-Barton 1985). By adopting an innovation, regardless of word of mouth communication, an opinion leader is influencing others through example. Mahajan et al. (1990) include nonverbal observations as a type of interpersonal communication which contributes to the diffusion process. If they are indeed a type of interpersonal communication, the observable actions of an opinion leader must be considered a strong influence in their social system.

2.2.2 Rogers's Diffusion and Adoption of Innovations

Diffusion is central to the work of Rogers. He defined it as "the process by which an innovation is communicated through certain channels over time along the members of a social system." (p. 5). Out of this definition come what Rogers defines as the four main elements of the diffusion of innovations; the innovation, communication channels, time, and a social system.

2.2.2.1 The Innovation

Rogers describes an innovation as "an idea, practice or object that is perceived as new by an individual or other unit of adoption"(Rogers 1995, p.11) The key phrase in this definition is, "perceived as new." A new product that is not perceived as new is not an innovation, whereas a product that has been on the market for years is still an innovation by Rogers's definition if it is perceived as new.

In past literature the convention is to characterize innovations by the degree to which they fit a set of five attributes. These are relative advantage, compatibility, complexity, trialability, and observability (Rogers 1995). Again, perception is key. The level of each attribute an innovation has is determined not by the innovation but by the perceiver.

2.2.2.2 Communication Channels

Communication is defined as the process by which information is created and shared between participants in order to reach a mutual understanding (Rogers 1995). Diffusion is a type of communication that involves passing a new idea from one person to one or more other people. Diffusion requires an innovation, as defined in the previous section. It also needs participants to communicate the innovation. One participant or unit of adoption must be knowledgeable or experienced with the innovation, while the other or others are unfamiliar with it. The final component for diffusion communication is a communication channel to carry the message between participants in the diffusion process.

There are two general types of communication channels considered in diffusion research. The first is mass media. Mass media channels use mediums such as print, radio and television to communicate their message. They can reach many people at one time so they are quite efficient. In the diffusion process mass media channels are good at providing information and knowledge but they are only good for changing weakly held attitudes (Rogers 1995). Another drawback of mass media channels is that they are only capable of one way communication.

On the other hand, interpersonal communication is a two-way communication channel. This makes it a more persuasive type of communication, capable of changing set attitudes and influencing the adoption of an innovation (Rogers 1995). It is a combination of both mass media and interpersonal communications that optimize the diffusion process. Mass media is needed to spread the initial concept of the idea to a mass audience. Interpersonal communications are needed after initial knowledge of an innovation is gained to promote the adoption of the innovation.

Mass communication flow has been described as a two step process (Katz 1957). The first step is the flow of information from mass media to opinion leaders. This is an information transfer. The second flow is from opinion leaders to their followers. This incorporates both information and influence.

2.2.2.3 Time

Time is an important concept in the diffusion of innovations. It can be used in three primary ways that provide useful insights into the diffusion process (Rogers 1995). First, the time it takes between a unit of adoption's first knowledge of an innovation and the time of outright adoption or rejection is important to those planning change. This time period is called the innovation decision process. Second, time is used in diffusion research to assess the relative earliness or lateness of an individual's adoption; often described as their innovativeness. The final way in which time is used in diffusion research is in measuring an innovation's rate of adoption into a system.

2.2.2.4 Social System

A social system is defined as a set of interrelated individuals, organizations or other adoption units that are engaged in joint problem solving to accomplish a common goal (Rogers 1995). In some situations, one social system may be considered a unit of another social system. What makes these units part of a system is a common problem or mutual goal. Units of adoption may be members of several social systems depending on the goal or problem in question. Social systems may also be further defined by their boundaries.

Not all units in a social system behave similarly. This is what gives rise to a social structure (Rogers 1995). Social structure is the pattern of social relations in a system. An example of a formal social structure would be the hierarchical system of a large company. Social structure provides for stability in a system.

Most systems also have an informal structure Rogers terms as the communication structure. Communication structure is the pattern of interpersonal communications between members of a system. Every system has a unique informal communications pattern.

2.2.3 Summary

Members of a social system do not adopt a new product or idea at the same time. Rogers grouped the population of adopters of an innovation according to what he termed innovativeness, which is the degree to which an individual is relatively early or late in adopting an innovation. Innovativeness depends on socioeconomic variables, personality, and communication characteristics of an individual or unit of adoption.

There are some individuals in a social system that seek out innovations and are early to adopt them. These people are called opinion leaders if they spread the innovation to others in their social system. For those wanting to bring about change these are important people to identify because they are the gateway into a social system and efficiently diffuse new ideas throughout their system.

2.3 Industrial Theories

Rogers's theories of diffusion apply to individuals or units of adoption. When considering an organization or company we are referring to units of adoption that are in fact groups. Ozanne et al. (1971) point out that much of the work on adoption involves the individual as the unit of adoption rather than groups. Early works involving social groups were anthropological studies. There are some questions as to whether organizations in an industry act as individuals in a social system.

Ozanne et al. (1971) defined the industrial adoption process as being unique as a decision making group is the most likely unit of adoption. They defined a group as two or more people participating in the decision to adopt. When a decision is made by a group the characteristics of the group must be considered.

Czepeil (1975) looked at interorganizational communications in the diffusion of a major technical innovation to determine whether industrial decision making fell within the bounds of the traditional theories on diffusion of innovations. As diffusion theory relies on interpersonal communication, Czepeil questioned if interorganizational communications existed analogous to interpersonal communications. Further, as businesses in an industry are in economic competition, Czepeil questioned if secrecy would reduce interorganizational communications. He also questioned if decisions made by multimember units (groups) followed the diffusion tradition. He found that communication channels were 'many and dense' and followed the general theories of diffusion. Therefore, Czepeil concluded that industrial decision-makers could be treated as a society.

The applicability of the diffusion tradition to organizations is confirmed by the work of other authors. Research by Martilla (1971) in three industrial markets looked at the characteristics of opinion leaders engaged in word of mouth communications. He found that depth of exposure to literature and trade journal articles by opinion leaders was statistically different (higher) than that of nonleaders. Opinion leaders also had higher levels of education than nonleaders. Finally, word of mouth communications were found to be more important later in the adoption process while impersonal channels of communication were of early importance. These findings are what would be expected when applying traditional diffusion theory.

The above findings point to the conclusion that organizations can indeed be treated much the same as individuals with regard to their behavior as members of a social system.

Rogers defined an organization as a stable group of individuals that work together towards a mutual goal (1995), and identified five major characteristics of organizations. First, organizations have formalized predetermined goals. Second, the participants in an organization have prescribed roles. Formal organizations usually have an authority structure as well as rules and regulations. Finally, organizations usually have informal patterns in social norms and relationships aside from the formal structure.

Given these characteristics, should single-family homebuilders be considered organizations? It can be argued that single-family homebuilders are not formal organizations. Homebuilder companies are often sole proprietorships. They do not employ a large number of people and may not have formal structures and set rules. It is more likely that the proprietor makes decisions alone and work is carried out by subcontractors. In this way it is argued that a homebuilder would most accurately be described as an individual rather than an organization. The one important distinction that must be made is that economic considerations are a stronger motivating variable for the homebuilder than for the normal consumer or individual adopter.

Although this middle ground between individual and organization may seem difficult to support, it is actually well studied in the diffusion literature. Much of Rogers's work looked at the adoption of new crops and agricultural methods by farmers.

Farmers are usually in business for themselves and operate different sizes of farms depending on their resources and operations. They are individual decision making units that are motivated by economics. This provides a nice parallel with single-family homebuilders as they too are usually in business for themselves.

2.4 Past Research in Forestry and Forest Products

Few studies in the field of forest products and forestry have addressed adoption and diffusion of new products and technologies. The field of forest products and forestry is very broad and the works that have been done on the subject reflect this diversity.

Shook (1997) studied innovation and diffusion of engineered wood products in the residential construction industry. Firm perception of industry competition, the presence of trade unions, and management intensity were found to negatively influence engineered wood product adoption. He also found that firm and product specific factors were more likely to affect adoption than were industry structure factors.

Research in the forest economics field has modeled the supply and demand for wood from the seedling to the final use. Technological change and product substitution has been addressed in some econometric models. Spelter (1985) modeled softwood lumber demand from a product diffusion approach. In his paper he looked at the elasticity of demand for softwood lumber as new technologies emerged; both wood and non-wood. Modeling past developments in the market, Spelter found that new technologies at first increase the price elasticity of softwood lumber demand.[9] However, in the long run markets adjust and demand becomes less price elastic. Though not directly applicable to the study at hand, this model provides some predictive value for how engineered wood will effect forest products markets.

Many of the adoption and diffusion studies on the forestry sector involve new processing technology. Cohen and Sinclair (1990) looked at the adoption of new production technology by major North American producers of softwood lumber and plywood. Firms were clustered based on their use of new technologies. The economic and market performance of each cluster was then analyzed. It was found that firms adopting more innovative technologies performed better than those adopting fewer technologies.

West and Sinclair (1992) did another study involving the adoption of production technology. This study looked at the household furniture industry's adoption of new manufacturing technologies. West and Sinclair looked at the adoption of new technologies using a combination of three approaches. First, they looked at environmental factors externally measuring factors such as competition, demand and uncertainty and the internal environment by capital expenditures, number of engineers, and technical progressiveness. Second, communication behaviors were measured through participation in trade shows, readership of trade journals, sales force, and communications with other manufacturers. The final factors considered were decision-maker cosmopolitanism, professionalism, and opinion leadership. Communications and decision-maker cosmopolitanism come directly from the diffusion of innovation tradition.

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[9] **Price elasticity of demand is the degree to which the change in price of a substitute product effects the demand for the product of interest.**

Indeed, West and Sinclair drew heavily on Rogers's work, while trying to balance this with consideration of environmental factors.

The authors started with Rogers's theory of the normal distribution of adopters. Citing the small number of potential adopters in industrial markets they define innovators to be those adopting earlier than one standard deviation from the mean adoption time. This includes both innovators and early adopters from Rogers's categorization. The authors then defined non-innovators as the balance of the population of adopters.

Once each manufacturer was grouped as an innovator or non-innovator, the author looked for group differences. None of the external environmental factors were significantly different between the two groups. Within the internal environment, innovator companies employed significantly more manufacturing and production engineers. They were also significantly more technically progressive.[10] Of the communication factors only dependence on trade shows for information was significant.[11] All decision maker variables were significantly different between innovators and non-innovators. Further, some of the demographics measured were significantly different. Innovators had more employees and had higher priced final products.

Smith and Bush (1995) looked at the perceptions of wood in the adoption of timber bridges by state departments of transportation. This study revolved around a very important concept of diffusion work; that perception is key. After surveying the perceptions of wood and other bridge building materials it was found that decision

[10] Technical progressiveness was measured by the response on a lickert scale to a statement "Our manufacturing organization tries to be the first in our industry to implement new production technologies and methods."

[11] 2-sided p-value 0.08

makers perceived wood as the poorest performing material. In this study the background of the decision-maker was not found to influence the perception of wood. The most important factor was past use of wood.

The past research done on adoption and diffusion in forest products and forestry involved many different subjects with many different characteristics. The diffusion and adoption of new products by the homebuilders segment has only been addressed in one study (Shook 1997). The characteristics of this market are, on the surface, not very comparable to the markets investigated in other studies. Homebuilders operate small companies that are very different from large forest companies or state departments. Adoption of engineered wood by homebuilders does not require a large capital expenditure, nor does it require the continued commitment to the innovation that adoption of new production technology does. However, the diversity of these studies reinforces the fact that adoption and diffusion is largely driven by the characteristics of the decision-maker.

3. METHODS

3.1 Sampling Procedures

The population of interest in this study is US firms involved primarily in single-family home construction. The Standard Industrial Classification (SIC) for this population is 1521.

The sampling frame for the population came from a list purchased from Dun and Bradstreet Information Services. Dun and Bradstreet lists 21,087 firms involved in single-family housing construction (SIC 1521) in California, Oregon, and Washington. A list of 1100 firms in these states, engaged primarily in SIC 1521, was randomly generated[12] by Dun and Bradstreet.

Previous studies on engineered wood products have provided some evidence of geographical differences in engineered wood use and perceptions (Eastin et al. 1996, Hansen and Adair 1996). This study did not attempt to measure regional differences in engineered wood product usage and firm innovativeness. Rather, we sought to limit regional effects that would cloud our definitions of innovativeness. In the west coast states of the US, engineered wood products have the longest history and most developed state of diffusion. Therefore, a late adopter in this region may still have adopted a new technology before early adopters in other regions. A further confounding factor when linking product usage with innovativeness is regional building differences. Some regions use less of these products simply because the local style of building does not require

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[12] Proportional representation was achieved by stratifying the sample based on the proportion of the population from each state.

them. For these reasons the geographical frame of the study was confined to California, Oregon, and Washington. These states have similar histories with respect to the products under study.

3.2 Questionnaire Development

A questionnaire was developed to be used in conjunction with telephone interviews. The questionnaire covered firm demographics, past engineered product usage, and communication channels and methods used by single-family homebuilders. Initial question formulation and survey instrument design took place at Oregon State University. The questionnaire was pretested by academics, building industry association representatives, and homebuilders.

Initial feedback on the survey instrument was provided by contacts at APA- the Engineered Wood Association, the Center for International Trade in Forest Products at the University of Washington, the National Association of Homebuilders Research Center, and the Field Company.

Pretesting took place with local Corvallis, Oregon area builders. In initial pretests builders not only answered the questions, but provided open-ended feedback. Two face-to-face, open-ended pretests were carried out. At this point the wording was reworked on some questions to ensure clarity. A second round of builder pretesting took place in Corvallis. In these two pre-tests, telephone interviews were used to simulate actual data collection conditions. This was the final check of questionnaire clarity and logic. Only minor changes were necessary as a result of the pretesting. The final version of the questionnaire appears in the appendix.

Survey measures included a mix of firm demographics, communications characteristics, and past product usage. Firm demographics were included because they were expected to be important in identifying the characteristics of firms in each adopter group. Measures such as sales, years in business, number of employees, primary market, and membership in industry organizations were assessed.

Product specific questions were also asked. Probably the most important questions addressed the trial and adoption of engineered wood products. Nine products that are relatively new to the building industry were considered. For each product respondents were asked whether they had ever used the product, and if so when they first used it. They were also asked if they had used each product in 1997. These measures were used to place respondents into innovativeness groups.

Finally, communication variables were measured. Respondents were asked to rate a series of communication channels on a 7 point likert scale as to how important each was to learning about new products. Other variables measured included the number of trade magazines received, number of trade shows attended, and number of professional associations in which the respondent firm held membership.

3.3 Data Collection

Data collection for the survey was performed by telephone interview. Previous mail surveys with this population, SIC 1521, have yielded low response rates. Hansen and Adair (1996) received a response rate of 8.6% from this population while Eastin et al.(1996) received a response rate of 11.7%. Low response rates increase the chance of non-response bias. Telephone interviews, which traditionally yield a much higher response rate, were used to ensure adequate participation.

A telephone research firm worked under contract to collect data. The firm has a long history of projects in the wood industry and has conducted telephone interviews with single-family homebuilders in the past. Therefore, the interviewers were familiar with engineered wood products and the type of respondent firm targeted.

Interviewer training took place on March 24, 1998, at the research company's headquarters near Seattle, Washington. Interviewers were introduced to the goals of the project and were walked through the questionnaire. Samples of each of the engineered wood products in the study were displayed to ensure the interviewers were familiar with each product[13].

One week prior to data collection, a prenotification letter was sent to potential respondent builders in the sample. As there were only five interviewers, prenotification letters were sent in three waves. This helped avoid a delay between a builder receiving the prenotification letter, and being contacted by an interviewer. Initially, 400 letters were sent March 30, 1998, and their contact information turned over to the interviewers the next week. When the initial list of 400 was nearly exhausted, a second round of 400 letters were sent April 20. When this list was exhausted the final 300 letters were sent May 4.

[13] Products considered in this study were Parallel Strand Lumber (PSL), Laminated Strand Lumber (LSL), Laminated Veneer Lumber (LVL), Wood I-Joists, Glue Laminated Beams (Glulam), Oriented Strand Board (OSB), Structural Insulated Panels (SIP's), Finger Jointed Studs (FJS), and Steel Studs.

3.4 Data Analysis

3.4.1 Defining Innovativeness

This project was intended to identify differences among groups of single-family homebuilders. This necessitated development of a system by which respondents could be categorized into adopter groups. The construct of innovativeness was a primary concern of this project and two innovativeness measures from the literature were compared in this study. One of these measures relies on time of adoption of a product. The second removes time from the analysis but adds more products to reduce the effect of one-time occurrences. A third method of defining innovativeness is presented here that uses both time of adoption and several products.

3.4.1.1 The Time Based Definition of Innovativeness.

Rogers (1995) defines innovativeness as the degree to which an individual or firm adopts an innovation relatively early compared to others. This is a time-based definition of innovativeness. He defines innovators as those that adopt earlier than two standard deviations from the mean time of adoption. There are four other adopter categories defined by the number of standard deviations from the mean.

In this study we collected data from firms on the time they first trialed certain wood products. The times of first trial for all respondents were then normalized. The resulting score is unitless and represents standard deviations from the mean.

Equation 3.1

$$AI = (t - m) / s$$ (taken from Midgley and Dowling 1978, equation 1)

AI = actualized innovativeness
m = mean time of adoption
t = time that individual adopted
s = standard deviation of adoption times

Midgely and Dowling (1978) term this actualized innovativeness as it is an innovativeness score directly tied to a respondent's actions. Using this definition of innovativeness, resulting scores can be directly applied to Rogers's (1995) adopter categorization.

The time element in the above definition presents two problems for our study. First, when respondents are asked when they first trialed an innovation there is the possibility for recall error. A second source of error to consider is situational factors. Actualized innovativeness is a measure of a firm's innovativeness over just one product introduction. Some firms may not have had the product available to them as early as other firms while other firms may have been in a situation where they had to use a new product even though it was not their decision. A one-product measure of actualized innovativeness may predict firms to be more or less innovative than they actually are.

In this study, I-joists were chosen as the product for which actualized innovativeness scores were assigned to respondents. This is because I-joists had the highest rate of trial among the respondents. Over 90% of respondents in this study had used wood I-joists at least once.

3.4.1.2 Cross-sectional Definition of Innovativeness.

The second way in which innovativeness is measured in this study is the cross-sectional approach (Robertson and Myers 1969). This method takes the time element out of the operational definition of adoption, thus eliminating many of the problems of a time reliant measure.

The method relies on a 'snapshot' approach where firms are asked whether or not they currently use a series of innovations in a given product category. The scoring for each innovation is binary. Firms score 1 if they employ a given innovation and a 0 if they do not.

A set of innovations that collectively span the product category of interest is needed. In this case the product category is engineered wood products. Once a list of innovative products is derived the relationships between the innovations must be studied to determine their appropriateness in the analysis. This is done by means of a correlation analysis. Bigoness and Perreault Jr. (1982) tested the inter-innovation correlation's of 12 items using a measure development subsample of 20 firms. Any items that were negatively correlated had to be eliminated as the adoption of one would seem to preclude the adoption of the other(s). Further, items that are too highly correlated must be evaluated as they may respond as one innovation, in which case including both in a measure of innovativeness provides no additional information for segmentation.

Of the original nine innovations considered in this study three were eliminated because of negative correlations with other products. These were glue laminated beams, structural insulated panels, and steel studs. The reasons for these negative correlations can be understood by looking at the function of each product. For example, glue laminated beams and Parallam® are both used for beams and headers. A builder will likely choose one product for this application in their projects, therefore they are negatively correlated. Steel studs and finger jointed studs are direct substitutes. Finally, as structural insulated panels do not require additional sheathing, the use of SIP's are negatively correlated with the use of oriented strand board. Respondents were given one point for each of the remaining six innovations they employed in the previous year (1997). Respondents with a greater number of innovations employed are considered more innovative. The scores were then normalized and the Rogers's distribution applied to them.

3.4.1.3 Composite Innovativeness

A composite measure of innovativeness is created here that controls better for situational effects, yet is still based on time of adoption. The following definition gives each respondent a score for each innovation they used, based on when they first used it relative to other builders. The scores for all products are then summed to make a composite score.

Equation 3.2

$$CI = \sum_{i=1}^{n} ((m_i - t_i) / s_i) \quad ^{14}$$

CI = composite actualized innovativeness
m_i = mean time of adoption of innovation i
t_i = time that individual adopted innovation i
s_i = standard deviation of adoption times for innovation

The time of first trial for each product was normalized. All scores were then multiplied by -1 to give the higher scores to those which trialed products earlier. At this point many respondents have no score on some products as they have never used them. These respondents were given a score of -3. This gives them a lower score on that product than any of the adopters. The scores for each product were then summed into a composite score. Finally, the composite scores were normalized and the Rogers's distribution was applied to them.

3.4.1.4 Assigning Group Membership.

Theoretically, the above three measures of innovativeness should be measuring the same construct. Once the scores from each measure are normalized the distribution of scores should approximate the normal curve and Rogers's distribution based assignment of group membership can be applied. Rogers used 5 groups to span the distribution of adopters. However, a sample size of 201 yields a smallest group size of 5 or less. The number of groups had to be reduced to provide large enough group sizes to provide for meaningful statistics. West and Sinclair (1992) used a 2 group model where innovators

[14] Respondents who did not trial a product were given a score equivalent to adopting the innovation 3 standard deviations after the mean.

were those one standard deviation before the mean, and all others respondents were grouped as non-innovators. Cooper (1995) applied a three group model to the West and Sinclair (1992) data. In this study a three group model was chosen for this project in order to isolate the latest adopters. The group assignments were as follows.

Early Adopters	<-1 sd
Majority Adopter	-1sd to 1 sd
Late Adopters	>1sd

These group definitions were applied to each of the innovativeness definitions.

3.4.2 Data Analysis

3.4.2.1 Testing the Innovativeness Measures for Diffusion

The first step of the analysis with the three innovativeness measures is to test if they have captured the time element of diffusion. If the above innovativeness measures have picked up the time based construct of innovativeness we will see the mean time of first trial increase from early adopters to late adopters in each measure. ANOVA tests for differences in group means were used to test for group differences. This procedure will be carried out for each of the products analyzed.

3.4.2.2 Testing the Innovativeness Measures for Adoption

While diffusion relies on the time of first trial of a product, adoption relies on a products continued usage. There is much debate in the literature as to the point at which adoption has taken place (Rogers 1995). It was discussed earlier that homebuilders may vary greatly in the degree to which they use engineered wood products. Therefore, in this study adoption was treated as a continuous construct, rather than a binary, yes/no, variable.

As I-joists were used in by over 90% of respondents in the study a surrogate for degree of adoption was created by asking respondents to indicate the percentage of 1997 floor area they built with I joists. Builders using I-joists for a greater percentage of floor area built are assumed to have adopted wood I-joists to the greatest degree.

3.4.3 Firm Demographics and Characteristics

Differences among groups were looked for in the firm demographics of the respondents. For metric variables ANOVA tests of group means were used. For non-metric variables crosstabulation tables were examined and chi-squared tests were used where appropriate. For communication variables, metric and non-metric communication variables were examined in the same way as the demographic variables.

3.4.4 Response Rate

Response rate was calculated to be 48.8% using the single stage sampling with eligibility requirement method (Wiseman and Billington 1984). Response to this study was quite good with 201 usable interviews completed and only 63 refusals. Unfortunately, the list of builders was very inconsistent. A total of 331 of 1100 firms were not eligible for the survey. These firm's core business activities were not homebuilding. An additional 110 were verified as disconnected numbers. Potential respondents at 385 operational phone numbers were never reached.

4. CHOOSING AN INNOVATIVENESS MEASURE

(Manuscript for submission to Industrial Marketing Management.)

4.1 Introduction

The introduction of a new product involves considerable risk. It is estimated that up to one third of new products fail at the launch stage (Cooper and Kleinschmidt 1987). One way to increase the chance of a successful product introduction is to segment the potential market and target those most likely to adopt a new product early. The study of the diffusion of innovations has produced two distinct approaches to measure innovativeness, the trait of adopting a new product early relative to others (Rogers 1995, Midgley and Dowling 1978). These methods fall into the historical (time of adoption) classification, and the cross-sectional (product usage) classifications.

In this study we compare results from classifying respondents according to these two methods. A third method of defining innovativeness, which is a hybrid of the two methods, is proposed.

The product category analyzed in this study is engineered wood products with single-family homebuilders in the western US serving as the corresponding user group. In the past two decades, the rate of new product development has increased in this industry segment. Traditional wood products are generally sold as commodities, with little product differentiation. New engineered wood products are generally proprietary, and require builders to learn new installation skills. These new products present marketing issues to an industry that has not done a great deal of marketing or market analysis in the past. This project seeks to segment the single-family homebuilding market based on firm innovativeness. It represents a first step in developing an understanding of the adoption and diffusion of new building products.

4.2 Literature Review

In 1962 Everett Rogers published his first edition of the "Diffusion of Innovations" bringing together diffusion research traditions from many fields. Diffusion is "the process by which an innovation is communicated through certain channels over time along the members of a social system." (Rogers 1995, p. 5). Out of this definition comes what Rogers defines as the four main elements of the diffusion of innovations; the innovation, a social system, communication channels, and time. Innovations are ideas or technologies that are perceived as new (Rogers 1995). A social system is a network of individuals through which innovations diffuse. Individuals use communication channels to pass innovations on to other individuals. Finally, this whole process does not happen instantaneously, rather it happens over time. "The individuals of a social system do not adopt an innovation at the same time. Rather, they adopt in an over-time sequence, so that individuals can be classified into adopter categories on the basis of when they first begin using an idea." (Rogers 1995, p.252).

The preceding excerpt hints at a way in which adoption and diffusion can be used in conjunction with one of the most valuable marketing tools, segmentation. It is desirable to identify the group of adopters that will be the earliest to use new products and to target marketing efforts on them when launching new products. Later in a product's lifecycle, this type of segmentation can be used to capture later adopters.

Rogers and Shoemaker (1971) called a person's or group's propensity to adopt a new idea or technology early relative to others, innovativeness. The simplest way of operationalizing innovativeness is to create a measure based on the point in time at which individuals adopted an innovation.

Rogers (1995) uses simple statistical definitions to segment the distribution of adopter's innovativeness scores, or time of adoption, into adopter groups. Group membership is assigned based on how many standard deviations from the mean innovativeness score an adopter falls. The classic Rogers model defines five adopter groups. However, in industrial marketing studies it is common to reduce this to a two group model (Bumgardner and Romig 1998, West and Sinclair 1992). This latter model sets innovators as those with innovativeness scores greater than one standard deviation from the mean; all other respondents were defined as non-innovators. Rogers then created a profile for each of the adopter groups with regard to demographics, personality, and communication characteristics.

The Rogers method has the advantage of being very simple to apply. The input is simply the respondent's time of adoption of a new technology. A mean and standard deviation are computed for this time distribution. Based on these two statistics respondents are assigned to Rogers's adopter categories.

However, this measurement of innovativeness has several shortcomings. First, it relies on the ability of individuals to recall the exact time they adopted an innovation. This may be simple when adoption is recent, but recall of events and exact times gets less precise as the event moves further into the past (Rogers 1995). The second problem arises from using only one product to generate the innovativeness scores, which then become product-specific and may not be broadly applicable (Midgley and Dowling 1978). A measure of innovativeness using just one occurrence of adoption may be very sensitive to situational factors. A firm which is generally late in adopting new products may happen to adopt the product under study early, and would be classified as an early adopter. Finally, as this method relies on time of adoption, nonadopters are not considered in the analysis (Rogers and Shoemaker 1971).

A second method of operationalizing innovativeness involves measuring the number of new products owned or used (Robertson 1971, Midgley and Dowling 1978). Robertson (1971) proposes that, given each product in a set of products are in a different stage of their diffusion, the earliest adopters will be using the greatest number of products at a point in time. Innovativeness, thus, can be measured by product usage. This is called cross-sectional innovativeness (Robertson and Myers 1969).

This method addresses some of the problems identified in Rogers's method. Several products are used, reducing the potential of miscategorizing a respondent based on the effect of any one product. This has the further benefit of making the innovativeness score applicable beyond a single product. As product adoption is not a prerequisite to be considered under this analysis, cross-sectional innovativeness allows us to include non-adopters in the analysis. Further, a time measure is not used, greatly reducing the recall problem.

Application of the cross-sectional measure requires that a list of innovative products be compiled that collectively represent a product category. These products must form a homogenous set of innovations (Bigoness and Perreault Jr. 1981), and must not be negatively correlated to each other in their use. Negatively correlated products tend to be substitutes or at least mutually exclusive, and their inclusion would make the measure underestimate adoption. Products that are too highly correlated (i.e., those consistently used together) would tend to overestimate the degree of new product adoption.

Midgely and Dowling (1978) argue that the time based definition of innovativeness and the cross-sectional definition of innovativeness do not measure the same construct. The time based definition of innovativeness is tied directly to the product under study at a low level of abstraction. On the other hand, cross-sectional innovativeness can be generalized to a product category, but is at a higher level of abstraction.

Midgley and Dowling also make a distinction between actualized and innate innovativeness. Actualized innovativeness is based on past behavior and does not control for situation factors such as the timing of communications. Innate innovativeness is an individual's predisposition to adopting innovations, discounting situational influences. While innate innovativeness is hypothetically carried by an individual across all product categories, actualized innovativeness is limited in its application.

From a marketing perspective we are interested in identifying those which will adopt a new product soon after its introduction. Situational factors are always present in the real world. Therefore, Gatignon and Robertson (1985) conclude that "innovators must be identified and characterized on a product category basis and that there is not a generalized innovator across product category or interest domains"(p. 861).

Downs and Mohr (1976) comment on single innovation versus multi-innovation measurements. They warn that "we should not hastily classify as early adopters organizations that have adopted many innovations"(p 708). They also comment to the fact that time of adoption and extent of adoption are very different constructs and may not be captured in the same measure.

4.3 Methods

4.3.1 Sampling

The population of interest in this study is firms involved primarily in single-family home construction in California, Oregon and Washington. The Standard Industrial Classification (SIC) for this population is 1521. A list of 1100 firms in the geographical frame was randomly generated by Dun and Bradstreet Information Services. Dun and Bradstreet lists 21,078 firms[15] involved in single-family housing construction (SIC 152100) in Oregon, Washington, and California.

Previous studies on engineered wood products have found geographical differences in engineered wood use and product perceptions (Shook 1997, Eastin et al. 1996, Hansen and Adair 1996). We sought to limit regional effects that would make it more difficult to separate firms according to their innovativeness. As a previous nation-wide study found evidence that material usage differed among regions, we selected these

[15] This figure as at August 12, 1998.

three states based on their similar usage of engineered wood products. Further, engineered wood products have the longest history and most developed state of diffusion in these states. A late adopter in this region, therefore, may have adopted a new technology before early adopters in other regions. For these reasons the geographical frame of the study was limited to California, Oregon, and Washington.

The number of firms included in the sampling frame was sufficient to assure a total of 200 valid responses. The target of 200 valid responses was based on the statistical methods to be used and the number of variables to be measured.

4.3.2 Survey Instrument.

A questionnaire was developed to be used in conjunction with telephone interviews. The questionnaire covered firm demographics, past engineered product usage, and communication channels and methods used by single-family homebuilders. Initial question formulation and survey instrument design took place at Oregon State University. The questionnaire was pretested by academics, building industry association representatives, and homebuilders.

Initial feedback on the survey instrument was provided by contacts at APA- the Engineered Wood Association, the Center for International Trade in Forest Products at the University of Washington, the National Association of Homebuilders Research Center, and the Field Company.

Pretesting took place with local Corvallis, Oregon, area builders. In initial pretests builders not only answered the questions, but provided open-ended feedback. Two face-to-face, open-ended pretests were carried out. At this point the wording was reworked on some questions to ensure clarity. A second round of builder pretesting took place in Corvallis. In these two pre-tests, telephone interviews were used to simulate actual data collection conditions. This was the final check of questionnaire clarity and logic. Only minor changes were necessary as a result of the pretesting.

4.3.3 Data Collection

A telephone research firm was contracted to collect the data. This market research firm has a long history of projects in the wood industry and has conducted telephone interviews with single-family homebuilders in the past. Therefore, the interviewers were familiar with engineered wood products and the type of respondent firm.

Interviewer training took place on March 24, 1998 at the research company's headquarters near Seattle, Washington. Interviewers were introduced to the goals of the project and were walked through the questionnaire. Samples of each of the engineered wood products in the study were displayed to ensure the interviewers were familiar with each product[16].

One week prior to data collection, a prenotification letter was sent to potential respondent builders in the sample. As there were only five interviewers, prenotification letters were sent in three waves. This helped avoid a delay between a builder receiving the prenotification letter, and being contacted by an interviewer. Initially, 400 letters

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[16] Products considered in this study were Parallel Strand Lumber (PSL), Laminated Strand Lumber (LSL), Laminated Veneer Lumber (LVL), Wood I-Joists, Glue Laminated Beams (Glulam), Oriented Strand Board (OSB), Structural Insulated Panels (SIP's), Finger Jointed Studs (FJS), and Steel Studs.

were sent March 30 1998, and their contact information turned over to the interviewers the next week. When the initial list of 400 was nearly exhausted, a second round of 400 letters were sent April 20. When this list was exhausted the final 300 letters were sent May 4.

4.3.4 Response Rate

Response rate was calculated to be 48.8% using the single stage sampling with eligibility requirement method (Wiseman and Billington 1984). Response to this study was quite good with 201 usable interviews completed and only 63 refusals. Unfortunately, the list of builders was very inconsistent. A total of 331 of 1100 firms were not eligible for the survey. These firm's core business activities were not homebuilding.

4.3.5 Data Analysis

4.3.5.1 Innovativeness and the Rogers Distribution.

In this study a reduced three category model of innovator groups was used (Cooper 1995)(see figure 4.1). This allowed us to not only differentiate early adopters from the average respondent, but it also allowed us to look at the attributes of the latest adopters. Table 4.1 compares the group definitions.

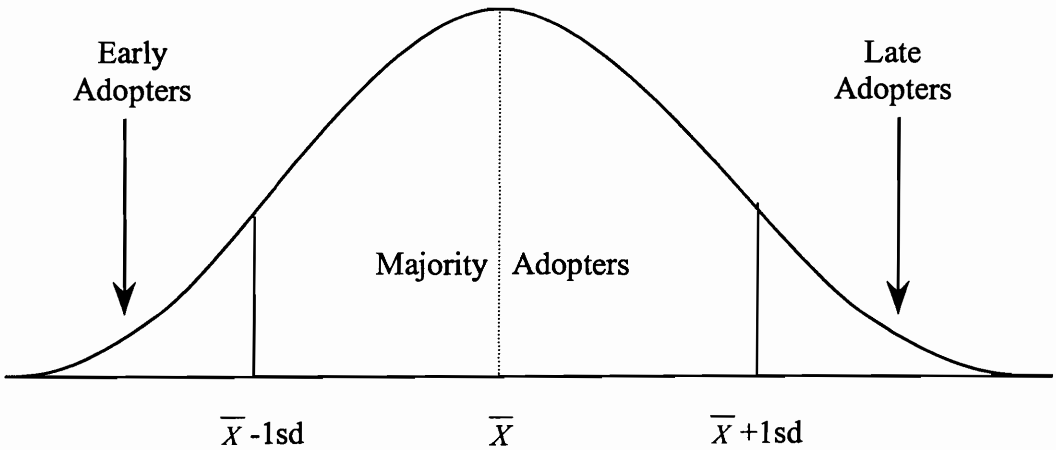

Figure 4.1 The Normal Distribution of Adopters

Table 4.1 Adopter group membership as defined by the normal distribution.

Position on Normal Distribution	Rogers's Original Model	Reduced Industrial Studies Model	**Model Used**
< -2 SD	Innovators	Innovators	**Early Adopters**
-2 SD to -1 SD	Early Adopters		
-1SD to $\overline{X}$	Early Majority	Non-innovators	**Majority Adopters**
$\overline{X}$ to 1 SD	Late Majority		
> 1 SD	Laggards		**Late Adopters**

4.3.5.2 The Classic Rogers Method

The product used for assigning time-based innovativeness scores was wood I-joists. Up to and including the year 1997, wood I-joists had been used by 90.8% of respondents at least once. As respondents must have used the product under consideration for this method we were able to keep most of the respondents in the analysis. A mean and standard deviation were computed for the time of first use of I-joists. Each respondent was then assigned an adopter group based on their time of first use. Respondents that had not used wood I-joists were not assigned an adopter group.

4.3.5.3 The Cross-sectional Method

Under the cross-sectional method, respondents were given a point for each of the innovative products they used at the time point in question. Assuming all the products are in different stages of their diffusion at the time point, respondents using the greatest number of products are most innovative. A mean and standard deviation for the cross-sectional innovativeness scores were computed. From these two statistics, respondents were assigned to one of the adopter groups.

Equation 4.1 $$CSI = \sum_{i=1}^{n} p_i$$

CSI = Cross-sectional innovativeness
p_i = 0/1 score for using product i
n = number of innovations
(adapted from Midgley and Dowling, 1978)

The cross-sectional definition of innovativeness addresses many of the problems associated with the traditional single product analysis. However, the definition of innovativeness, and the motivation for measuring it, relies on the time of adoption. The link between cross-sectional innovativeness and observable time of adoption of a given product may be weak. Therefore, the mean time of first trial of each product in the analysis will be computed for each adopter group. If the cross-sectional method indeed captures the time element of innovativeness, group mean year of adoption will increase from early adopters to late adopters.

4.3.5.4 The Composite Measure of Innovativeness

The third method of assigning innovativeness scores is a hybrid of the above two methods called composite innovativeness. It uses several products, selected based on the same criteria as they were in the cross-sectional method. However, the score for each product is not binary. Scores depend on when a respondent adopted a product relative to other respondents as in the Rogers method. The times of adoption for each product are normalized. Respondents who did not use a product are given a score equivalent to adopting the product three standard deviations after the mean time of adoption. Scores for all products are then summed and normalized a second time. These summated normalized scores are used to assign respondents to one of the three adopter groups.

Equation 4.2 $$CI = \sum_{i=1}^{n} (m_i - t_i) / s_i$$

CI = composite innovativeness
m_i = mean time of adoption of innovation i
t_i = time that individual adopted innovation i
s_i = standard deviation of adoption times for innovation i
n = number of innovations

4.3.6 Adoption and Diffusion

The terms adoption and diffusion are often used interchangeably in the innovation literature. Adoption is usually viewed as a binary variable. A respondent has either adopted a technology or has not adopted. If a respondent has adopted, then the innovation is considered to have diffused past the respondent. Diffusion is the rate at which adoptions occur over time.

It is predicted that early adopters are the first group through which a new technology will diffuse. Therefore, when observing the time of adoption of a certain technology, we would expect to see a diffusion effect where early adopters use a new technology before majority adopters, who in turn use a new technology before late adopters. This time effect of diffusion was tested for in this study by comparing adopter group means of year of first trial for each product in the analysis.

Adoption is not always simple enough to be considered a binary variable. A singular definition of adoption eludes innovation researchers as the adoption of a new idea or technology does not always completely displace traditional ideas or technologies (Rogers 1995). This is particularly true when considering the use of substitute building materials. Market economics between solid and engineered wood may come into play when products can be easily substituted. Further, home plans or consumers may specify product use, in which case a builder's ability to choose the product is diminished.

This project makes two assumptions concerning adoption. First, as it is difficult to define when a product was fully adopted, time of first trial is used in place of time of adoption for time measures (Eastin et al. 1996). The second assumption is that adoption is a continuous variable rather than binary. As the time of first trial measure sets no lower boundary on product usage, it is of interest to measure the degree of adoption separate from the time measure.

Again, wood I-joists were chosen as the product on which to measure degree of adoption. As most respondents used wood I-joists in 1997, performing the analysis on this product allows us to keep the greatest number of respondents in the analysis. The major use of wood I-joists is for floor joists. Respondents were asked what percentage of floor area they built with I-joists in 1997. This percentage of floor area was used as a surrogate for degree of adoption of a new product, wood I-joists. This measure of degree of adoption will be compared across adopter groups for each method of scoring innovativeness. The degree of adoption is a useful measure since it allows us to compare the dedication of respondents to a new technology.

4.4 Results

4.4.1 Choosing an Innovativeness Measure

The three innovativeness measures under consideration were compared on their ability to capture the time element of diffusion and the degree of adoption of an innovation.

4.4.1.1 Classic Rogers Innovativeness

The average year of adoption of wood I-joists was 1990.9 with a standard deviation of 4.42 years. Based on these two statistics, respondents were assigned to one of the three adopter groups.

The classic Rogers definition of innovativeness was successful in capturing the time element of diffusion. While group membership was based on a single product, wood I-joists, the diffusion time trend is evident for four out of the remaining five products. Group mean time of first trial increases from early adopters through late adopters for LVL, OSB, PSL, and LSL. These group differences are significant at the p=0.05 level for three of the products, and p=0.10 level for one product (see table 4.2). The Rogers model, or one product approach, adequately captures the time element of innovativeness.

Table 4.2 Mean time of first trial for products with adopter groups defined by Rogers, one product (I-joists), innovativeness.[17]

	Product					
	I-joists	LVL	OSB	PSL	LSL	Finger-jointed Studs
Early Adopters	*1982.5*	1990.6	1988.8[a]	1991.5	1993.1[a]	1992.3[a]
Majority Adopters	*1991.6*	1993.9[a]	1990.7[a,b]	1993.8[a]	1994.7[a]	1992.8[a]
Late Adopters	*1996.5*	1995.2[a]	1992.1[b]	1995.3[a]	1996.0[a]	1993.4[a]
ANOVA P-value	*.000*	.000	.034	.000	.088	.909
N=	*182*	111	164	126	68	82

[17] Cells sharing the same letter (in same column) are not significantly different at the P=.05 level, using the Bonferroni multiple comparison test.

The second criterion for a satisfactory innovativeness measure is that it capture the adoption element of innovation. The percentage of floor area built with wood I-joists in 1997 was used as a surrogate for degree of adoption. Table 4.3 displays the percentage of floor area built with wood I-joists for each adopter group. While early adopters built a greater percentage of floor are with I-joists, there is not a significant difference among adopter groups (p=.215). Therefore, the single product, time measure of innovativeness fails to capture a degree of adoption effect.

Table 4.3 Percentage of 1997 floor area built with I-joists for Rogers 1 product (I-joists) innovativeness groupings.

	Percentage of Floor Area
Early Adopter	71.8 [a]
Majority Adopters	58.9 [a]
Late Adopters	58.8 [a]
ANOVA P-value	.215

4.4.1.2 Cross-sectional Innovativeness

The cross-sectional innovativeness measure is the sum of innovative products used by a firm in a given time frame. Builders were asked if they had used a set of 9 products in 1997. This set of products was then checked for homogeneity. Table 4.4 displays the correlation among the nine products. Structural insulated panels and steel studs were eliminated from the set as they were negatively correlated with many of the other products. Glulam was eliminated from the analysis for two reasons. First as 96.5%

of respondents used glulam in 1997 it provides little power for differentiating builders. Second, glulam was negatively correlated with the use of I-joists.

Table 4.4 Product Usage Correlations

	FJ Studs	*Glulam*	*I-Joists*	*LSL*	*LVL*	*OSB*	*PSL*	*SIP's*	*Steel Studs*
FJ Studs	1								
Glulam	*.127*	*1*							
I-Joists	.042	*-.075*	1						
LSL	.160*[18]	*.084*	.138*	1					
LVL	.223*	*.002*	.224**[19]	.253**	1				
OSB	.178*	*.019*	.116	.032	.218**	1			
PSL	.129	*.154**	.124	.258**	.164*	.238**	1		
SIP	*-.048*	*-.137*	*.120*	*.037*	*-.029*	*.006*	*-.126*	*1*	
Steel Studs	*.044*	*-.108*	*.105*	*.025*	*-.061*	*-.022*	*-.008*	*.107*	*1*

Six products were used in the final cross-sectional innovativeness model. These products varied in their stage of diffusion (see table 4.5). Therefore, the builders using the greatest number of products in 1997 are assumed to be most innovative.

Table 4.5 Percentage of Builders Using Engineered Wood Products in 1997.

Product	Percentage Using in 1997
I-joists	86.6
Oriented Strand Board	75.6
Parallel Strand Lumber	66.7
Laminated Veneer Lumber	57.7
Laminated Strand Lumber	35.3
Finger Jointed Studs	30.8

18 * Significant at the p=.05 level.

19 ** Significant at the p=.01 level.

This model was tested for reliability using the KR-20 method (Kuder and Richardson, 1937). The KR-20 coefficient of reliability for the composite measure was 0.55. This is lower than ideal for such a measure. For predicting the performance of an individual, a coefficient of 0.7 or higher is desired (Wolf 1998). Therefore, caution must be used when interpreting results from this method. At the 0.55 level this method is reliable for making generalizations about groups of builders. However, when considering individual builders the reliability of the cross-sectional method is questionable.

The cross-section method was not able to capture both constructs of innovativeness in which we were interested, specifically the time element of innovativeness (see table 4.6). When builders were grouped based on the number of innovative products used, there were no significant group differences in the time of first trial. This is to say that builders using the greatest number of innovative products in 1997 did not adopt these products earlier than other builders using fewer innovative products.

Table 4.6 Mean of time of first trial for products with adopter groups defined by cross-sectional innovativeness.

	Product					
	I-joists	LVL	OSB	PSL	LSL	Finger-jointed Studs
Early Adopters	1990.5 [a]	1992.9 [a]	1991.0 [a]	1993.2 [a]	1995.1 [a]	1993.7 [a]
Majority Adopters	1990.9 [a]	1993.7 [a]	1990.4 [a]	1993.5 [a]	1994.7 [a]	1992.2 [a]
Late Adopters	1991.2 [a]	1991.3 [a]	1990.6 [a]	1992.9 [a]	1993.8 [a]	1992.8 [a]
ANOVA P-value	.858	.183	.689	.749	.556	.230
N=	182	115	179	136	72	88

However, the cross-sectional definition of innovativeness did capture the degree of adoption construct of innovativeness. Builders who used all 6 of the innovative products in 1997 built 71% of floor area with wood I-joists (see table 4.7). Majority and late adopters used I-joists for an average of 62% and 51.4% of floor area. This result is significant at the p=0.10 level, not conclusive, but perhaps suggestive.

Table 4.7 Percentage of 1997 floor area built with I-joists for cross-sectional innovativeness groupings.

	Percentage of Floor Area
Early Adopter	71.0 [a]
Majority Adopters	62.0 [a]
Late Adopters	51.4 [a]
ANOVA P-value	.090[20]

Overall, the cross-sectional method did not prove to be the best method for segmenting adopters. Firstly, the reliability of the measure is low. Further, the measure failed to find significant differences in time of first trial across adopter groups. Finally, though the cross-sectional method did capture the adoption component of innovativeness, the difference in group means was significant at only the p=0.10 level.

4.4.1.3 Composite Innovativeness

The composite measure captured both the diffusion and the adoption components of innovativeness. The six products in the analysis were selected based on the product

[20] Significant at the p=0.10 level.

selection methods of cross-sectional innovativeness. This assured we were working with as homogenous a product group as possible, making results applicable to the set of engineered wood products. The times of first trial for each product were then normalized to provide a summated score based on time of adoption. The resulting innovativeness measure captured the innovativeness elements from the Rogers and the cross-sectional methods.

The time of first trial for four out of six of the products followed the diffusion time trend. Innovator group mean time of first trial increased from early to late adopters for these products (see table 4.8). The ANOVA test for a difference in group means is significant at the p=0.01 level for five of the products. However, the time trend observed for LSL does not follow the predicted pattern.

Table 4.8 Mean of year of first trial for products with adopter groups defined by composite innovativeness.

	Product					
	I-joists	LVL	OSB	PSL	LSL	Finger-jointed Studs
Early Adopters	1987.5	1991.8[21]	1988.5	1991.4 [a]	1993.1[a]	1992.3 [a]
Majority Adopters	1991.2	1994.0	1990.7	1993.9 [b]	1995.2[b]	1992.9 [a]
Late Adopters	1994.3	None	1992.9	1994.4[a,b]	1994.4[a,b]	1995.7 [a]
ANOVA P-value	.000	.004	.000	.001	.002[22]	.544
N=	182	115	179	136	72	88

[21] Two sample T-test significant at the p=0.05 level.

[22] Although group means for LSL are significantly different, they do not follow the expected diffusion pattern.

The groups also differed in their degree of adoption of wood I-joists. Early adopters, as defined by the composite method used I-joists to the greatest degree. The evidence for a difference in group means is even stronger for this method than for the cross-sectional method (see table 4.9). While the p-value for the difference in group means under the cross-sectional method was significant at the p=0.10 level, it is significant at the 0.01 level for the composite measure.

Table 4.9 Percentage of 1997 floor area built with I-joists for composite innovativeness groupings.

	Percentage of Floor Area
Early Adopter	71.8[a]
Majority Adopters	61.2[a]
Late Adopters	41.0
ANOVA P-value	.006[23]

4.4.1.4 Relationships Among Innovativeness Measures

The group assignment of respondents can be compared among the three innovativeness measures. The scores for each method were normalized and groups were assigned based on the normal distribution. If these methods are measuring innovativeness in the same manner we would expect groupings among methods to be correlated. Table 4.10 displays the correlations among group membership. Groupings derived from the composite innovativeness method are correlated to the two other methods, but most highly to the cross-sectional innovativeness method. Rogers's

[23] Significant at the p=0.01 level.

innovativeness groupings and cross-sectional innovativeness groupings are not highly correlated.

Table 4.10 Correlation's Among Innovativeness Measures Group Assignment.

	Classic Rogers Innovativeness	Cross-sectional Innovativeness	Composite Innovativeness
Classic Rogers Innovativeness	1		
Cross-sectional Innovativeness	.134	1	
Composite Innovativeness	.335**	.673**	1

4.4.1.5 Choosing a Method

Table 4.11 summarizes the characteristics of the three innovativeness measures. As the composite innovativeness measures includes all the elements of the other two measures, it was chosen to segment builders in this study.

Composite innovativeness captures adoption and diffusion in the same measure. Early adopters, as classified by this method, use new technologies early, and use them to a higher degree. These are both desirable to look for when marketing a new product. Therefore, by targeting the profile of early adopters under the composite method those who are both early adopters and dedicated to using new products are captured.

Table 4.11 Summary of the Innovativeness Measures Considered.

	Classic Rogers	*Cross-sectional*	**Composite**
Time-based Measure	YES	NO	YES
Multi-product Based Measure	NO	YES	YES
Captures Diffusion Element	YES	NO	YES
Captures Adoption Element	NO	YES	YES

4.4.2 Characteristics of Composite Innovativeness Adopter Groups

Rogers (1995) created a series of generalizations in comparing the characteristics of early adopters and later adopters. The composite definition of innovativeness captured some of these differences. These similarities support the composite method's adequacy in capturing the innovativeness construct.

For example, Rogers (1995) generalization 7-7 states early adopters are generally larger companies. Using composite innovativeness we found that larger firms are the most innovative. The average number of houses built in 1997 was significantly different among groups. While early adopters built an average of 8.6 houses, majority adopters built an average of 6 homes, and late adopters built an average of 3.4 homes[24].

Rogers generalizes that innovators tend to have greater financial resources. We found that revenues also differed among the groups (see table 4.12). A total of 46.9% of early adopters had 1997 revenues over $1,000,000. This figure was 34.6% and 20.7% for majority and late adopters respectively. On the lower end of the revenues scale, 55.1% of

[24] The five firms building over 35 homes per year are excluded from this statistic. Of these firms 1 was classified an early adopter, and 4 were majority adopters.

late adopters made less than $500,000 in 1997. Only 39.9% of majority adopters and 28.2% of early adopters made less than $500,000 in revenues in 1997.

Table. 4.12 Firm revenues by adopter group.

	1997 Revenue ($)						
	Less than 100,000	*100,000 to 499,999*	*500,000 to 999,999*	*1,000,000 to 4,999,999*	*5,000,000 to 10,000,000*	*Over 10,000,000*	*Total*
Early Adopter	9.4%	18.8	25.0	37.5	9.4	0	100
Majority Adopter	4.6	33.8	25.4	28.5	3.8	2.3	100
Late Adopter	17.2	37.9	24.1	20.7	0	0	100
Total	7.3	31.9	25.1	28.8	4.2	1.6	100%

It has also been found that innovators are generally heavy users within the product category being examined (Robertson 1971). In this study, the percentage of firm revenues generated in SIC 1521 differed among adopter groups. Early adopters generated 85.6% of their 1997 revenues in SIC 1521 while late adopters only generated 72.7% of their revenues in the single-family homebuilding market. This result indicates that those which are more involved in the product category, the heavier users, are more innovative.

Table 4.13 Variables that Differed Among Adopter Groups.

	Number of Homes	Manufacturer Field Representatives	Opinion Leader-ship
Early Adopters	8.63[a]	2.89[a]	27.4[a]
Majority Adopters	5.97	2.19	25.4[b]
Late Adopters	3.44[a]	1.82[a]	20.8[a,b]
ANOVA P-value	0.008	0.039	0.006

Rogers's generalization 7-21 states that early adopters have greater change agent contact than later adopters. Early adopters rated communications with manufacturer's field representatives to be more important than other adopter groups did. They rated communications with manufacturers field representatives to be 2.8 out of 7 on a likert scale[25], while majority and late adopters rated these communications on average to be 2.2 and 1.9 respectively. However, communications with manufacturers field representatives were not rated highly compared to other communication channels measured.

Rogers's generalization 7-26 stated, early adopters have a higher degree of opinion leadership than later adopters. Opinion leadership was measured using the Childers (1986) scale. Six bipolar scale questions were asked which covered interpersonal communication among builders about engineered wood products. The Childers one to five scale was replaced with a one to seven scale for this study. The adopter groups had significantly different mean scores of opinion leadership ($p=0.006$). It was found that early adopters had the highest level of opinion leadership and late adopters the lowest.

The above examples confirm that the composite innovativeness measure captures at least some of the elements Rogers identifies to be part of innovativeness. There were many other demographic and communication variables measured that did not differ among groups. However, no variables saw group differences that were inconsistent with Rogers's theories.

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[25] A one to seven likert scale was used to evaluate the importance of communication channels in learning about new products. The scale ends were "1-not at all important" and "7-very important".

4.5 Conclusions

4.5.1 Summary

In this study we found that the two most common methods of measuring innovativeness did not measure the same construct. The Rogers time of adoption method does capture the *time element* of diffusion of innovations. On the other hand, the cross-sectional method of defining innovativeness differentiated builders on their *degree of adoption* of an innovation. Group membership of respondents, as assigned by these two methods, is not significantly correlated. They appear to be measuring different constructs.

By creating a hybrid of the two innovativeness measures we were able to capture simultaneously *both* the diffusion and adoption elements. Group membership as assigned by this composite method is correlated with group membership from the other two methods. Profiling the demographic and communication characteristics of the three composite innovativeness adopter groups produced a number of group differences that are suggested in the diffusion literature. We are confident, therefore, that the composite measure of innovativeness is an acceptable, and perhaps superior, method of segmenting industrial markets for new products.

4.5.2 Managerial Implications

It is important to discuss the practical applications of any method put forward. The use of composite innovativeness scores in segmenting a market requires significant up-front investment of research efforts. Of the three methods proposed, composite innovativeness has the greatest data collection requirements. It requires that time of first trial be recalled for a *set* of innovations, rather than just *one* as in the simpler Rogers method. When using a cross-sectional design, current behavior is often readily observable, reducing data collection efforts. Time of first trial is not readily observable unless records are available. Therefore, interviews or questionnaires are required to do this research. The up-front investment of time and money is highest for composite innovativeness.

It can be argued, however, that high costs on the front end are offset by the wide usefulness of the resulting adopter group profiles. First, in one measure composite innovativeness captures the profile of adopters that are both early adopters and active users of new products. This is more valuable than a measure that captures only one of the two innovativeness constructs, adoption or diffusion.

By understanding the adopter segments of a market before entering it, organizations may be able to reduce marketing expenditures while increasing their chances of a successful product launch.

Further, results based on the composite can be widely applied. Because several products go into the measure, the adopter group profiles are applicable to an entire product category in relation to a user segment. The results from a one-product, time-based model are specific to that product. Therefore, profiles created from such a specific classification are of little value beyond that product. On the other hand, as composite innovativeness provides a general measure of innovativeness for a product category, results can be used when marketing a new product in the category to the user group in question.

This method can also be valuable in marketing products that have progressed beyond the launch stage of their product life cycle. To capture majority adopters or late adopters, marketing messages can be customized to their profiles. For example, as later adopters of engineered wood products tend to be in urban areas, marketing efforts would shift from smaller counties to larger counties as a new product gains acceptance.

Studies of this type are specific to a single product category in relation to a single consumer group. Therefore, any organization wishing to use such information will likely have to commission a study customized for their specific circumstances. Decision makers differ among markets. Further, communication channels and attitudes towards new technologies differ across markets.

A single iteration of this type of study has a limited period of applicability. While the basic characteristics of innovativeness are relatively stable, the most useful outputs of this type of study are market specific. The characteristics of markets shift over time. For example, big box home centers have significantly changed the distribution of building materials in recent years. In the next five years we would expect to see the Internet become a more important tool in learning about new products. These shifts in market characteristics demonstrate the need to repeat this type of study at regular intervals.

5. SEGMENTING SINGLE-FAMILY HOMEBUILDERS

(For submission to Forest Products Journal)

5.1 Introduction

The past two decades have seen the rate of new wood products introduced into the home building market increase dramatically. The combination of new technology, a changing timber supply, and increased recovery of wood inputs is credited with moving the forest products industry towards the production of engineered wood products. These supply side factors are well documented (Vlosky et al 1994, Leichti et al. 1990).

However, the demand side has seen few studies on the development of the engineered wood products market. Of the markets for wood based building materials, the single-family homebuilding sector is the largest, and therefore, most important. However, little information is available on the adoption of new engineered wood products by single-family homebuilders.

The introduction of a new product into a market carries considerable risk. Urban and Hauser (1980) estimate the failure rate of products that make it to the launch stage is 30%. It is, therefore, important to understand potential consumers of a new product to minimize the risk of product failure. Potential consumers generally differ in the timing of their adoption of new products (Rogers 1995). In the single-family homebuilder market, this may be the result of differing company demographic and communication characteristics. These differences in adoption characteristics form a basis on which consumer segments can be studied. Properly targeting these segments is one way to aid the transition from traditional products to engineered wood.

5.2 Literature Review

In 1962 Everett Rogers published his first edition of the "Diffusion of Innovations" bringing together diffusion research traditions from many fields. Diffusion is "the process by which an innovation is communicated through certain channels over time along the members of a social system." (Rogers 1995, p. 5). Out of this definition comes what Rogers defines as the four main elements of the diffusion of innovations; the innovation, a social system, communication channels, and time. Innovations are ideas or technologies that are perceived as new (Rogers 1995). A social system is a network of individuals though which innovations diffuse. Individuals use communication channels to pass innovations on to other individuals. This whole process does not happen instantaneously, rather it happens over time. "The individuals of a social system do not adopt an innovation at the same time. Rather, they adopt in an over-time sequence, so that individuals can be classified into adopter categories on the basis of when they first begin using an idea." (Rogers 1995, p.252)

The above excerpt hints at a way in which adoption and diffusion can be used in conjunction with one of the most valuable marketing tools, segmentation. It is desirable to identify the group of adopters that will be the earliest to use new products and to target marketing efforts to them when launching new products.

Rogers and Shoemaker (1971) defined innovativeness as adopting a new idea or technology early relative to others. The simplest way of operationalizing innovativeness is to create a measure based on the point in time which individuals adopted an innovation. Rogers (1995) created five adopter groups based on standard deviations from the mean time of adoption of a single product. He then created a profile for each of the adopter groups with regard to demographics, personality, and communication characteristics.

A second method of operationalizing innovativeness, known as cross-sectional innovativeness, involves measuring new product use or ownership (Robertson 1971, Midgley and Dowling 1978). Robertson (1971) proposed that given each product, in a set of products, are in a different stage of their diffusion, the earliest adopters will be using the greatest number of products at a point in time. Innovativeness, thus, can be measured by product usage.

Midgely and Dowling (1978) argue that the time based definition of innovativeness and the cross-sectional definition of innovativeness do not measure the same construct. The time based definition of innovativeness is tied directly to the product under study at a low level of abstraction. On the other hand, cross-sectional innovativeness can be generalized to a product category, but is at a higher level of abstraction.

From a marketing perspective we are interested in identifying those which will adopt a new product early. Situational factors are always present in the real world. Therefore, Gatignon and Robertson (1985) conclude that "innovators must be identified and characterized on a product category basis and that there is not a generalized innovator across product category or interest domains"(p. 861).

Studies in the field of forest products and forestry that deal with adoption and diffusion of new products and technologies are few. The field of forest products and forestry is very broad and the works that have been done on the subject reflect this diversity.

Shook (1997) studied innovation and diffusion in the residential construction industry with respect to engineered wood products. Firm perception of industry competition, the presence of trade unions, and management intensity were found to negatively influence engineered wood product adoption. He also found that firm and product specific factors were more likely to affect adoption than were industry structure factors.

Many of the adoption and diffusion studies in the forestry sector involve new processing technology. Cohen and Sinclair (1990) looked at the adoption of new production technology by major North American producers of softwood lumber and plywood. Firms were clustered based on their usage of new technologies. The economic and market performance of each cluster was then analyzed. It was found that firms adopting more innovative technologies performed better than those that adopted fewer technologies.

West and Sinclair (1992) studied the adoption of innovative production technology in the household furniture industry. They found that innovator companies employed significantly more manufacturing and production engineers. They were also significantly more technically progressive.[26] Dependence on trade shows for information

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[26] Technical progressiveness was measured by the response on a likert scale to a statement "Our manufacturing organization tries to be the first in our industry to implement new production technologies and methods."

was the only communication variable that was significantly different between innovators and non-innovators.[27] Of the firm demographic variables, innovators were found to have more employees and had higher priced final products.

The perceptions of engineered wood products among single-family homebuilders were studied by Hansen and Adair (1996). They found geographical differences in engineered wood product perceptions. Eastin et al. (1996) looked at engineered wood product usage and also found evidence of geographical differences.

Past research on adoption and diffusion in forest products and forestry involves many different subjects with many different characteristics. The characteristics of the single-family homebuilding market are, on the surface, not comparable to most forest products industry studies. Homebuilders operate small companies that are very different from large forest companies or state departments. Adoption of engineered wood by homebuilders does not require a large capital expenditure, nor does it require a future commitment to the innovation as the adoption of new production technology does. However, the diversity of these studies reinforces the fact that adoption and diffusion is largely driven by the characteristics of the decision-maker and their perceptions.

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[27] 2-sided p-value 0.08

5.3 Methods

5.3.1 Sampling

The population of interest in this study is firms involved primarily in single-family home construction in California, Oregon and Washington. The Standard Industrial Classification (SIC) for this population is 1521. A list of 1100 firms in the geographical frame was randomly generated by Dun and Bradstreet Information Services. Dun and Bradstreet lists 21,078 firms involved in single-family housing construction (SIC 152100) in Oregon, Washington, and California.

We sought to limit regional effects that would make it more difficult to separate firms according to their innovativeness. As previous nation-wide studies found evidence that material usage differed among regions (Eastin et al. 1996, Hansen and Adair 1996), we selected these three states for their similar engineered wood product usage. Further, engineered wood products have the longest history and most developed state of diffusion in these states. Therefore, a late adopter in this region may have adopted a new technology before early adopters in other regions. For these reasons the geographical frame of the study was limited to California, Oregon, and Washington.

The number of firms included in the sampling frame was sufficient to assure a total of 200 valid responses. The target of 200 valid responses was based on the statistical methods to be used and the number of variables to be measured.

5.3.2 Survey Instrument.

A questionnaire was developed to be used in conjunction with telephone interviews. The questionnaire covered simple firm demographics, past engineered product usage, and communication channels and methods used by firms. Initial question formulation and survey instrument design took place at Oregon State University.

The questionnaire was pretested by academics, building industry association representatives, and homebuilders. Initial feedback on the survey instrument was provided by contacts at APA- the Engineered Wood Association, the Center for International Trade in Forest Products at the University of Washington, the National Association of Homebuilders Research Center, and the Field Company.

Pretesting took place with local Corvallis, Oregon area builders. In initial pretests builders not only answered the questions, but provided open-ended feedback. Two face-to-face open-ended pretests were carried out. Wording was adjusted on some questions to ensure clarity. A second round of builder pretesting took place in Corvallis. In these two pre-tests, telephone interviews were used to simulate actual data collection conditions. This was the final check of questionnaire clarity and logic. Only minor changes were necessary as a result of the pretesting.

5.3.3 Data Collection

A telephone research firm was contracted to collect the data. This market research firm has a long history of projects in the wood industry and has conducted telephone interviews with single-family homebuilders in the past. Therefore, the interviewers were familiar with engineered wood products and the type of respondent firm.

Interviewer training took place on March 24, 1998 at the research company's headquarters in Seattle, Washington. Interviewers were introduced to the goals of the project and were walked through the questionnaire. Samples of each of the engineered wood products in the study were displayed to ensure the interviewers were familiar with each product.

One week prior to data collection a prenotification letter was sent to potential respondent builders in the sample. As there were only five interviewers, prenotification letters were sent in three waves. This helped avoid a delay between a builder receiving the prenotification letter, and being contacted by an interviewer. Initially, 400 letters were sent on March 30 1998, and their contact information turned over to the interviewers the next week. When the initial list of 400 was nearly exhausted, a second round of 400 letters were sent on April 20. When this list was exhausted the final 300 letters were sent on May 4.

5.3.4 Response Rate

Response rate was calculated to be 48.8% using the single stage sampling with eligibility requirement method (Wiseman and Billington 1984). Response to this study was quite good with 201 usable, completed interviews and only 63 refusals. Unfortunately, the list of builders was very inconsistent. A total of 331 of 1100 firms were not eligible for the survey. These firms core business activities did not include homebuilding.

5.3.5 Segmenting Based on Innovativeness

In this study, three methods of segmenting builders were used. They were all based on the concept of innovativeness, the tendency to adopt a new product early relative to others. Each measure gave firms higher scores for higher levels of innovativeness. For each measure of innovativeness, firms were placed into the three adopter groups based on a pre-existing theory of adopter segments. The 13.5% of builders with the highest scores were considered early adopters. The 66% of builders with the next highest scores were considered majority adopters. Finally, the 13.5% of firms with the lowest scores were designated as late adopters. These groups are based on previous work in new product adoption, and rely on simple statistical definitions for group thresholds.

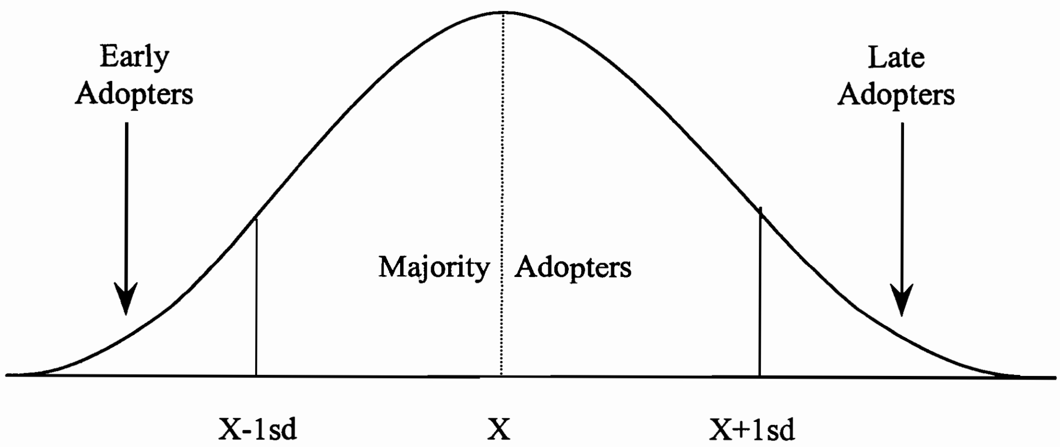

Figure 5.1 The Normal Distribution of Adopters.

5.3.5.1 The Classic Rogers Method.

The first method segmented builders based on the time they adopted a single innovation. In this case the innovation was wood I-joists, as over 90% of the sample had used them. Each firm was placed into one of three adopter groups based on when they first used wood I-joists relative to all other firms.

The one product model is very simple to apply. It requires only that a product has been used at least once by a majority of respondents and that respondents can recall the time they first trialed the product. However, as this method uses only one product and one occurrence of first use it has a great potential for misclassifying respondents. This is because there is no way to control for situation factors and one time occurrences. Further, the ability of builders to recall the exact year they first used wood I-joists directly effects the accuracy of the classification.

5.3.5.2 The Cross-sectional Method

The second method used to segment builders was the cross-sectional method. This method took the time measure out of the innovativeness definition and added more products to the analysis. Respondents were given one point for every innovative product they used in 1997. By including products in the analysis that are in different stages of their diffusion, a builder using more products is expected to be more innovative. Referring to table 5.1, the percentage of builders who have ever used a product is a measure of diffusion. Note that the percentage of builders who ever used a certain product ranges from 10.4% to 98%. They were then put into groups based on their scores.

For this analysis the group of innovations analyzed was reduced to six. This is because some of the innovations were substitutes for each other. Structural insulated panels, glulam, and steel studs were, therefore, removed from the analysis.

Table 5.1 Percentage of builders who have trialed each product, and the percentage of builders who continued and discontinued using each product in 1997.

	Percentage of Builders		Mean Year of First Trial
	Ever Used	Continued in 1997	
I-joists	90.5	86.6	1990.9
OSB	89.1	75.6	1990.6
PSL	66.7	66.7	1993.4
LVL	57.7	57.7	1993.4
Finger-Jointed Studs	44.3	30.8	1992.8
LSL	36.3	35.3	1994.5
SIP's	10.4	8.5	1990.7
Steel Studs	51.7	30.8	1990.0
Glulam	98	96.5	-

5.3.5.2 The Composite Method

The third method of defining innovativeness is a composite measure of the time of first trial of all six products. It maintains a time measure while using multiple products in the analysis. For each product, respondents were given a score based on the time they adopted the product. Earliest adopters were given the highest scores while late adopters were given lower scores. Non-adopters were given the lowest score for each product. Scores were computed for each product then summed together into a composite measure of innovativeness. Respondents were then divided into three groups based on their composite innovativeness scores.

Equation 5.1

$$CI = \sum_{i=1}^{n} (m_i - t_i) / s_i$$

CI = composite innovativeness
m_i = mean time of adoption of innovation i
t_i = time that individual adopted innovation i
s_i = standard deviation of adoption times for innovation i
n = number of innovations

5.4 Results- The Single-family Homebuilding Market

5.4.1 Characteristics of Single-family Homebuilders

5.4.1.1 Communicating with Single-family Homebuilders

A primary motivation for this study was to find out how builders learn about new building products. Builders were asked to rate a series of communication channels according to how important they were in learning about new products. A seven point likert scale was used, one being "not at all important", and seven being "very important". Table 5.2 provides a summary of the communication channels, their scores, and their rank relative to each other.

Table 5.2 Average rating of communication channels where 1 is not at all important in learning about new products and 7 is very important.

Communication Channel	Average Rating (out of 7)	Rank
Building Product Suppliers	4.99	1
Trade Magazines and Journals	4.43	2
Talking to Other Builders	4.36	3
Manufacturer's Literature	3.68	4
Visiting Other Building Sites	3.49	5
Professional Association Literature	2.83	6
Trade Shows	2.61	7
Manufacturers Field Representatives	2.24	8
Training Seminars	1.84	9
Internet	1.3	10

Only three of the above communication channels were rated above the neutral value of 4.0 on the scale. Builders report that building products suppliers are the most important source of new product information. This is followed by information learned through trade magazines and journals. The third communication channel rated to be of above average importance is talking to other builders or word-of-mouth communication.

The Internet, though a good vehicle for transporting mass quantities of information, has not yet developed into an important communication device with homebuilders. Only 41 out of the 201 respondents rated the Internet higher than "1", not at all important. This is likely due to limited access to the Internet at this time.

Trade shows only received an average rating of 2.61 out of 7 in this study. The average number of trade shows attended per year by builders was 0.96. Only 10 builders participated in trade shows as exhibitors.

5.4.1.2 Product Usage

The building materials of interest in this study were engineered wood products. Nine engineered wood products and wood substitute building materials were studied. One of the definitions of innovativeness used requires that the products considered be at different stages of their market diffusion. Therefore, we selected a spectrum of products from relatively old to relatively new, that were in different stages of their product lifecycles. The oldest product in the analysis was glue-laminated beams, which have been around for over a century. Oriented strand board and wood I-joists are widely used but relatively new.

Three forms of structural composite lumber were considered. These were laminated veneer lumber (LVL), parallel strand lumber (PSL), and laminated strand lumber (LSL). Structural insulated panels (SIP's) were considered as they are in the introductory phase of their product lifecycle. Finally, two alternatives to solid wood studs were considered. These were steel studs, and finger-jointed studs.

Builders were asked if they had ever used each of the products, and if so, what year they first used each product. They were also asked if they used each product in 1997. If a product was not used in 1997 the firm is considered to have discontinued its use.

Table 5.1 provides a summary of product trial and continuance. Usage rates for engineered products are very high with the firms in this sample. This is due in large part to the selection of the states of California, Washington and Oregon. These states have been shown in the past to have very high rates of engineered wood product usage (Eastin et al. 1996).

Almost all builders have used, and continue to use, glue laminated beams. This is not surprising as glulam is by far the oldest product considered in this study. In fact, glulam has been around so long that we did not ask when firms first used it, as the product likely predated all the firms or individual respondents in the sample. However, the continuance statistic for glulam is of interest with other new beam products entering the market. Very few builders did not use glulam in 1997. Though we cannot account for volume of products used with our data, there is no evidence of builders substituting all their beam applications for newer beam products.

Of the new engineered wood products, wood I-joists have the highest trial rate at 90.5%. In 1997, 86.6% of respondents used wood I-joists. This drop of only 3.9% is very low and may not even represent discontinuance as it is feasible that this many builders did not have an application suitable for wood I-joists in 1997.

Oriented strand board has the second greatest degree of diffusion of the new wood products with 89.1% of firms having trialed it. However, only 75.6% of builders surveyed continued to use OSB in 1997. Comments from builders seem to indicate that the high profile failure of some OSB siding products have affected OSB's image as a structural panel product as well. This effect may have been masked by the low price of OSB relative to plywood sheathing in 1997.

The three types of structural composite lumber show very low rates of discontinuance. All builders who had trialed LVL and PSL by 1997 continued to use them. Only 1% of builders quit using LSL in 1997.

Other products have much higher rates of discontinuance. While 44.3% of builders have used finger-jointed studs, only 30.8% continued to use them in 1997.

However, several builders commented on the inconsistent supply of finger-jointed studs in their areas. Therefore, supply factors may play a role in this high discontinuance statistic. Steel studs faired even worse with regard to discontinuance. While 51.7% of builders who had a some point used steel studs, only 30.8% used them in 1997.

The final product category considered was structural insulated panels. While 10.4% of builders who had used SIP's at one point, 8.5% used them in 1997. Of all the products in the study, builders were least familiar with SIP's. Many commented that they had never heard of them.

5.4.2 Segmenting Single-family Homebuilders

General firm characteristics of product usage and communication methods were described in the previous section. This information is valuable in marketing to this audience. However, the adoption of a new technology usually happens over time. In other words, not all builders will begin using a new product at the same time. Early adopters of a new technology may differ from later adopters not only in their product usage, but in their demographics and communication behavior as well. It is desirable then to segment the single-family homebuilders by their tendency to adopt a new product relatively early, or their innovativeness.

5.4.2.1 Adoption and Diffusion

The terms adoption and diffusion are often used interchangeably in the innovation literature. Adoption is usually viewed as a binary variable. A respondent has either adopted a technology or has not adopted. If a respondent has adopted, then the innovation is considered to have diffused past the respondent. Diffusion is the rate at which adoptions occur over time.

It is predicted that early adopters are the first group through which a new technology will diffuse. Therefore, when observing the time of adoption of a certain technology, we would expect to see a diffusion effect where early adopters use a new technology before majority adopters, who in turn use a new technology before late adopters. This time effect of diffusion was tested in this study by comparing adopter group means of year-of-first-trial for each product in the analysis.

Adoption is not always simple enough to be considered a binary variable. A singular definition of adoption eludes innovation researchers as the adoption of a new idea or technology does not always completely displace traditional ideas or technologies (Rogers 1995). This is particularly true when considering the use of substitute building materials. Market economics between solid and engineered wood may come into play when products can be easily substituted. Further, home plans or consumers may specify product use, in which case a builder's ability to choose the product is diminished.

This project makes two assumptions concerning adoption. First, as it is difficult to define when a product was fully adopted, time of first trial is used in place of time of adoption for time measures (Eastin et al. 1996). The second assumption is that adoption is a continuous variable rather than binary. As the time of first trial measure sets no lower boundary on product usage, it is of interest to measure the degree of adoption separate from the time measure.

Again, wood I-joists were chosen as the product on which to measure degree of adoption. As most respondents used wood I-joists in 1997, performing the analysis on this product allows us to keep the greatest number of respondents in the analysis. The major use of wood I-joists is for floor joists. Respondents were asked what percentage of floor area they built with I-joists in 1997. This percentage of floor area was used as a surrogate for degree of adoption of wood I-joists, and will be compared across adopter groups for each method of scoring innovativeness. The degree of adoption is a useful measure since it allows us to compare the dedication of respondents to a new technology.

5.4.2.2 Choosing a Definition of Innovativeness.

We found that each method defined different aspects of new product adoption and diffusion. The time based definition picked up on the diffusion of a product through the homebuilding community over time. While the three groups created under this classification were based on when builders first used I-joists, the groups succeeded in capturing the time element of diffusion for four out of the six products in the analysis. For example, the average time of adoption of LVL for early adopters was before majority adopters, who were in turn before late adopters, even though the adopter groups were based only on when builders first used I-joists. This means that on average, those who adopted I-joists early also adopted the other products early. Table 5.3 displays the average year of adoption of each time-based group for the six products analyzed. Three groups were defined for the cross-sectional innovativeness definition as well, however, these groups did not pick up on the time trend of innovativeness.

Table 5.3 Average year of first trial for six innovations with groups based on the *Rogers* (I-joists) definition of innovativeness.

	Product					
	I-joists	LVL	OSB	PSL	LSL	Finger-jointed Studs
Early Adopters	*1982.5*	1990.6	1988.8[a]	1991.5	1993.1[a]	1992.3[a]
Majority Adopters	*1991.6*	1993.9[a]	1990.7[a,b]	1993.8[a]	1994.7[a]	1992.8[a]
Late Adopters	*1996.5*	1995.2[a]	1992.1[b]	1995.3[a]	1996.0[a]	1993.4[a]
ANOVA P-value	*.000*	.000	.034	.000	.088	.909
N=	*182*	111	164	126	68	82

The cross-sectional innovativeness measure captured the construct of adoption. As builders are able to move between the use of new and traditional products, adoption varies in the degree to which a builder chooses to use the new product. A builder may have used a product once and be considered an early adopter in terms of diffusion, but may use the new product very seldom. Therefore, from a marketing standpoint it is important to identify not only who early users are, but who dedicated users are as well.

Degree of adoption was measured by asking builders what percentage of floor area they built in 1997 utilized wood I-joists. The three groups based on time of first trial did not differ significantly on this measure (table 5.4). However, the groups based on the cross-sectional definition did. Those builders that employed a greater number of innovations in 1997 also used wood I-joists for a greater percentage of floor area built. This is to say that builders who use a wider variety of innovative products also use these products to a greater extent than builders using fewer innovative products.

Table 5.4. Percentage of 1997 floor area built with I-joists with group membership assigned by *cross-sectional* scores.

	Percentage of Floor Area
Early Adopter	71.0[a]
Majority Adopters	62.0[a]
Late Adopters	51.4[a]
ANOVA P-value	.090[28]

The constructs of diffusion and adoption are both very important for marketing new products to homebuilders. It is important to identify those builders who will be the first to use a product when it is launched. The time based diffusion measure is best for this. However, we are also interested in identifying the builders who are loyal to new products and consume them in larger quantities. This adoption construct is captured by the cross-sectional definition of innovativeness. The ideal solution would be to capture both of these constructs in one measure.

5.4.2.3 The Composite Method

The composite method of defining innovativeness captured both the diffusion and adoption constructs. The diffusion time trend appeared for five out six of the products. Further, the percentage of floor area built with wood I-joists was highest for the early adopter group and lowest for the late adopter group. Therefore, the composite definition of innovativeness was chosen as the most appropriate for segmenting builders. Results reported below are based on the composite method of segmentation.

[28] Significant at the p=0.10 level.

Table 5.5 Average time of first trial for six innovations with groups based on the composite definition of innovativeness.

	Product					
	I-joists	LVL	OSB	PSL	LSL	Finger-jointed Studs
Early Adopters	1987.5	1991.8[29]	1988.5	1991.4 [a]	1993.1[a]	1992.3 [a]
Majority Adopters	1991.2	1994.0	1990.7	1993.9 [b]	1995.2[b]	1992.9 [a]
Late Adopters	1994.3	None	1992.9	1994.4[a,b]	1994.4[a,b]	1995.7 [a]
ANOVA P-value	.000	.004	.000	.001	.002[30]	.544
N=	182	115	179	136	72	88

Table 5.6 Percentage of 1997 floor area built with I-joists for composite innovativeness groupings.

	Percentage of Floor Area
Early Adopter	71.8[a]
Majority Adopters	61.2[a]
Late Adopters	41.0
ANOVA P-value	.006[31]

[29] Two sample T-test significant at the p=0.05 level.

[30] Although group means for LSL are significantly different, they do not follow the expected diffusion pattern.

[31] Significant at the p=0.01 level.

Table 5.7 Summary of the Innovativeness Measures Considered.

	Classic Rogers Innovativeness	*Cross-sectional Innovativeness*	**Composite Innovativeness**
Time Based Measure	YES	NO	**YES**
Multi-product Based Measure	NO	YES	**YES**
Captures Diffusion Element	YES	NO	**YES**
Captures Adoption Element	NO	YES	**YES**

5.4.2.4 Firm Demographics

In general, larger firms that work primarily in single-family homebuilding are the most innovative. The average number of houses built in 1997 was significantly different among groups. While early adopters built an average of 8.6 houses, majority adopters built an average of 6 homes, and late adopters built an average of 3.4 homes[32]. Early adopters are also more likely to build luxury or high-end homes. Fifty-three percent of early adopters reported building primarily up-scale homes while only 29% of late adopters were primarily in the high-end market. A total of 25.8% of late adopters reported being involved primarily in the construction of starter homes. Only 12.5% and 12.4% of early adopters and majority adopters respectively were involved primarily in starter homes.

[32] The five firms building over 35 homes per year are excluded from this statistic. Of these firms 1 was classified an early adopter, and 4 were majority adopters.

Table 5.8 Primary housing market builders work in by adopter group.

	Primary Market			Total
	Starter	Move-up	Luxury/High-end	
Early Adopters	12.5%	34.4	53.1	100
Majority Adopters	12.4	47.4	40.1	100
Late Adopters	25.8	45.2	29.0	100
Total	*14.5*	*45.0*	*40.5*	*100*

The percentage of firm revenues generated in SIC 1521 also differed among adopter groups. Early adopters generated 85.6% of their 1997 revenues in SIC 1521 while late adopters only generated 72.7% of their revenues in the single-family homebuilding market. This difference is even more remarkable given that only firms generating 50% and above of their revenues from single-family homebuilding were included in the study. The most likely alternate source of revenues for firms in this category is repair and remodeling.

Total revenues also differed among the groups. A total of 46.9% of early adopters had 1997 revenues over $1,000,000. This figure was 34.6% and 20.7% for majority and late adopters respectively. On the lower end of the revenue scale, 55.1% of late adopters generated less than $500,000 in 1997. Only 39.9% of majority adopters and 28.2% of early adopters made less than $500,000 in revenues in 1997.

Table 5.9 Population of the county where firms are based and adopter groups.

	County Population						Total
	10,000 to 24,999	*25,000 to 49,999*	*50,000 to 99,999*	*100,000 to 249,999*	*250,000 to 499,999*	*500,000 and Over*	
Early Adopter	6.3%	0	15.6	37.5	21.9	18.8	100
Majority Adopter	4.4	10.2	11.7	15.3	24.1	34.3	100
Late Adopter	3.2	3.2	9.7	16.1	12.9	54.8	100
Total	*4.5*	*7.5*	*12.0*	*19.0*	*22.0*	*35.0*	*100*

One very interesting outcome is an apparent county population effect on innovativeness. Close to 55% of late adopters came from large counties over 500,000. The most often observed county size for early adopters was 100,000 to 249,999 in population, suggesting that builders in these smaller counties are more likely to be innovative.

One final firm demographic that differed among adoption groups was membership in the National Association of Homebuilders (NAHB). Early adopters were most likely to be members of the NAHB. While 37.5% of early adopters were members of the NAHB, only 29% of majority adopters, and 6.7% of late adopters were. This is an expected result as the NAHB provides considerable support to builders in applying new technologies.

Builders were also questioned as to how new products fit into their business philosophy. On a scale from one to seven, one being strongly disagree and seven being strongly agree, builders were asked to evaluate two statements as they applied to their firm. The first statement asked builders if they agreed that their firm used new products as a competitive edge in their local market. Early adopters responded with an average rating of 5.5 out of 7. On the other hand, late adopters neither agreed or disagreed with the statement, with an average rating of 3.9. The second statement asked if respondents believed their firms had a reputation in their local market for using new products. Again early adopters responded with an average rating of 5.5. Late adopters mildly disagreed with this statement with an average rating of 3.5.

Table 5.10 Variables that Differed Among Adopter Groups.

	Number of Homes	Revenues in SIC 1521 (%)	Manu-facturer Field Represent-atives	Compete Using New Products	Reputation For New Products	Opinion Leader-ship
Early Adopters	8.63[a]	85.61[a]	2.89[a]	5.5[a]	5.53[a]	27.4[a]
Majority Adopters	5.97	83.00[b]	2.19	4.94[b]	4.86[b]	25.4[b]
Late Adopters	3.44[a]	72.67[a,b]	1.82[a]	3.87[a,b]	3.52[a,b]	20.8[a,b]
ANOVA P-value	0.008	0.010	0.039	0.001	0.000	0.006

5.4.2.5 Communications Variables.

Very few of the communications variables differed among the adoption groups. Early adopters rated communications with manufacturers field representatives to be more important than other adopter groups did. They rated communications with manufacturers field representatives to be 2.8 out of 7 on a likert scale, while majority and late adopters rated these communications on average to be 2.2 and 1.9 respectively. However, communications with manufacturers field representatives are not rated highly compared to other communication channels. Manufacturers field representatives generally target larger firms which build more houses and have higher revenues. This is the profile of early adopters. Therefore, the fact that early adopters rated contact with manufacturers field representatives higher than other builders may be a result of having actually met with these representatives while other adopters have not. Overall, early adopters still rated these communications to be below average importance.

Rogers (1995) predicts that early adopters have a higher degree of opinion leadership than later adopters. Opinion leadership was measured using the Childers (1986) scale. Six bipolar scale questions were asked which covered interpersonal communication among builders about engineered wood products. The Childers one to five scale was replaced with a one to seven scale for this study. The adopter groups had significantly different mean scores of opinion leadership ($p=0.006$). It was found that early adopters had the highest level of opinion leadership and late adopters the lowest.

5.5 Conclusions and Implications

5.5.1 Conclusions

In this study we found that the two most common methods of measuring innovativeness did not measure the same construct. The Rogers time of adoption method does capture the *time element* of diffusion of innovations. On the other hand, the cross-sectional method of defining innovativeness differentiated builders on their *degree of adoption* of an innovation. Group membership of respondents, as assigned by these two methods, is not significantly correlated. They appear to be measuring different constructs.

By creating a hybrid of the two innovativeness measures we were able to capture simultaneously *both* the diffusion and adoption elements. Group membership as assigned by this composite method is correlated with group membership from the other two methods. Profiling the demographic and communication characteristics of the three composite innovativeness adopter groups produced a number of group differences that are suggested in the diffusion literature. We are confident, therefore, that the composite measure of innovativeness is an acceptable, and perhaps superior, method of segmenting industrial markets for new products.

By understanding the adopter segments of a market before entering it, organizations may be able to reduce marketing expenditures while increasing their chances of a successful product launch. This method can also be valuable in marketing products that have progressed beyond the launch stage of their product life cycle. To capture majority adopters or late adopters, marketing messages can be customized to their profiles. For example, as later adopters of engineered wood products tend to be in urban areas, marketing efforts would shift from smaller counties to larger counties as a new product gains acceptance.

5.5.2 Marketing To Single-family Homebuilders.

This study identifies the communication characteristics that are most important to builders when learning about new products. It also identifies the demographic characteristics of early adopters, majority adopters, and late adopters. Though significant differences do not appear among adopter groups on the importance of communication channels, this still provides insights into targeting new products to early adopters.

For example, building products suppliers were rated the most important source of new product information by the entire sample. Displays, in-store demonstrations, and point of sale incentives are strategies to marketing through building product suppliers. If the demographic characteristics of early adopters are taken into account when designing these promotions the marketing efforts will be even more effective.

Early adopters tend to build more high-end and move-up housing. They are also the builders who do the most building and the least remodeling. Finally, they build a greater number of homes per year than other adopters. Promotions, displays, and demonstrations should be created with this adopter profile in mind. New products should be promoted to capture upscale markets early and lower end markets later.

Further, the selection of building suppliers to distribute through, or to run promotions through, can be targeted to the early adopter profile. Placing new products in building supply stores that serve upscale markets should be emphasized. This can be done by studying the appropriate demographic indicators of cities and towns. Areas with a high level of housing starts and a high income level should be targeted by distributing a product through local building centers, and promoting the product at these retailers.

With regard to magazines and trade journals the importance of advertising is apparent. In advertising, the characteristics of early adopters should be taken into account. Early advertising should be pitched towards builders of larger, higher quality homes. Magazines typically collect demographic data on their subscribers. This allows advertisers to choose a magazine with the desired audience. Further, the actual advertising copy should target these early adopters. As early adopters build higher quality houses, emphasize the quality and performance benefits of a product.

However, these sources can be used in other ways. By getting a product into a feature article or supplying a product for a magazine's demonstration projects, companies can take advantage of free advertising. This type of exposure is also more credible than traditional advertisements. However, as the message is not controlled by the manufacturer, but by the magazine, poor product performance will also be reported. The average number of different magazines builders regularly receive was 2.66 for this sample.

The third and final communication channel rated to be above average importance is word-of-mouth communications with other builders. This is a very powerful source of communication. Unfortunately, it is a very difficult communication channel to control. In a 1995 article in American Demographics, Walker states that those with positive experiences with a good or service share their impressions with an average of five peers. Those with a negative experience share it with nine peers. The importance of word-of-mouth communication demonstrates how providing a reliable product, good service, and prompt reaction to product failures is vital to producers, especially those in the process of launching new products.

The National Association of Homebuilders produces a building magazine as well as technical training materials for builders. They also maintain a catalogue of building products arranged by product and company. As early adopters are more likely to have access to this catalogue, producers of new products should use this tool in promotion. Finally, it seems that much focus is put on targeting early adopters. This is warranted as they are instrumental in getting products accepted by later builders through word-of - mouth recommendations. Further, early adopters build more homes per firm annually than do later adopters. Therefore, efforts spent inducing the adoption of a new product by these builders have the additional benefit of higher potential volumes per adopter. Successfully capturing early adopters is an essential step to wide market acceptance of a new product.

6. CONCLUSIONS

6.1 Summary

The single-family homebuilding market can be segmented by a meaningful measure of innovativeness. The composite method captured adoption and diffusion in the same measure. Early adopters, as classified by this method, use new technologies early, and use them to a higher degree. These are both desirable characteristics when marketing a new product. Therefore, by targeting the profile of early adopters under the composite method those who are both early adopters and dedicated to using new products are captured.

In this study we found that the two most common methods of measuring innovativeness did not measure the same construct. The Rogers time of adoption method captures the *time element* of diffusion of innovations. On the other hand, the cross-sectional method of defining innovativeness differentiated builders on their *degree of adoption* of an innovation. Group membership of respondents, as assigned by these two methods, is not significantly correlated. They appear to be measuring different constructs.

By creating a hybrid of the two innovativeness measures we were able to capture simultaneously *both* the diffusion and adoption elements. Group membership as assigned by this composite method is correlated with group membership from the other two methods. Profiling the demographic and communication characteristics of the three composite innovativeness adopter groups produced a number of group differences that are suggested in the diffusion literature. The author is confident, therefore, that the composite measure of innovativeness is an acceptable, and perhaps superior, method of segmenting industrial markets for new products.

By understanding the adopter segments of a market before entering it, organizations may be able to reduce marketing expenditures while increasing their chances of a successful product launch. This method can also be valuable in marketing products that have progressed beyond the launch stage of their product life cycle. To capture majority adopters or late adopters, marketing messages can be customized to their profiles.

It seems that much focus is placed on targeting early adopters. This is warranted as they are instrumental in getting products accepted by later builders through word-of-mouth recommendations. Further, early adopters build more homes per firm annually than do later adopters. Therefore, efforts spent inducing the adoption of a new product by these builders have the additional benefit of higher potential volumes per adopter. Successfully capturing early adopters is an essential step to wide market acceptance of a new product.

6.2 Future Research

Directions for future research fall into the market research methodology category, and the single-family homebuilder market intelligence category. Future market research methodology studies should replicate the use of the composite innovativeness measure to test for the capture of both the degree of adoption, and timing of adoption elements of innovativeness. It is important to isolate the factors which caused the two innovativeness elements to converge in this study. The first source may have been the composite innovativeness measure itself, in which case this measure will be very useful for identifying adopters who are both early to use and dedicated users of a new product. However, this convergence may have been due to the characteristics of a specific market.

Comparability between studies in different markets is always an issue. As with all markets, the single-family homebuilder market is unique. It is an industrial market that is characterized by repeat purchases of building products, and the ability to adopt new products to varying degrees. This market also has a high degree of subcontracting which means that products utilized in a housing project are often applied by someone other than the primary contractor. Any of these factors may have caused the convergence of the innovativeness elements in the composite measure.

Further information is needed to fully identify the factors contributing to firm innovativeness and the use of new products in the single-family homebuilding industry. Further investigation of communication channels and firm demographics of homebuilders could make the issue of innovativeness more clear.

A better understanding of wood product specification is needed to more effectively market products for use by single-family homebuilders. A study of the power over specification and actual product purchase could be very important in understanding other factors that effect new product adoption. Stakeholders may be builders, subcontractors, building inspectors, architects, engineers, and home buyers.

Results of this study provide an encouraging first step in understanding the development of the market for new engineered wood products. However, this study accounts for only a portion of the factors influencing new product adoption by single-family homebuilders. The avenues identified above for future research will help provide a more complete picture of this market when combined with the results of this study, and a historical account of the market's development.

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APPENDIX

The questionnaire used for this survey appears on the following pages.

Hello, I'm _________ of the Field Company, a market research firm based in Seattle. I 'm calling on behalf of the Department of Forest Products at Oregon State University regarding a study being done on the use of new structural engineered wood products in the building industry in an effort to identify more efficient ways to transfer new product technologies to the building sector. All interviews will be confidential and used only for statistical summaries. Would you be willing to help us for a few minutes?

1) Are over 50% of your firm's revenues generated from building single-family homes?

1. ___Yes
2. ___No
3. ___other _________________.

INTERVIEWER:

If 'yes' continue with question 2.

If 'no' or 'other' then terminate interview.

The following questions relate to how your firm learns about new products.

2) On a scale from 1 to 7 (1 being very seldom, 7 being very often), how often does your firm utilize the following sources in learning about new products and technologies?

	Very Seldom					Very Often		
Building product suppliers	1	2	3	4	5	6	7	N/A
Manufacturer field representatives	1	2	3	4	5	6	7	N/A
Manufacturer's Literature	1	2	3	4	5	6	7	N/A
Professional Association Literature	1	2	3	4	5	6	7	N/A
Trade magazines/journals	1	2	3	4	5	6	7	N/A
Trade Shows	1	2	3	4	5	6	7	N/A
Training Seminars	1	2	3	4	5	6	7	N/A

Talking to other Local Builders	1	2	3	4	5	6	7	N/A
Visiting other local Building sites	1	2	3	4	5	6	7	N/A
Internet (Websites)	1	2	3	4	5	6	7	N/A

Other ______________________________________.

3) Is your firm a member of the local chapter of the National Association of Homebuilders?

1.___Yes

2.___No

3.___other ___________________.

What other building-related associations is your firm a member of?

_____________________________.

_____________________________.

_____________________________.

_____________________________.

_____________________________.

_____________________________.

(total____)

4) Other than trade association publications, what building-related publications does your firm regularly receive?

_____________________________.

_____________________________.

_____________________________.

_____________________________.

_____________________________.

_____________________________.

Interviewer: List the publications that are easily recalled.

How many building related publications in total does your firm receive?

(total____)

5) Approximately, how many building-related trade shows do you or others in your firm attend per year?

___(#)

Of these, how many did your firm participate in as an exhibitor?

___(#)

6) The following questions ask about the interactions you and others in your firm have with other local builders. Responses for the following questions are on a scale from 1 to 7.

a. In general do you talk to other builders about engineered wood products; '7' very often, '1' never, or somewhere between '1' and '7'?

___(response 1-7)

b. When you talk to other builders about engineered wood products do you; '7' give a great deal of information, '1' give very little information, or somewhere between '1' and '7'?

___(response 1-7)

c. During the last year, how many builders have you told about new engineered wood products? Is it '7' your firm told a number of builders, '1' your firm told no one, or somewhere between '1' and '7'.

___(response 1-7)

d. Compared with other local builders, how likely are you to be asked about engineered wood products? Is it '7' very likely to be asked, '1' not at all likely to be asked, or somewhere between '1' and '7'?

___(response 1-7)

e. In discussions about engineered wood products, which of the following happens most often? '7' you tell other builders about engineered wood products, '1' other builders tell you about engineered wood products, or somewhere between '1' and '7'.

___(response 1-7)

f. Overall, in all your discussions with other builders, are you '7' often used as a source of advise, '1' not used as a source of advise, or somewhere between '1' and '7'?

___(response 1-7)

g. Does your firm have a reputation in your local area for it's use of new products and techniques? Do you '7' strongly agree, '1' strongly disagree, or is your answer somewhere between '1' and '7'?

___(response 1-7)

h. Does your firm use new products and techniques as your competitive edge in your local market. Do you '7' strongly agree, '1' strongly disagree, or is your answer somewhere between '1' and '7'?

___(response 1-7)

7) a. Have you or any other employees in your firm received formal training in the use of one or more structural engineered wood product(s)?

1.___ Yes

2.___ No

3.___ Other (______________________________)

4.___ Don't Know / No Answer

b. For which structural engineered wood products have your employees received training?

____

____

____

____

The following questions will ask about your firms' usage of nine different products. These questions apply only to your product usage for single-family construction.

8) a. Did your firm use OSB (Oriented Strand Board) as structural panels in 1997?

1.___ Yes

2.___ No

3.___ Other (______________________________)

4.___ Don't Know / No Answer

If YES go to 8.c

b. Has your firm ever used OSB?

1.___ Yes

2.___ No

3.___ Other (______________________________)

4.___ Don't Know / No Answer

If NO continue to question 9

c. Approximately, what year was OSB first used by your firm?

19__.

9) The next questions deal with your experiences with wood I-joists.

a. On a scale from one to seven, (one being poor, and seven being excellent) please indicate how you perceive the following attributes of wood I-joists.

	Poor						Excellent		
Quality		1	2	3	4	5	6	7	N/A
Availability	1	2	3	4	5	6	7	N/A	
Low Purchase Cost	1	2	3	4	5	6	7	N/A	
Low Installed Cost	1	2	3	4	5	6	7	N/A	
Reliability	1	2	3	4	5	6	7	N/A	

b. Has your firm ever used wood I-joists?

1.___ Yes

2.___ No

3.___ Other (______________________________)

4.___ Don't Know / No Answer

If NO continue to question 10

c. Approximately, what year did your firm first use wood I-joists?

19___.

d. What prompted your company to first use wood I-joists?

____

____

____

____

e. Approximately what percent of single-family floor area built by your firm last year utilized engineered wood I-joists verses concrete and solid sawn lumber?

I- joists	____%
Concrete	____%
Solid Sawn Lumber	____%

f. What types of applications did your firm use wood I-joists for in 1997?

Top of Mind		Aided Response
1.___	Floor joists.	1.___
2.___	Ceiling joists.	2.___
3.___	Roof trusses.	3.___
4.___	Headers.	4.___
5.___	Other (________________________)	

10) a. Has your firm ever used LVL (Laminated Veneer Lumber)?

1.___ Yes

2.___ No

3.___ Other (______________________________)

4.___ Don't Know / No Answer

If NO continue to question 11

b. Approximately, what year was LVL first used by your firm?

19___

c. What types of applications did your firm use LVL for in 1997?

Top of Mind		Aided Response
1.___	Headers	1.___
2.___	Joists	2.___
3.___	Studs	3.___
4.___	Beams	4.___
5.___	Rim boards	5.___
6.___	Stair Stringers	6.___
7.___	Other (________________________)	

11) a. Has your firm ever used Parallam?

1.___ Yes

2.___ No

3.___ Other (______________________________)

4.___ Don't Know / No Answer

If NO continue to question 12

b. Approximately, what year was Parallam first used by your firm?

19___

c. What types of applications did your firm use Parallam for in 1997?

Top of Mind		**Aided Response**
1.___	Headers	1.___
2.___	Joists	2.___
3.___	Studs	3.___
4.___	Beams	4.___
5.___	Other (________________________)	

12) a. Has your firm ever used Timberstrand (Laminated Strand Lumber, LSL)

1.___ Yes

2.___ No

3.___ Other (______________________________)

4.___ Don't Know / No Answer

If NO continue to question 13

b. Approximately, what year was Timberstrand first used by your firm?

19___

c. What types of applications did your firm use Timberstrand for in 1997?

Top of Mind		**Aided Response**
1.___	Headers	1.___
2.___	Joists	2.___
3.___	Studs	3.___
4.___	Beams	4.___
5.___	Rim boards	5.___
6.___	Other (________________________)	

13) a. Did your firm use finger-jointed studs in 1997?

1.___ Yes

2.___ No

3.___ Other (______________________________)

4.___ Don't Know / No Answer

If YES go to 13.c

b. Has your firm ever used finger jointed studs?

1.___ Yes

2.___ No

3.___ Other (______________________________)

4.___ Don't Know / No Answer

If NO go to question 14.

c. Approximately, what year did your firm first use finger jointed studs?

19___.

14) a. Did your firm use Structural Insulated Panels in 1997?
(also called SIP's or foam core panels)

1.___ Yes

2.___ No

3.___ Other (______________________________)

4.___ Don't Know / No Answer

If YES go to 14.c

b. Has your firm ever used Structural Insulated Panels?

1.___ Yes

2.___ No

3.___ Other (______________________________)

4.___ Don't Know / No Answer

If NO go to question 15

d. Approximately, what year did your firm first use structural insulated panels?

19___.

15) a. Did your firm use steel studs in 1997?

1.___ Yes

2.___ No

3.___ Other (________________________________)

4.___ Don't Know / No Answer

If YES go to 15.c

b. Has your firm ever used steel studs?

1.___ Yes

2.___ No

3.___ Other (________________________________)

4.___ Don't Know / No Answer

If NO go to question 16

c. Approximately, what year did your firm first use steel studs?

19___.

16) a. Did your firm use Glulam (Glue-laminated beams) in 1997?

1.___ Yes

2.___ No

3.___ Other (________________________________)

4.___ Don't Know / No Answer

If YES go to 16.c

b. Has your firm ever used Glulam beams?
1.___ Yes
2.___ No
3.___ Other (______________________________)
4.___ Don't Know / No Answer

If NO go to question 17

Finally, we would like to ask some demographic questions about your firm for statistical purposes. Remember, this information will be kept totally confidential.

17) What year did your firm begin operations.

19___.

18) Approximately, how many homes did your firm build in 1997?

___(#)

19) How many square feet, on average, were the houses your company built in 1997?

Square feet. ________.

20) What percentage would you estimate of your firm's revenues in 1997 were generated through single-family construction?

____%

21) What types of single family dwelling does your firm consider its primary market?

	Primary Market	Secondary Market
Starter	(__)	(__)
Move-up	(__)	(__)
Luxury / High End	(__)	(__)

Allow for a secondary market choice if builder selects more than one market. Check only one box in each column.

(__) QUESTIONS 22 AND 23 AVAILABLE ON CALLER CARD

<END CALL>

(__) QUESTIONS 22 AND 23 NOT AVAILABLE ON CALLER CARD.

<CONTINUE>

INTERVIEWER:

NOTE THE INFORMATION ON THE RESPONDENT INFORMATION CARD PRIOR TO MAKING THE CALL. IF ANY OF THE INFORMATION IS MISSING QUESTIONS 22 AND 23 THEY MUST BE ASKED HERE. FOR QUESTIONS 22 AND 23 IF THE CODE EQUALS '2' ON THE INFORMATION SHEET THESE QUESTIONS MUST BE ASKED. IF THE CODE EQUALS '0' THEN RECORD THE INFORMATION STRIAGHT ONTO THE QUESTIONNAIRE.

22) In 1996, how many employees worked at your location?

____(#)

How many employees in total did your company have in 1996?

____(#)

23) Approximately, what were your firm's 1996 revenues?

$_________.

If this question must be asked first ask the respondent for a figure. If they are hesitant then ask them to indicate their annual sales volume in the following categories.

What range did your firm's 1996 revenue fall within?

__ less than $100,000
__ $100,000 to $499,999
__ $500,000 to $999,999
__ $1,000,000 to $ 4,999,999
__ $5,000,000 to $10,000,000
__ Over $10,000,000

PLEASE RECORD THE INFORMATION FROM THE RESPONDENT INFORMATION CARD FOR THE FOLLOWING QUESTIONS.

24) State (_ _) (2 LETTER ABBREVIATION)

25) County population code. (__) *from respondent information card*

26) SIC #2______________.

SIC #3______________.