

# NOTE TO USERS

Copyrighted materials in this document have not been scanned at the request of the author. They are available for consultation in the author's university library.

117-122

This reproduction is the best copy available.

**UMI**<sup>®</sup>

DISSERTATION

ATTRIBUTE PERCEPTIONS OF COLORADO HOMEBUILDERS  
SEGMENTED BY INNOVATIVENESS

Submitted By

David G. Bueche

Department of Forest, Range Land and Watershed Stewardship

In partial fulfillment of the requirements

For the Degree of Doctor of Philosophy

Colorado State University

Fort Collins, Colorado

Spring 2005

UMI Number: 3173053

### INFORMATION TO USERS

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleed-through, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

**UMI**<sup>®</sup>

---

UMI Microform 3173053

Copyright 2005 by ProQuest Information and Learning Company.

All rights reserved. This microform edition is protected against unauthorized copying under Title 17, United States Code.

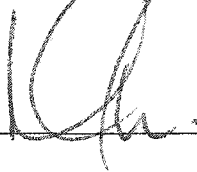
ProQuest Information and Learning Company  
300 North Zeeb Road  
P.O. Box 1346  
Ann Arbor, MI 48106-1346

COLORADO STATE UNIVERSITY

December 7, 2004

WE HEREBY RECOMMEND THAT THE DISSERTATION PREPARED UNDER OUR SUPERVISION BY DAVID G. BUECHE ENTITLED ATTRIBUTE PERCEPTIONS OF COLORADO HOMEBUILDERS SEGMENTED BY INNOVATIVENESS BE ACCEPTED AS FULFILLING IN PART REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY.

Committee on Graduate Work



Advisor



Co-Adviser



Department Head

ABSTRACT OF DISSERTATION  
ATTRIBUTE PERCEPTIONS OF COLORADO HOMEBUILDERS  
SEGMENTED BY INNOVATIVENESS

The purpose of this study was to segment Colorado's single-family homebuilders into adopter groups on likelihood of using wood products derived from restoration thinning activities in Colorado's forests based on their personality characteristics and to compare the groups across various dependent variables related to "green" building materials, substitute building materials, and quality of life principles. The results were obtained from 112 mail surveys conducted in Colorado in spring 2004.

The adopter categories used in this study were adapted from Roger's (1995) "diffusion of innovation" model. The adopter groups for the study were (1) early adopters, (2) early majority, (3) late majority, and (4) laggards. Respondents were placed into adopter groups based on how they responded to a question that asked them the likelihood of using wood products. The responses to the question represented the adopter groups.

The adopter groups were discriminated by four personality and eight socio-economic variables using discriminant function analysis. The discriminant function analysis revealed that the twelve predictor variables accounted for 27% of the absolute variance in the discrimination of the adopter groups. Function 1 accounted for 88 % of the relative variance in the discriminator variables that predicted the groups and 24 % of the absolute variance in the predictor variables. The discriminant model correctly classified 73.3 % of the originally grouped cases. Earlier adopters placed more importance on the environmental and social images of wood, the natural environment to their quality of life principles, and the importance of "green" building materials to their business practices than did laggards.

The results of this study demonstrate the ability to segment Colorado single-family homebuilders into discrete audience segments based on their personality related to environmental tendencies. The major implication for planners and managers when dealing with marketing green building materials is the value of segmenting homebuilders into adopter categories. This provides a more thorough and accurate view of the different groups and their unique characteristics. Recognition that each group has different characteristics leads to devising a variety of communication strategies to more effectively interact with them. In the past, managers and planners have used intuition and experience to make decision concerning audience characteristics and needs. This study and future efforts can help provide useful information into the diverse characteristics and needs of each adopter group and provide a systematic way to understand audiences in order to assure the success of marketing Colorado forest products.

David G. Bueche  
Department of Forest, Range Land,  
and Watershed Stewardship  
Colorado State University  
Fort Collins, Colorado 80523  
Spring 2005

## ACKNOWLEDGEMENTS

To my committee members Dr. Don Zimmerman and Dr. Larry Gross, my sincere thanks for all the quality time and timely advice given to me for the completion of this Doctoral program. To my committee co-chair, colleague, and friend, Dr. Pat Pellicane, thank you for the years of interest and support that you have provided since that first wood engineering course in 1984. To my major advisor, Dr. Kurt Mackes, I would like to offer my sincere gratitude and thanks for helping me focus on my dissertation, keeping me on track, and providing me the opportunity to pursue my scholarly interests.

I would like to thank my best friend, Debby Mieke, for her love, support, and understanding during the period of my doctoral program at Colorado State University. I would also like to thank my children, daughter, Kathrin, and son, Ryan, for their patience and the sacrifices that they made during this time. To my colleagues (Chris Jennings, Joe Duda, and Tim Reader) at the Colorado Wood Utilization and Marketing Assistance Center, thanks for the rewarding work, funding for my dissertation and of course, the great friendships. Most of all, I would like to thank my parents, mother, Bernice, and father, Ken for their constant encouragement with school and support with the children. I would like to dedicate this study to my father whose assessment of my abilities has always been optimistic and greater than mine and who has taught me to look at the cup of life as being “half full” instead of “half empty.” Thanks Dad!

## TABLE OF CONTENTS

Title Page	i
Signature Page	ii
Abstract	iii
Acknowledgements	v
Table of Contents	vi
List of Tables	viii
List of Figures	x
CHAPTER I – INTRODUCTION	1
Problem Statement	1
Purpose of the Study	8
Definition of Terms	8
Limitations of the Study	9
CHAPTER II – THEORETICAL FRAMEWORK	10
Audience Segmentation	10
Diffusion of Innovation	22
Background of Product Orientation and Attributes in the Forest Products Industry	42
Framework Guiding the Study	47
Hypotheses	51
CHAPTER III – RESEARCH METHODOLOGY	53
Research Design	53
Sampling Design	53
Pre-testing	54

Data Collection	55
Research Instrument	55
Data Analyses	62
CHAPTER IV – RESULTS	68
Survey Response Rate	68
Characteristics of Respondents	69
Reliability Analysis of the Constructed Indices	77
Discriminant Function Analysis	81
Hypotheses Testing	88
Summary of Findings	93
CHAPTER V – IMPLICATIONS	96
Conclusion	100
REFERENCES	102
APPENDICES	
Appendix A: Environmental Wood Product Distribution	116
Appendix B: Green Building Materials	117
Appendix C: Survey Instrument	123
Appendix D: Cover Letters	135
Appendix E: Colorado Single-Family Building Permit	139
Appendix F: Importance of Various Building Materials	140
Appendix G: Quality of Life Principles	142
Appendix H: Importance of Green Building Materials	143
Appendix I: Price Premium Willing to Pay	144

## LIST OF TABLES

<u>Table</u>	<u>Page</u>	
1	Segmentation Bases	13
2	Self-reported adopter group membership	70
3	Reconfigured adopter group membership	71
4	Single-family reconfigured adopter group membership	72
5	Single-family homebuilder percentage response to “How important are each of the following to your quality of life.”	72
6	Average age of respondents by adopter group members	73
7	Level of education by adopter group members	74
8	Membership in NAHB <sup>1</sup> by adopter group members	74
9	Sex by adopter group members	75
10	Number of domestic pleasure trips and trade shows by adopter group members	75
11	Annual sales volume by adopter group members	76
12	Reliability analysis for items in four personality scales	78
13	Reliability analysis for items in four wood image scales	80
14	Reliability analysis for items in three lumber attribute scales	81
15	Evaluation of the discriminant functions that predicted adopter groups	83
16	Discriminant function analysis to predict adopter groups	84
17	Discriminant functions at adopter group centroids	85
18	“Double-split cross-validation” adopter groups classification results	87
19	Calculation of chance criteria for adopter group classification	88
20	Comparison of adopter groups by importance of wood image scales	90
21	Comparison of adopter groups by importance of lumber attribute scales	91

<u>Table</u>		<u>Page</u>
22	Comparison of adopter groups by importance to quality of life principles	92
F1	Comparison of adopter groups by importance of lumber as a building material	140
F2	Comparison of adopter groups by importance of wood I-joist as a building material	140
F3	Comparison of adopter groups by importance of wood-plastic composites as a building material	141
F4	Comparison of adopter groups by importance of galvanized steel studs as a building material	141
G1	Comparison of adopter groups by importance to quality of life principles	142
H1	Detailed comparison of adopter groups by importance of green building materials	143
I1	Detailed comparison of adopter groups by percent premium willing to pay for green building materials derived from Colorado's forests	144

## LIST OF FIGURES

<u>Figure</u>		<u>Page</u>
1	The P's and C's of marketing.	4
2	Concepts of green building developed by the Institute for the Built Environment	7
3	Wood product market as segmented by SIC code 24	14
4	Grunig's nested segmentation model	19
5	Adopter categorization on the basis of innovativeness	27
6	The Bass new product diffusion model	31
7	Proposed model to study adopter characteristics	50
8	Plot of group centroids and individual discriminant scores on functions 1 and 2	86

## CHAPTER I

### INTRODUCTION

The primary purpose of this research is to segment single-family homebuilders into various adopter categories based on Rogers' (1995) diffusion of innovation model. Homebuilders are classified into adopter categories based on self-reported reactions to the use of wood-based building materials derived from forest restoration thinning activities. The adopter categories include early adopters, early majority, late majority, and laggards. This study also demonstrates how techniques of audience segmentation in conjunction with characteristics of the various adopter categories can be used to validate group discriminators and compare group differences on various issues including importance of "green" building materials, attribute perceptions of wood and substitute materials, and quality of life principles. Discriminators are independent variables used in discriminant function analyses to predict group differences.

This report is composed of five chapters: Introduction, Theoretical Framework, Research Methodology, Results, and Implications. This first chapter has four sections. The first section presents the problem statement and justification for the study. The second section addresses the study objectives. The third section defines key terms. The final section discusses the limitations of the study.

#### Problem Statement

Ecologically, the public and private forests of Colorado are different today than they were prior to European settlement. Forest biodiversity, stand composition and crown coverage have been altered by factors such as logging, grazing, and fire suppression. A substantial fire risk exists in forested areas that are at the interface with urban environments. Statewide, 6.3 million

acres of forest in the urban-wildlife interface are at risk. These forests are composed of massive and presently un-merchantable volumes of stagnant and overcrowded stands of small-diameter trees. Along the Front Range alone there are approximately 2.4 million acres that contribute to excessive fuel loading and need to be treated to reduce the risk of catastrophic fire (USDA, 1996).

Treatments, such as thinning and removing trees from critical forest areas, and restoring normal ecological processes, such as low-intensity fires, can mitigate high-risk areas. Forest ecology research has demonstrated that accomplishing forest restoration objectives requires mechanical removal of undesirable small trees, retention of larger trees and snags, and use of prescribed fire (Lynch, Romme, Kemp & Garrison, 1998; Lynch, Romme & Floyd, 2000). This is essentially the opposite of traditional logging where large trees are removed and the small trees are left.

Lynch et al. (2000) demonstrated that the cost to thin the forest is usually more than the value of the material removed. If cost-effective and value-added uses for the thinned material could be found, forest management costs would be offset, economic opportunities would be created for rural, forest-dependent communities, and catastrophic wildfires would be prevented or minimized. Therefore, especially along the Colorado Front Range, it is necessary to identify innovative wood products and markets that can increase the value of wood sales from small-diameter trees.

Traditionally, small-diameter and underutilized (SDU) material has been left in the forest because it is not economical to remove, and local markets and capacity to process it do not exist (LeVan-Green & Livingston, 2001; Lynch & Mackes, 2002). Considerable activity has been dedicated toward developing new product technologies that can use SDU and thus improve the economics of using SDU material. Given the necessity for the development of new products, industry needs to understand new ways of doing business and developing markets. One of the basics of understanding the business environment of rapid product development is the adoption and diffusion of new technologies. Businesses and individuals differ in their openness to new

ideas and technologies. For a product to launch successfully, it is important to identify the most likely early adopters. They not only provide a new product with its first sales, they also pass on their experience to others. This helps the new product to broaden its market penetration.

The key for successful innovation in business is meeting the customer's needs. New products can be created, but unless the business really knows who their customers really are—unless they know to whom to sell those new products—they will fail as an innovator because they won't be able to make new products profitable (Rydz, 1986). A market approach rather than a sales approach needs to be used to increase the value of wood sales coming from forest restoration thinning

Webster (1991) defines marketing as "knowing customers and their problems, innovating solutions to those problems, and communicating them to a carefully defined target market" (p. 1). Marketing is a societal process by which individuals and groups obtain what they need and want through creating, offering, and freely exchanging products and services of value with others. Marketing is also the process of planning and executing the conception, pricing, promotion, and distribution of ideas, goods, and services to create exchanges that satisfy individual and organizational goals (Bennett 1995).

Marketing management is the art and science of choosing target markets and obtaining, keeping and growing customers through creating, delivering, and communicating superior customer value (Kotler, 2000). The aim of marketing is to know and understand the customer so well that the product or service fits them and the product sells itself (Drucker, 1973).

Marketers use numerous tools to elicit responses from their target markets. These tools have been classified in a number of different ways. Lazer and Kelly (1962) proposed a three-factor classification: goods and service mix, distribution mix, and communications mix. McCarthy (1996) classified these tools into four broad groups that he referred to as the four Ps of marketing: product, price, place, and promotion. The four P's (Figure 1) represent the seller's view of the marketing tools available to influence buyers. From the buyer's perspective, each tool

is designed to deliver a customer benefit. It has been suggested that there are four customers' C's (Figure 1) that corresponding to the sellers' four P's (Webster, 1994).

<u>Four P's</u>	<u>Four C's</u>
Product	Customer solution
Price	Customer cost
Place	Convenience
Promotion	Communication

Figure 1. The P's and C's of Marketing.

Market orientation assumes that competitive advantage can be created from the company's ability to produce superior benefit for its customers. This aim should guide product planning (Desphande, Farley & Webster, 1993). Narver and Slater (1990) showed a positive connection between market orientation and economic performance within the U.S. forest industry. Bush and Hansen (1996) showed that lumber buyers are willing to pay extra for product and service characteristics that they emphasize.

Part of the market orientation is producing new products to meet specifications that are more exigent or to improve current uses of wood. An example is the substitution of wood I-beams for solid-wood joists and rafters. The combination of solid wood and composite products in engineered wood products enables new applications, as well as improvements to existing applications. Market orientation can also be connected with marketing strategies focusing on customer segments and products.

A significant trend in the forest products markets is the increased communication between the forest sector and the public. Consumer awareness of environmental issues is an ever-increasing phenomenon. As education of today's younger generation regarding environmental concerns reaches higher levels, a different consumer perspective is evolving (Shrum *et al.* 1995).

Concern about the environment is so great that environmentalism has been designated as potentially "the biggest business issue of the 1990s" (Kirkpatrick 1990). Affecting this increased wave of interest is the realization that natural resources are of a finite nature and that the ecological balance can be easily disrupted. Specifically, forests and forestry-based issues have held the spotlight in this decade and have become world-wide concerns since the UN Conference on Environment and Development (UNCED) in 1992. Although the dialogue has been primarily between special interest groups, scientists, and industry, the general public has also become concerned about forestry issues (Spinazze & Kant, 1999).

In response to these forestry concerns, national governments, environmental organizations, and the forest products industry have developed standards for sustainable forest management practices. In many cases, upgrading traditional forest management practices to sustainable management practices involves an added cost. Hence, a challenge to agencies involved in sustainable forest management practices is to accommodate this extra cost without a major adverse impact on their share of the market. One way of dealing with this challenge may be to pass the additional costs to the consumer through appropriate marketing strategies such as "environmental" or "green" marketing to redirect consumer demand to environmentally preferable products and services (Coddington, 1993). Lessons from other industries show that firms who take the lead and cater to the "green" market segment have found the endeavor profitable (Leslie, 1990). Environmentally conscious citizens appear to be willing to change their buying behaviors to improve the environment (Chase, 1991). See Appendix A for an example of how this is being addressed in the distribution of wood products.

To address these concerns, concepts of sustainable management have been increasingly discussed and utilized over the past several years in the forest products and construction industries. Although a variety of definitions are used for the term 'sustainability,' depending on what is to be sustained, the common idea is to minimize impacts upon the environment so as to

maintain the health and productivity of the area for future generations (Floyd, Seyfang & Vonhof 2001, p. 8).

Parallel to the development of sustainable forestry emerged the evolution of sustainable design, which can be traced back to the 1970's alternative energy movement. A great deal of research on energy efficiency as well as increased recycling efforts by citizens began after the oil crisis. These popular trends caught the attention of architects and engineers in the building industry, leading to the development of either energy efficient or recycled material buildings, but not a combination of the two (Building Design & Construction, 2003). During the 1980's, "sick building syndrome" arose as certain health issues were related to toxic materials used in the construction of indoor environments. As public concern for health and the environment continued to increase, some architects began integrating solutions. This resulted in buildings created with minimal environmental impacts and using materials and designs for optimal human health (U.S. Green Building Council 2002).

Green building architecture takes into account multiple aspects of the building process. As shown in Figure 2, there are five central considerations of green building architecture, each takes into account the health of the ecosystem and the occupants of the building. The first is sustainable site planning, which allows for an analysis of potential impacts upon the environment, including those upon wildlife and aesthetics. It also allows for a review of how to most effectively place the building and ensure the energy efficiency and durability of the building. The second aspect of green building design maintains water quality and minimizes its use. This includes installing water efficient appliances and plumbing, and the use of native and xeriscape landscaping. The third aspect is to use alternative energy sources and energy efficient building designs. These designs may incorporate the calculated placement of windows for solar heat, planting trees for windbreaks and summer shade, and the overall orientation of the building based upon geography. The fourth consideration is to improve the quality of the indoor environment in order to promote the health and well being of the residents. This includes the use of non-toxic

materials as well as the application of interior designs promoting tranquility. The final general consideration of green building architecture is to conserve materials and resources used during the building process. This includes minimizing resource waste by calculating correct measurements, as well as building with certified, reusable, and recycled materials (U.S. Green Building Council 2002; Institute For the Built Environment 2002). See Appendix B for a description of green building materials.



Figure 2. Concepts of green building developed by the Institute for the Built Environment  
 Source: Institute for the Built Environment (2002). <http://ibe.colostate.edu>.

The expansion of green building construction has enhanced the market opportunities for sustainable wood and has the potential to increase the value of wood coming from forest restoration thinning activities. Therefore, there is a need to learn more about the demographics, psychosocial elements, and behaviors of homebuilders relative to green building materials, their views of competing materials, and the importance they place on the natural environment. It is crucial to use the appropriate messages to reach the various segments of this market. This is best accomplished through science-based research that helps to define and understand this audience.

## Purpose of the Study

The purpose of this study is to describe the environmental image of wood and to analyze its attributes in relation to other residential building materials. The study follows a market/customer-oriented perspective and focuses on Colorado's single-family homebuilders.

The objectives of this research include:

1. to develop a descriptive profile of adopter groups,
2. to discriminate the adopter groups across predictor variables that will best explain the group differences and validate the self-reported adopter group memberships, and
3. to compare the adopter groups across various dependent variables related to "green" building materials, substitute building materials, and quality of life principles.

## Definition of Terms

### *Diffusion of Innovation*

Diffusion of innovation is a conceptual model used to understand and explain social change. The word "diffusion" is defined by Rogers (1995) as "the process by which an innovation is communicated through certain channels over time among the members of a social system" (p. 5). Innovation is "an idea, practice, or subject that is perceived as new by an individual or other unit of adoption" (Rogers, 1995, p. 11). An innovation presents an individual or an organization with new alternative or alternatives, with new means of solving problems.

### *Segmentation*

Segmentation is a strategy that divides people into homogenous subgroups based on certain defining characteristics. In industrial marketing, for instance, advertising and products can be tailored and designed to meet special needs, interests, and desires of targeted groups. In social marketing, on the other hand, the audience is segmented so messages can be designed with specific attitudes, behaviors, preferences, and patterns of media use.

### *Adopter categories*

According to Rogers (1995), adopter categories fit a normal distribution curve on an innovation by time graph. The adopter categories begin with "innovators," followed by "early adopter," "early majority," "late majority," and ends with the "laggard" category. Each of the homogenous groups has its own unique characteristics as described by Rogers (1995).

### *Discriminant analysis*

Discriminant function analysis is a technique that allows the researcher to simultaneously examine and describe differences between two or more mutually exclusive groups with respect to several continuous variables.

### Limitations of the Study

1. Few references reporting adopter characteristics of single-family residential homebuilders were available for use in the study.
2. This study only examined one segment of the residential construction industry in Colorado, the single-family homebuilder. Other major segments in the residential construction industry include 2 to 4 family builders and 5 or more family builders.
3. The response rate for this study was approximately 19 % and the results may not generalize to the entire single-family residential construction industry in Colorado.
4. This study examined self-reported levels of innovativeness that may not truly reflect actual measures of company innovativeness.
5. The unit of measurement was companies, but respondents were individuals reporting their opinions and this might not truly represent the views of their company.

## CHAPTER II

### THEORETICAL FRAMEWORK

This chapter reviews the literature on audience segmentation, diffusion of innovation, earlier studies on diffusion of innovation in the forest products industry, innovativeness and adopter categories, and product orientation and attributes in the forest products and construction industries. The literature review is followed by the proposed theoretical framework and study hypotheses.

#### Audience Segmentation

According to Mendelsohn (1973, p. 55), between 1940 and 1970 an impressive fund of data was gathered that indicates "The publics who are most apt to respond to mass mediated information messages have prior interest in the subject area presented. As a consequence, information directed to this segment of potential audience requires a totally different communication strategy and tactics from information that is to be disseminated to an audience that is initially different. At the very least, communicators who intend to use mass media to produce information gain, or attitude and behavior modification, must realize that their targets do not represent a monolithic mass, although the media they decide to utilize have the potential of reaching high population aggregates."

Grunig (1989) demonstrated that information campaigns succeed only when specific conditions are met. Meeting these conditions has typically been ignored. The most important condition is the requirement that campaigns be directed to carefully selected segments of the mass audience. This selection of audience segments or audience analysis is referred to as segmentation. Segmentation is typically referred to in two ways: explicitly, with concepts such as market

segmentation, and implicitly, with concepts such as target marketing, niche marketing, target groups, and demographics.

A market can be thought of as the collection of people (audience) or entities that have an interest in or a need for a particular product or service (Harner & Zimmerman, 2002). The association of potential buyers or users may have nothing in common other than their interest in a particular subject. Or they may have many things in common across multiple markets. By thinking of markets in this way, communicators can use the theories and methods of marketing for analyzing their audiences.

This section reviews the basic concepts and tools of market segmentation research. Whether it is marketing a product, idea or knowledge, for most companies the question is not whether to communicate but rather what to say, to whom, and how often. Market segmentation provides marketers with these important details concerning the audiences that they are trying to reach. Market segmentation and audience analysis are similar concepts and can be used interchangeably for classifying groups into homogenous segments. Arguably, there is little if any difference between audience and market segmentation because both segment people into homogenous groups using various bases. Note that segments are not homogenous groupings of the target audience naturally occurring in the market place. Market segments are determined by the marketing manager's strategic view of the market.

### Segmentation

Smith (1956) introduced segmentation in a seminal article as it was related to marketing. He contrasted market segmentation with product differentiation where he claimed that product differentiation attempts to bend demand to the will of supply. Product differentiation uses advertising and promotion to distinguish a product from competing products and, as a result, to increase demand and reduce competition for that product (Smith, 1956).

Market segmentation, in contrast, works from the demand side of the market, the

consumer. Segmentation bends supply to demand by identifying lucrative segments of the market and developing products to fit those segments (Walters & Robin, 1956).

Identifying homogenous segments and understanding their characteristics based on different management purposes facilitates the delivery of effective products to the audience. Market segmentation is one component of a broader strategy of an organization, which is known as the "four P's of strategic marketing": probing (market research), partitioning (segmentation), prioritizing (selecting the target segments), and positioning (pinpointing the options in each target segment) (Kotler, 1989).

Segmentation at the basic level is simply the classification of people into homogenous groups or segments. It is the process of dividing the market or audience based on differences and forming smaller subgroups based on common characteristics (e.g., age, gender, income). Groups will have both differences and commonalities. According to Levitt (1986), segmentation is a powerful organizing principle in modern business and if a company is not thinking segments, they are not thinking.

Segmentation strategies have been heavily used in the marketing of products to consumers. Market segmentation results from the determination of factors that distinguish a certain group of consumers from the overall market. The challenge of implementing effective segmentation lies in determining which differences and which similarities are important in helping an organization achieve its marketing objectives. The ideal segmentation strategy maximizes differences within each segment in terms of criteria of interest (Levitt, 1986).

Classifying consumers in this way can help marketers to adjust their advertising, marketing, distribution channels, and prices to reach target markets more effectively (Gunter & Fumharn, 1992). Since the concept of market segmentation emerged in the late 1950s, it has been one of the most researched topics in the marketing literature (Desarbo & Cron, 1988; Frank, Massy & Wind, 1972; Kamakura & Russell, 1992; McDonald & Dunbar, 1995; Wedel, 1995).

Frank, Massy, and Wind (1972) classified market segmentation research into two schools

based on their theoretical orientation. The first school has its foundation in microeconomic theory, whereas the other is grounded in the behavioral sciences. They also distinguish between the two major dimensions of segmentation research--bases and methods.

### Bases

A segmentation bases is defined as a set of variables or characteristics used to assign potential customers to homogeneous groups. Segmentation bases can be classified into general (independent of products, services, or circumstances) and product-specific (related to both the customer and the product, customer, and/or particular circumstances) bases (Table 1). Bases can also be classified as either being observable (i.e., measured directly) or unobservable (i.e., inferred).

Table 1. Segmentation Bases

	General	Product Specific
Observable	Cultural, geographic, demographic, and socioeconomic variables	User status, usage frequency, store loyalty and patronage situations
Unobservable	Psychographics, values, personality, and life-style	Psychographics, benefits, perceptions, elasticities, attributes, preferences, and intentions.

In the early studies researchers used "observable general bases" like cultural variables, geographic variables, neighborhood, geographic mobility, demographic and socio-economic variables, postal classifications, household life cycle, household and firm size, and standard industrial classifications for segmenting markets (McDonald & Dunbar, 1995; Wedel & Kamakura, 1998).

Generally, demographic information is readily available and easy to use. For example, most government data and much privately collected market data on the U.S. marketplace is organized by the Standard Industrial Classification System (SIC). SIC is a uniform numbering system for classifying enterprises according to their economic activity. SIC 24 includes all manufacturers of lumber and wood products except for furniture and fixtures which is SIC 25. Primary two-digit industry groups are further defined by three- and four-digit subgroups (see Figure 3). Classifications are available extended out to a seven-digit code.

24- Lumber and Wood Products					
241	242	243	244	245	249
Logging	Sawmills	Millwork	Wood Containers	Wood Buildings	Misc. Wood Products
2411	2421	2431	2441	2451	2491
Logging	Sawmills General	Millwork	Nailed Wood Boxes	Mobile Homes	Wood Preserving
	2426	2434	2448	2452	2493
	Hardwood Flooring	Kitchen Cabinets	Wood Pallets	Prefabricated Buildings	Reconst. Wood
	2429	2435	2449		
	Special Products	Hardwood Veneer	Wood Containers		
		2436			
		Softwood Plywood			
		2439			
		Structural Wood			

Figure 3. Wood Product Market as Segmented by SIC Code 24.

The observable general bases that are more familiar to science and technical communicators are socioeconomic variables. Pearsall (1969) suggests that the socioeconomic variables are appropriate for segmenting readers of technical information. In this case, job classifications are used for analyzing audiences. Pearsall provides five general classifications that have been extended for this report to include descriptions relating to the residential construction market. These include:

1. The layman - homeowner
2. The executive – purchasing agent of the home building company
3. The expert - architect, engineer, and building code official
4. The technician - carpenter
5. The operator - lumberyard.

The observable product specific variables include: user status, usage frequency, brand loyalty, store loyalty, store patronage, usage situation, and stage of adoption (Wedel & Kamakura, 1998). Social psychology and marketing researchers have found correlates between characteristics of adopters and the time to adoption. Characterizing audiences by stage of adoption is helpful for identifying the firms that are most likely to adopt and suggests ways for targeting them with marketing messages and communication channels (Robertson, 1971; Rogers, 1995). With respect to stage of adoption, Rogers (1995) has provided the following definitions:

1. Innovators - venturesome and willing to try new ideas at some risk
2. Early adopters - opinion leaders who adopt early but carefully
3. Early majority - deliberate, adopt before the average person, and rarely lead
4. Late majority - are skeptical and adopt only after the majority
5. Laggards - bound by tradition and suspicious of change.

The segmentation variables that are "unobservable general bases" fit into three groups including: (1) personality traits, (2) personal values, and (3) lifestyle (Gunter & Furnham, 1992). Marketers developed these psychographic segmentation bases extensively in the 1960s in response to the need for a more lifelike picture of consumers and a better understanding of their motivations. Personality, values, and lifestyle provide a richer perspective of the market based on a more lifelike portrait of the consumer and, therefore, provide actionable bases that are especially useful for the development of advertising copy (Wedel & Kamakura, 1998). Typically this is accomplished through surveys where respondents are asked to rank order the importance of various values. The most important instrument for the measurement of human values and identification of value systems is the Rokeach (1973) value survey. Based on Maslow's (1954) hierarchy, Kahle, Beatty and Holmer (1986) created a shorter list of values (LOV) especially designed for consumer research. The LOV consists of the following nine items:

1. Sense of belonging
2. Excitement
3. Warm relationship with others
4. Self-fulfillment
5. Being well-respected
6. Fun and enjoyment in life
7. Security
8. Self-respect
9. Sense of accomplishment

The variables comprising unobservable product-specific bases include product specific psychographies, product benefit perceptions and importances, brand attitudes, preferences and behavioral intentions (Wedel and Kamakura, 1998). The concept of benefit segmentation was

introduced by Haley (1968). Haley suggested that the benefits people seek in products are the basic reasons for the heterogeneity in their choice behavior, and benefits are thus the most relevant bases for segmentation.

### Methods of Segmentation

Since segmentation is essentially a grouping task, many methods are available. The methods used in segmentation research can be classified in two ways. First, they can be classified into a-priori and post-hoc approaches (Green, 1978; Wind, 1978). A segmentation approach is a priori when the type and number of segments are determined in advance by the researcher and post hoc when the type and number of segments are determined on the basis of the results of the data analyses (Wedel & Kamakura, 1998).

According to Wedel (1995), the second way to classify segmentation approaches is according to whether descriptive or predictive statistical methods are used. Descriptive methods analyze the associations across a single set of segmentation bases with no distinction between independent and dependent variables. Predictive methods analyze the association between two sets of variables, where the independent variable(s) predict the dependent variable. In addition, there are hybrid forms of segmentation that have been used in segmentation approaches that combine both the a-priori and post-hoc procedures (Wedel & Kamakura, 1998).

#### Post-hoc Predictive Methods

Post-hoc predictive methods identify segments based on the estimated relationships between a dependent variable and a set of predictors (i.e., independent variables). The segments formed by post-hoc predictive methods are homogenous; that is, the relationship between dependent and independent variables is the same for segments produced by predictive methods (Wedel & Kamakura, 1998). The traditional method for predictive clustering is known as "automatic interaction detection" (AID). The AID method identifies interactive effects of

categorical segmentation bases on a dependent variable (Assael, 1970; Assal & Roscoe, 1976). The AID method splits a sample into groups that differ maximally according to a dependent variable on a set of independent variables. AID has been generalized to handle multiple dependent variables (MAID) (MacLachlan & Johnson, 1981) and categorical dependent variables (CHAID) (Kass, 1980).

Conjoint analysis is useful in post-hoc predictive segmentation because in marketing studies it allows for grouping of consumers according to how they respond to product features in making choice decisions (Wedel & Kamakura, 1998). Componential segmentation involves an extension of conjoint analysis in which both product profiles and respondent profiles are considered (Green, 1977; Green & DeSarbo, 1979).

## Segmentation Models

### Grunig's Nested Model

Although audience segmentation models are usually heuristic, there are notable exceptions. Grunig's (1989) nested model of segmentation is theory based and consists of inner and outer nest arranged in concentric circles. The inner nests contain individual communication behaviors and effects, and publics. The outer nests consist of: (1) communities, (2) psychographics, lifestyles and subcultures, and social relationships, (3) geodemographics, (4) demographics, and (5) mass audience (see Figure 4).

Information pertaining to variables in the inner nests is obtained by direct questioning. In contrast, information pertaining to variables in the outer nests can be obtained from sources other than the individual. Variables within the inner and outer nests are related such that knowledge of one can provide information about the other. Grunig (1989) considers variables in the inner nests as the most useful in segmentation because they provide the most direct and specific information about individuals, thus permitting more precise targeting.

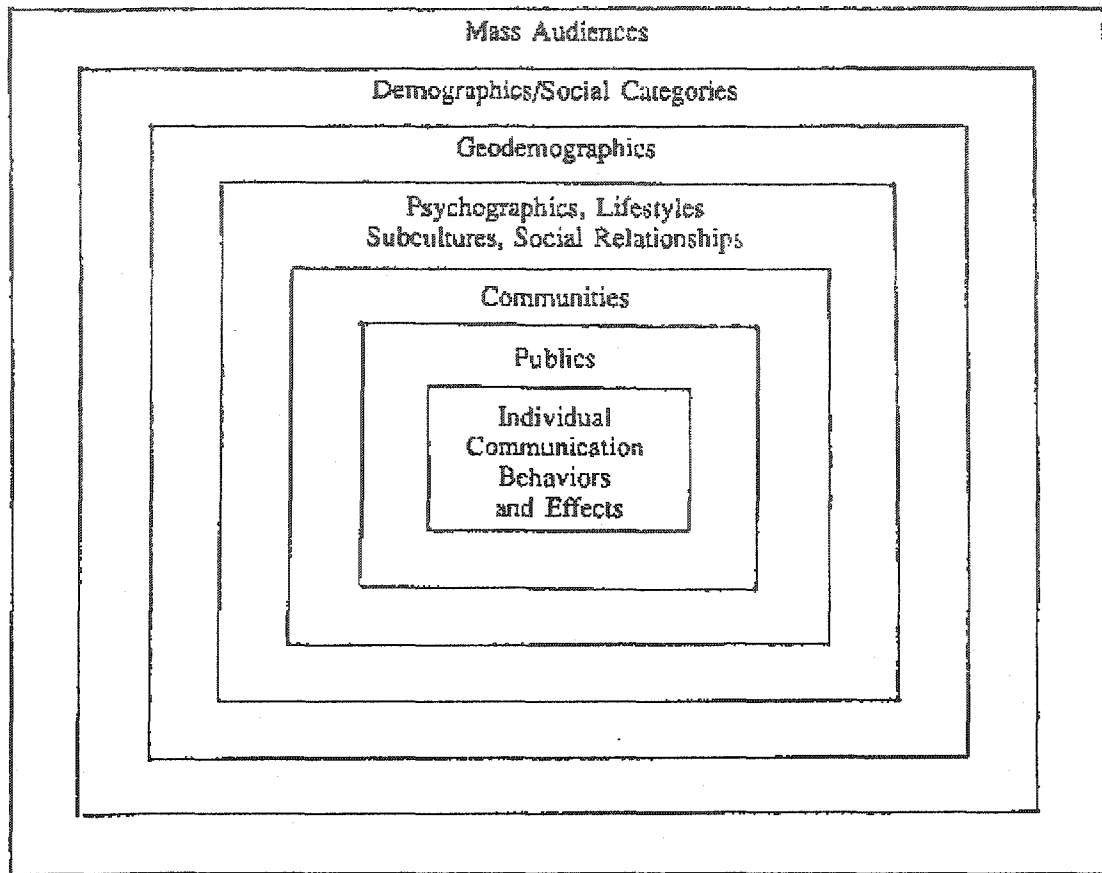


Figure 4. Grunig's nested segmentation model.

Source: Grunig, J. E. (1989). Publics, audiences and market segments: Segmentation principals for campaigns. In T. Salmon (Ed.), *Information campaigns: Balancing social values and social change*. Newsbury Park, CA: Sage, 207.

#### Market-Oriented Ethnographic Segmentation

Market-oriented ethnographic segmentation is not just a method of data collection. It aims at clarifying the way culture is simultaneously constructed and formulated by people's behaviors and experiences (Tedlock, 1983). Ethnography aims to explain patterns of action that are cultural and/or social rather than cognitive constructs (Sherry, 1990). Ethnography not only establishes the context and emic of experience for particular groups of people, but it also seeks to convey the comparative and interpreted cultural significance of this experience (Denzin, 1989). Ethnographers study audiences that are grounded in culture, and ethnography employs distinctive methods of data collection and interpretation (Tedlock, 1983).

As is the case for many sciences, ethnography does not express a universal sequence of data collection method. The specific sequence of data collection in an ethnographic project is dictated by the nature of the phenomenon (such as complexity, ubiquity, frequency, and duration), the researcher's prior experience and degree of conceptual understanding, and the research questions that emerge during the research process (Sherry, 1990).

Four distinctive features guide ethnographic research. First, ethnography gives primacy to systematic data collection and recording of human actions in natural settings (Rainbow, 1986). Secondly, ethnographic research involves extended, experiential participation by the researcher in a specific cultural context, referred to as participant observation (Belk, Wallendorf & Sherry, 1989; Fernandez, 1986). The third feature is that ethnography produces interpretations of behaviors that subjects and the intended audience find credible. The final feature of ethnography involves incorporating multiple sources of data, which is a research strategy long advocated in other social science traditions (Campbell & Fiske, 1959).

#### Statistical Segmentation

Various statistical methods can be used to cluster an audience into segments. Researchers who attempt to segment their audience based on how the respondents answered the question commonly use cluster analysis. For example, variables can be analyzed using k-means procedures to create clusters in multidimensional space and to define group membership for each case or subject in one's study. Cluster analytic techniques such as k-means procedure are conceptually similar to Q-factor analysis<sup>1</sup> or the grouping of individual observation across variables rather than the grouping of variables across observation as in standard factor analysis or exploratory factor analysis.

Although cluster analysis is frequently recommended and used, some critical methodological issues must be addressed. For example, selection of the clustering approach, depending whether on preference for hierarchical or iterative partitioning, will make some

---

<sup>1</sup> Q factor analysis involves factoring the subjects vis-à-vis the variables. The result is a "clustering" of the subjects into independent groups based upon factors extracted from the data.

difference in how the cases are segmented or clustered (Punj & Stewart, 1983). Similarly, how the researcher determines the number and significance of the clusters becomes an important question (Calantone & Sawyer, 1978). Finally, the issue of evaluating the reliability and validity of the cluster analysis solution needs to be addressed (McIntyre & Blashfield, 1980).

Researchers can also employ other statistical strategies for segmenting audiences. These include exploratory factor analysis, confirmatory factor analysis (i.e., linear structural modeling), conjoint analysis, latent structure analysis, and discrimination function analysis.

### Using Existing Theory

Using existing theory is another appropriate method for segmenting audiences. Existing theories can help one define or segment audiences more accurately. First, there needs to be a way to generalize previous findings to the current audience being studied. When populations are alike, there should not be any problems in using existing theories directly to partition the audience.

In a health-related study, existing theory was used to partition a large group of individuals into seven healthy lifestyle groups (Slater & Flora, 1991). This model drew substantially from other theories of behavior change, including Bandura's (1986) social cognitive theory and Fishbein and Azjen's (1975) theory of reasoned action.

The Slater and Flora (1991) framework consists of determinants of health behavior including: (1) cognitive-health knowledge, (2) attitudes, (3) issue involvement, (4) perceived preventability of disease, (5) perceived risk, and (6) perceived self-efficacy. This framework has been labeled a psychographic-segmentation method based on existing theory. This kind of segmentation is invaluable for shaping positioning strategies, product development, and communication decisions.

Innovation diffusion theory provides well-developed concepts and a large body of empirical results applicable to the study of new product evaluation, adoption, and implementation. The diffusion literature has developed across a number of disciplines to explain

the flow of new ideas and practices and the adoption of new products and services throughout a social system (Rogers, 1995; Gatignon & Robertson, 1985). Diffusion theory provides tools, both quantitative and qualitative, for assessing the likely rate of diffusion of an innovation. It also identifies numerous factors that facilitate or hinder adoption and implementation of the innovation. These factors include characteristics of the innovation, characteristics of adopters, and the means that adopters learn about and are persuaded to adopt the innovation (Rogers, 1995).

### *Diffusion of Innovation*

An innovation is any idea, practice, or object that is perceived as new by the adopter. Rogers (1995), provides a synthesis of over 3000 previous studies of adoption and diffusion. The results of this synthesis include numerous generalizations about innovation diffusion, i.e., the process by which innovations spread through populations of potential adopters. Among the more well-established generalizations are: (1) Innovations possess certain characteristics (i.e., relative advantage, compatibility, complexity, trialability, and observability) which, as perceived by adopters, determine the ultimate rate and pattern of adoption; (2) Some potential adopters are more innovative than others and can be identified as such by their personal characteristics ("cosmopolitanism," level of education, etc.); (3) The adoption decision unfolds as a series of stages (flowing from knowledge of the innovation through persuasion, decision, implementation, and confirmation), and adopters are predisposed towards different kinds of influence (e.g., mass market communication versus word-of-mouth) at different stages; (4) The actions of certain kinds of individuals (opinion leaders and change agents) can accelerate adoption, especially when potential adopters view such individuals as being similar to themselves; and (5) The diffusion process usually starts out slowly among pioneering adopters, reaches "take-off" as a growing community of adopters is established and the effects of peer influence kick-in, and levels-off as the population of potential adopters becomes exhausted, thus leading to an "S-shaped" cumulative adoption curve. The influence of interpersonal communication, including nonverbal

observations, is seen as a key factor accounting for the speed and shape of the diffusion curve (Gatignon & Robertson, 1985; Mahajan, Muller & Bass, 1990; Rogers, 1995).

The generalizations of classical diffusion were developed mainly by looking at the adoption of innovations by individuals making autonomous choices about whether to adopt personal-use innovations that do not require extensive specialized knowledge prior to adoption. Recent research has focused on extending diffusion theory to more complicated adoption scenarios. These include the adoption of innovations by individuals subject to strong managerial influences (Leonard-Barton & Deschamps, 1988) or by organizations as a whole (Kwon & Zmud, 1987; Robertson & Gatignon, 1986; Rogers, 1995) and the adoption of special classes of technologies, i.e., those that involve marked adopter interdependencies (Katz & Shapiro, 1986; Markus, 1987) or that impose an exceptional knowledge burden on would-be adopters (Attewell, 1992; Cohen & Levinthal, 1990).

Individuals rarely have complete autonomy regarding the adoption and use of work place innovations. Management can encourage (or discourage) adoption explicitly through expressed preferences and mandates (Leonard-Barton & Deschamps, 1988; Moore & Benbasat, 1991), or implicitly through reward systems and incentives (Leonard-Barton, 1987). In addition, immediate supervisors typically control access to the infrastructure supporting adoption, such as training and consulting, and may even control physical access to the hardware and/or software needed to use innovation (Leonard-Barton, 1987; Leonard-Barton & Deschamps, 1988). The net result is that studies of individual adoption within organizational settings must either incorporate managerial influences into the analysis or rule them out as a potentially confounding factor.

Rogers provides a useful summary of early research on organizational diffusion (1995, Ch. 10) and notes the potential relevance of such factors as individual leader characteristics (e.g., attitude towards change) and organizational structure (e.g., centralization, formalization, organizational slack). More recently, Kwon and Zmud (1987) and Robertson and Gatignon (1986) have developed more comprehensive frameworks for studying organizational adoption

and diffusion. The Kwon and Zmud framework defines five contextual factors, including user community characteristics, organizational characteristics, technology characteristics, task characteristics, and environmental factors. These factors may impact any of six stages of innovation implementation, including initiation, adoption, adaptation, acceptance, routinization, and infusion.

While much of classical diffusion theory is still applicable to adoption of innovations by organizations (Van de Ven, 1991), modifications and extensions are needed because: (a) some classical variables do not map cleanly to the organizational level of analysis (e.g., adopter characteristics), (b) the organizational adoption of an innovation is not typically a binary event, but rather, one stage in a process that unfolds over time, and (c) the organizational decision process, particularly in the absence of a dominant individual decision maker, frequently involves complex interactions between vested stakeholders.

For technologies that are intertwined with organizational routines, the implementation characteristics of the technology can become important factors impacting adoption and diffusion (Leonard-Barton, 1988). Implementation characteristics include the transferability (maturity and communicability), organizational complexity (number of people and functions affected), and divisibility (ability to divide implementation by stages or by sub-populations) of the innovation. At the project level, achieving a proper fit between implementation characteristics and implementation strategies can largely determine adoption success. At the macro-level, innovations with favorable implementation characteristics may be adopted more easily and diffused more rapidly than those with unfavorable characteristics.

Robertson and Gatignon (1986) propose that a variety of competitive effects in the technology consumer's industry (competitive intensity, demand uncertainty, professionalism, and cosmopolitanism) and within the technology supplier's industry (level of competitiveness, reputation, R&D allocation, and technology standardization) impact the rate and level of diffusion of high technology innovations. The Kwon and Zmud (1987) framework is most relevant to

studying differences in adopter innovativeness, while Robertson and Gatignon are more concerned with variables affecting the macro diffusion process.

Typical dependent variables here include binary adoption/non-adoption, time of adoption, and frequency of use. Organizational adoption studies look at adoption by large aggregates, such as companies, business units, agencies, or departments. Typical dependent variables here include binary adoption/non-adoption and stage of implementation (e.g., adoption, adaptation, infusion).

As Attewell (1992) points out, knowledge barriers to adoption for the "same" technology tend to get lower over time. For example, early personal computers imposed a substantial knowledge burden and were only adopted by die-hard hobbyists. Modern window-based personal computers, by contrast, require comparatively little in the way of specialized knowledge prior to adoption and can be adopted by almost anyone.

Some technologies cannot be adopted as a "black-box" solution but rather impose a substantial knowledge burden on would-be adopters. While classical diffusion focuses on the determinants of a would-be adopter's willingness to adopt, in circumstances where knowledge barriers are high the more telling issue can be an adopter's ability to adopt. Cohen and Levinthal (1990) develop the idea that an organization's innovative capability is determined by its absorptive capacity, where absorptive capacity is defined as the organization's ability to recognize the value of new information, assimilate it, and apply it to productive ends. An analogous notion of absorptive capacity also exists for individuals. Cohen and Levinthal argue that absorptive capacity is developed over time through prior investments in learning in areas that are closely related to the innovation at hand. The implication is that an important determinant of adopter innovativeness--for both individuals and organizations--is the level of skills and knowledge gained over the course of the adopter's cumulative history of innovation activities. At the macro diffusion level Attewell (1992) has argued that the diffusion of complex organizational technologies is better understood as a process driven by decreasing knowledge barriers than as a process driven by communication and social influence (as per classical diffusion theory). The

main implication here is that the rate and pattern of diffusion may depend less on how supply-side institutions signal the innovation (e.g., through communication media), than on the development of institutions for lowering knowledge barriers (e.g., universities and trade associations).

Most diffusion research conforms to one of two distinctive styles: adopter studies and macro diffusion studies (Attewell, 1992). Adopter studies like those of Rogers are primarily concerned with understanding differences in adopter "innovativeness." Innovativeness is usually defined according to time of adoption (early versus late). Macro diffusion researchers, including Bass (1969), are primarily concerned with characterizing the rate and pattern of adoption of a technology across some community of potential adopters; these researchers typically employ mathematical models of the diffusion process. The following discussion evaluates the traditional approach of Rogers (1995) and compares it to a model of new product diffusion proposed by Bass.

#### *Adopter Studies*

Rogers (1995) developed a model of diffusion that has become widely established in the marketing literature. However, this model has a number of limitations that are seldom recognized, including some severe limitations in its practical application. Rogers's model of diffusion is based on the classical "bell-shaped" normal distribution curve, where the curve represents the frequency of consumers adopting a product over time. If the cumulative number of adopters is plotted, the result is an S-shaped (sigmoid) pattern.

Rogers contends that the adoption curve is normally distributed because of a learning effect due to personal interaction within social systems. As the number of adopters in the system increases, so does the level of interpersonal influence on non-adopters. The result of this influence on adoptions is held to follow a binomial expansion--a mathematical function that follows a normal curve when plotted over a series of successive periods. Rogers (1995) states:

“Many human traits are normally distributed, whether the trait is a physical characteristic, such as weight or height, or a behavioral trait such as intelligence or the learning of information. Hence, a variable such as innovativeness is expected to be normally distributed (p.258).”

Rogers (1995) defines innovativeness 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" (p.252). On this basis, Rogers has proposed that adopters of an innovation can be classified into five categories. These categories are defined in terms of the number of standard deviations from the mean time of adoption for the population (see Figure 5).

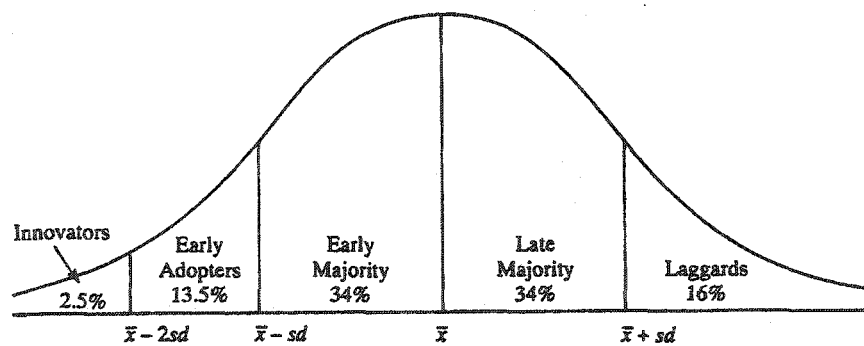


Figure 5. Adopter Categorization on the Basis of Innovativeness

Source: Rogers, Everett M.(1995). Diffusion of Innovations (4th edition). NY: The Free Press, p. 262.

Rogers (1995) has developed a detailed profile of "ideal types" for each of the adopter categories on the basis of demographic, socioeconomic, and personality characteristics. The adopter categories are analogous to the grouping of consumers in a market segmentation study. For example, innovators are "venturesome," they are cosmopolitan in outlook, tend to be better educated, willing to take risks, and are more socially mobile than their peers. In a similar manner, each of the five adopter categories has been given a consumer profile (Hawkins, Best, & Coney, 1989).

A considerable amount of research has been conducted to validate the profiles of these adopter categories. The majority of this research is based on major and discontinuous innovations examining the correlation between variables. These include age, education, dogmatism, social participation, and income with time of adoption. From these studies Rogers (1995) has developed thirty-one generalizations of adopter characteristics. For example, "early adopters have more years of education than later adopters" (p. 269). In marketing, these generalizations have been used as the basis of a prescriptive guideline for speeding up the diffusion process by using "differential communications programs to reach innovators versus later adopters" (Gatignon & Robertson, 1985).

Although Rogers attempted to identify common traits for each adopter category, the empirical evidence has demonstrated that there is no consistent link between the trait of innovativeness and other personality characteristics. For example, late adopters are characterized as being more dogmatic, but while 17 studies have found a negative correlation between dogmatism and innovativeness, another 19 studies have found no relationship between these two variables (Rogers, 1995). Similarly, while 203 studies have found a positive correlation between innovativeness and years of education, a further 72 studies have found no such relationship (Rogers, 1995).

The inconsistent nature of adopter groups has serious implications for the model. As Kotler (2000) states: "No one has demonstrated the existence of a general personality trait called innovativeness. Individuals tend to be innovators in certain areas and laggards in others" (p. 343).

While Rogers (1995) acknowledges that adopter profiles are product specific, he provides no method for predicting how these profiles will vary across industries. Consumers are innovators not because of some underlying general trait of "innovativeness", but because they are one of the first 2.5% of first purchasers, regardless of their demographic, socio-economic, or personality characteristics, and regardless of their adoption behavior in other circumstances.

As the model is based on a distribution about the mean time of adoption, calculation of the mean and standard deviation and the identification of adopter categories cannot take place until the process of diffusion is complete. Thus, the marketer cannot predict who the innovators in a given market are or what characteristics they are going to have.

The prescriptive guideline of using a "moving target market" approach faces two other potential problems. First, it assumes that targeting "innovators" and "early adopters" will speed the diffusion process due to the personal influence of these segments on the "early majority". In some markets, however, interpersonal communication is limited. For example, many low involvement products receive little word-of-mouth advertising (Gatignon & Robertson, 1985). In such markets the personal influence assumption does not hold, and targeting a small group of consumers first is likely to cause the rate of diffusion to be much slower than had the marketer approached the whole market (Mahajan & Muller, 1998). Second, even in markets where word-of-mouth does have a strong influence, the inconsistent nature of adopter profiles makes it impossible to identify and specifically target the "early adopter" segment. Under such conditions, there is no logical reason that targeting specific segments would produce a better result than targeting the market as a whole (Wright & Esslemont, 1994). In fact, mass marketing is likely to lead to a faster rate of diffusion, simply because more potential adopters are being exposed to the new product idea (Mahajan & Muller).

#### Macro Diffusion Studies

Bass (1969) proposed and tested an epidemiological model for the diffusion of consumer durables and other innovations. This type of model is used in medicine to predict the spread of communicable diseases. The analogy is quite direct. One person or a small group of people (the innovators) is infected and spreads the disease (the innovation) through personal contact (for example, word of mouth). The epidemic spreads, or diffuses, until all who are susceptible have been infected.

Because of the long time intervals between individual purchase occasions for consumer durables, the number of adopters in a time period is virtually identical to the number of sales throughout most of the diffusion process. This enables the number of adoptions in a period to be used as a proxy for sales, and vice versa. Figure 6 provides a plot of the conceptual and analytical structure underlying the Bass model. Mathematically, the model can be expressed as:

$$P(t) = p(0) + (q/m)Y(t)$$

where  $P(t)$  is the probability of a purchase at time  $t$ , given that the individual has not previously purchased the innovation. In effect, it is a prediction of adoption at the individual level, although Bass also offers equations to determine the aggregate number of adoptions in each time period.

The second term,  $p(0)$ , is the initial probability of trial. It reflects the tendency to innovate, or to try the product without interpersonal influence, and is referred to as the coefficient of external influence or “mass media effect” (Mahajan et al., 1990). The Bass model assumes that innovators, or those who adopt purely because of mass media communication, are present throughout the diffusion process (see Figure 6). This differs from Rogers's (1995) model that defines innovators as the first 2.5% to adopt.

The term  $m$  is the total number of potential buyers, while  $q$  is a parameter measuring the rate of diffusion, also called the imitation effect (Mahajan et al., 1990);  $q/m$  is therefore a constant social interaction or “word of mouth” effect that depends on the total size of the market and the effect of inter-personal influence. This effect of social interaction will be magnified by increases in the total number of people who have ever purchased (represented by  $Y(t)$ ).

The number of adopters in each period will, therefore, rise due to the increasing impact of social interaction ( $(q/m)Y(t)$ ) until such time as this effect is outweighed by the reducing number of people who have not yet adopted ( $m-Y(t)$ ). The point at which this occurs is the peak of the curve in Figure 6.

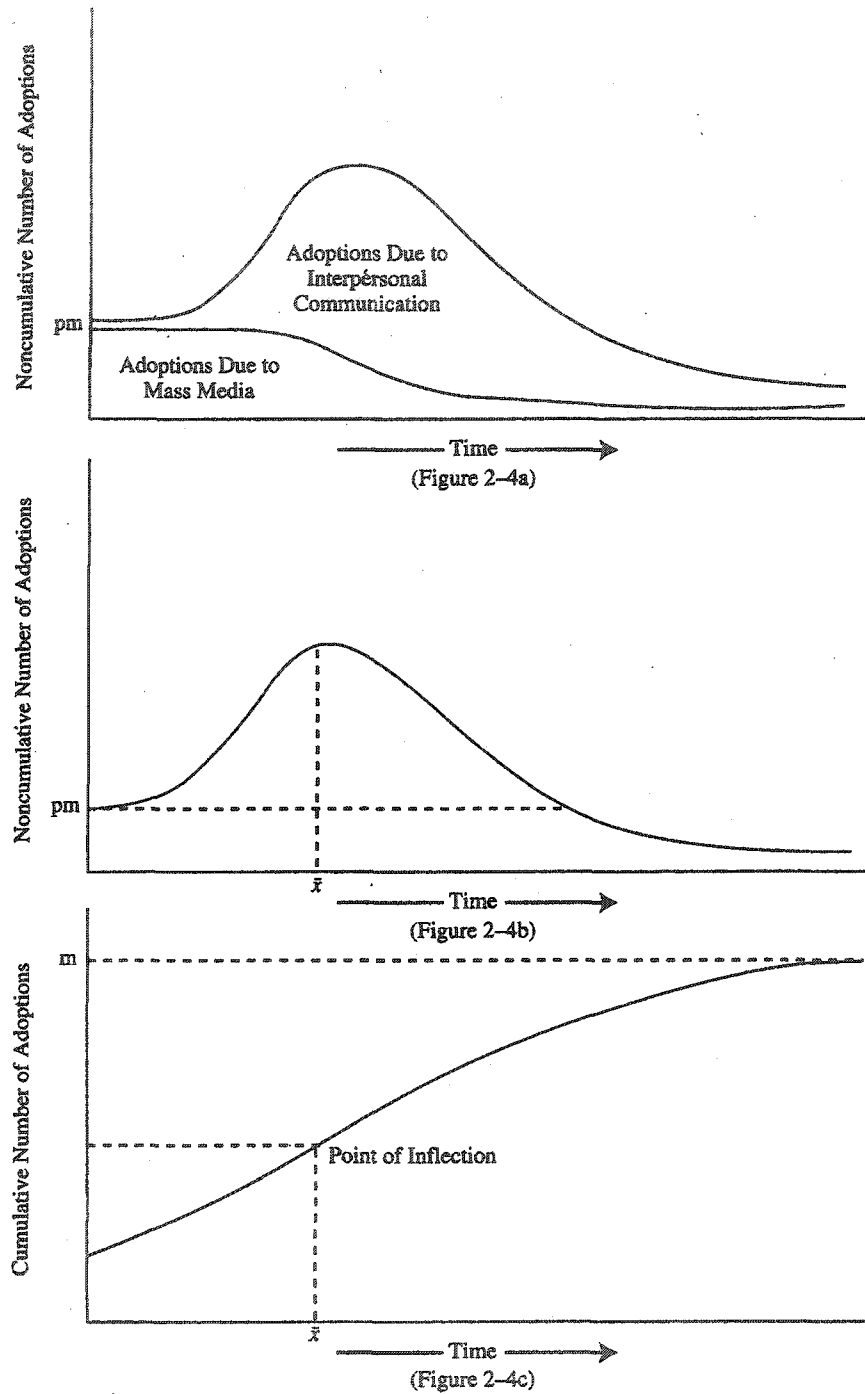


Figure 6. The Bass New Product Diffusion Model

Source: Rogers, Everett M.(1995). Diffusion of Innovations (4th edition). NY: The Free Press, p 80.

Estimating the diffusion curve requires that the values of  $p(0)$ ,  $q$ , and  $m$  be identified.

One method is to analyze historical data once diffusion is complete, but this is no more helpful

than Rogers's approach. It is important to be able to identify the values of the parameters before diffusion is well advanced, and this can be done by comparison with historical data for similar products, through market research, by using managerial judgment, or by using secondary data to identify  $m$ . When diffusion is partly complete, the data from the early stages can also be used to predict the rest of the diffusion curve, and this is especially useful if the peak of the curve has not yet been reached (Mahajan et al., 1990).

The Bass model and its revised forms have been used for forecasting innovation diffusion in retail service, industrial technology, agricultural, educational, pharmaceutical, and consumer durable goods markets (Akinola, 1986; Bass, 1969; Dodds, 1973; Kalish & Lillien, 1986; Lawton & Lawton, 1979; Nevers, 1972; Tigert & Farivar, 1981). Companies that have used the model include Eastman Kodak, RCA, IBM, Sears, and AT&T (Rogers, 1995).

The Bass model has been tested in three main ways. First, the correlation between the predicted and actual number of new adopters for the diffusion period has been examined using historical data. Bass (1969) tested the model on eleven durable goods, including refrigerators and black and white televisions with good fits between actual sales and those predicted by the model.

Jeuland (1994) compared the performance of the Bass model across 32 data sets, including the 11 durable goods in the original Bass study, 17 VCR markets in the United States and Europe, and four surveys of hospitals and schools. The diffusion periods varied in these studies from five to fifteen years. They report a very good fit for the model across the data sets, with R-squares of about 0.9.

Similarly, the Bass model performed well in three other studies with R-squared values of 0.96 (diffusion of cocoa-spraying chemicals among Nigerian farmers over a 25 year period), 0.98 (diffusion of an educational innovation in the US over 11 years), and 0.89 (diffusion of photovoltaic home energy system in South-West US over 10 years) (Akinola, 1986; Lawton & Lawton, 1979; Kalish & Lillien, 1986).

Second, the ability of the model to forecast the number of adoptions at the peak of the curve has been tested. Dodds (1973) used the model to forecast the adoption of cable television in the U.S. He states "a forecast based on early data would have provided a reasonably good forecast of peak sales four years before the event" (p.310). Similarly, Lawton and Lawton (1979) used the model to forecast the adoption of a semester system by Ontario High Schools. Projections made in 1973 by the model predicted the innovation to peak during 1976 with 228 schools adopting. Indeed, the actual peak occurred in 1976 with 257 schools adopting. Tigert and Farivar (1981) state that the Bass model performs well when appropriate data is available, but warn "no forecasting model should be a substitute for other elements in the strategic planning process" (p.90).

Third, the ability of the model to predict the long-term pattern of diffusion has been tested. Three studies using the model have provided good results, with correlations between the predicted and actual number of adopters over time of 0.96 (21 year period), 0.98 (29 year period) and 0.99 (24 year period) (Akinola, 1986; Mahajan & Peterson, 1978).

Although much of the assessment of the Bass model has used historical data, it is not merely a post hoc method of analysis. As noted, both predictions based on early data and predictions made before diffusion has peaked have been successful. Furthermore, a significant amount of work has been completed on methods of estimating the parameters of the Bass model during the early stages of an innovation (Mahajan et al., 1990).

Other diffusion patterns have been documented, particularly exponential patterns (Cox, 1967; Polli & Cook, 1969; Rink & Swan, 1979; Robertson, 1971). If there were no reason to expect a sigmoid pattern as opposed to an exponential pattern, the predictive validity of the Bass model would be significantly degraded. The sigmoid pattern is primarily due to the process of interpersonal influence; when this is minimal compared to marketing effects, an exponential curve of diffusion is predicted (Gatignon & Robertson, 1985). Thus, like Rogers' approach, the Bass model relies on the assumption of social interaction between buying units.

Both Rogers' approach and the Bass model combine the effect of innovation from external influences with the effect of interpersonal communication to model a sigmoid cumulative adoption curve. Neither provides a method of modeling diffusion of adoption in markets where interpersonal influence is absent.

Rogers' approach suffers from empirical evidence that membership of the "innovator" and "early adopter" categories cannot be reliably predicted. The generalizations on which the adopter profiles are based do not hold in different industries, and an individual may be an innovator for one product category but a laggard for another.

By contrast, the Bass model of diffusion of innovation is able to predict the actual shape of the diffusion curve and the timing and magnitude of its peak. The Bass model is based on estimating three parameters; unlike Rogers' approach, these parameters are not tautological but can be based on measures exogenous to the model, while the relationship between them is clearly defined in terms of the mathematical function of the model. A precise method for adopter segmentation in a specific industry can be developed through measuring for Rogers' generalizations about adopter profiles, Table 2, and then verifying the results with the more rigorous mathematical function of the Bass model.

#### Earlier Studies on Diffusion of Innovation in the Forest Products Industry

Characterizing innovators and early adopters of technological innovations can benefit developers of new products and technologies. Social psychology and marketing researchers have found correlates between characteristics of adopters and the time to adoption. This is helpful for identifying the firms that are most likely to adopt and suggests ways for targeting them with the most likely marketing messages and communication channels (Robertson, 1971; Rogers 1995). In comparison to the large body of multidisciplinary diffusion research, few published studies exist describing adopter categories in industrial or construction settings. However, these multidisciplinary studies provide guidance to the characteristics of new product adopters.

However, they are most applicable to the specific industries studied. Only a small number of studies are specific to the forest products industry in general and wood products specifically (Bengston, 1985; Rosenberg, Ince, Skog & Plantinga, 1990). These studies have looked at three types of innovations: pulp and paper, wood-based panels, and residential construction.

Hankanson (1974) studied the diffusion of four different types of special presses used in paper making in six countries. He hypothesized that the profitability of adoption, date of first information about special presses, firm size, and an innovation index would be positively related to early adoption by a firm. His findings concluded that the profitability and company size variables explained a large amount of variability in adoption rates.

Globerman (1976) studied the inter-and-intra-firm diffusion of special presses in the Canadian paper industry. For inter-firm diffusion he found that higher profitability of special press adoption was positively related to early adoption, whereas firm size was not related to time of adoption, and domestically owned firms were slower to adopt than foreign subsidiaries. His analysis of intra-firm diffusion determined that there was no difference between domestic and foreign firms in the spread of innovations within a firm after initial adoption.

Several researchers have studied the diffusion of innovations in wood-based panels. Buongiorno and Oliveria (1977) in the examination of particleboard adoption in 25 countries found that countries with higher economic growth and lower wood availability tended to have more rapid rates of adoption. Leefers (1981) examined the diffusion of particleboard and southern pine plywood in the U.S. He was mainly interested in the effects of the diffusion of these panels on wood requirements in the future and determined that while the univariate models that he used were useful for depicting diffusion trends over time, they were not helpful for explaining the diffusion process. Shook (1999), while studying the adoption of successive generations of structural wood panel (SWP) products in the U.S., suggests that the diffusion process for SWPs is affected mostly by such factors as word of mouth, advertising, and promotions. He believes this result is intuitive since the major consumers of SWPs in the U.S. are risk adverse residential

construction firms, and, as such, innate innovativeness among SWP consumers does not appear to contribute substantially to the diffusion process for structural wood panel products.

Residential construction has been identified as a neglected sector in the study of technological change (Strassmann, 1978). However, there have been several investigations into the diffusion of innovations in residential construction. Martin, Swan, Banks, Barker, & Beaudry (1979) examined the diffusion of wood roof trusses in Canada. They concluded that diffusion of roof trusses is closely related to cycles in residential construction. This reinforces Stier's (1983) findings that increased demand can induce rapid diffusion. Martin et al. also found that proximity to large local markets is an important factor for roof truss adoption due to high transportation costs.

In a study of the adoption of roof trusses and finger-jointed studs in the U.S. residential construction industry, Spall (1971) interviewed 20 firms building homes in Michigan. He concluded that the entrepreneur's extent of adoption was not correlated with his years of formal education, his experience in the industry, his subjective receptiveness to innovations, the size of his firm and volume of business, or the possibility of increased competition. Adoption or non-adoption was found to depend only on estimates of profitability of adoption. This finding contradicts Rogers' (1995) generalizations concerning innovativeness and adopter categories.

Ventre (1979, 1980) examined 14 innovations in residential construction, including wood roof trusses, several other wood-related innovations, and a variety of non-wood innovations. He considered an innovation to be adopted in an area when local building codes were modified to permit its use. The main finding of his work was a refutation of the common perception of the homebuilding industry as technologically backward. According to Ventre, innovations diffuse throughout the homebuilding industry in much the same way as in other industries.

Shook (1997) studied innovation and diffusion of engineered wood products in the homebuilding industry and found that perception of industry competition, the presence of trade unions, and intensity of management all negatively influenced diffusion. Additionally, he

determined that firm- and product-specific factors were more likely to affect adoption than were industry structure factors. Fell, Hasen, and Becker (2003) found that early adopters of a single engineered wood product tended to adopt other new wood products earlier. Hansen, and Adair (1996) and Eastin, Shook, and Simon (1999) uncovered geographical differences in the perceptions and adoption tendencies of engineered wood products among homebuilders.

West, and Sinclair (1992) provide one of the first attempts to identify early adopters in the wood products industry. They segmented firms based on adoption of 13 processing technologies into an innovator group and a non-innovator group. Innovators were found to differ significantly from non-innovators in firm size, technological expertise, opinion leadership, information sources, and cosmopolitanism. A significant difference in amount of international travel was found between innovators and non-innovators. Innovators traveled out of the country an average of 2.8 times per year while non-innovators traveled internationally less than once a year.

Fell, Hansen, and Panches (2002) reported similar findings in their study of single-family homebuilders. They segmented homebuilders on tendency to adopt new technologies relatively early or late and provided a demographic profile for each segment. A strong measure of homebuilder innovativeness was identified as membership in the National Association of Homebuilders (NAHB). Thirty-seven-point-five (37.5) percent of early adopters were members of the NAHB while 29 percent of majority adopters and 6.7 percent of late adopters were members.

#### Innovativeness and Adopter Categories

When attempting to standardize adopter categories, one is expected to determine (1) the number of adopter categories, (2) the portion of the members of a system to include in each category, and (3) the method, statistical or otherwise, of defining the adopter categories (Rogers, 1995). The criterion for adopter categorization is innovativeness, which is a continuous variable.

Therefore, dividing it into discrete groups is a conceptual mechanism, very similar to the way one divides the continuum of social status into upper, middle, and lower classes. If this is the case, then a set of categories of groups should be exhaustive by including all the units of a study. The groups must be mutually exclusive by having orthogonal categories. To avoid the problem of incomplete adoption of an innovation Rogers suggests that a series of innovations should be combined into a composite innovative scale.

The five ideal types of adopter categories are mainly based on abstractions made from empirical investigations that were conducted by Rogers (1995). These investigations included various studies conducted over the years by many researchers. The characteristics of adopter categories that follow are all based on Rogers' ideas and compilations from his book entitled, "Diffusions of Innovations."

#### Innovators

Innovators are very venturesome people who for the most part are interested in new ideas that normally lead them away from a local circle of peer networks and into more cosmopolite social relationships. For the most part, innovators tend to control substantial financial resources that help to absorb possible losses from unprofitable innovations. Innovators must be able to understand and apply complex technical knowledge and be able to cope with a high degree of uncertainty about an innovation at the time of adoption. They are venturesome and willing to accept setbacks from unsuccessful innovations. Innovators tend to import new ideas from outside the system and launch these innovations into the system. Their role as gatekeepers allows many innovations into the system in which other groups may have a chance at adopting the innovations.

#### Early Adopters

Early adopters are an integral part of the local system, unlike innovators, who spend a lot of time outside their social systems. Early adopters are localities, whereas innovators are

cosmopolites. Early adopters provide opinion leadership to the system and potential adopters look to them for advice and information about new ideas. They also serve as role models for the majority in a social system. It is essential that they make judicious innovation decisions to maintain the peoples' trust and their role as advisers. The early adopters decrease uncertainty about a new idea by first adopting it, and then conveying a subjective evaluation of the innovation to near-peers through interpersonal communication.

#### Early Majority

The early majorities adopt new ideas just before the average member of a system. Although they frequently interact with their peers, they do not hold positions of opinion leadership in a system. This group is an important link in the diffusion process because they are in between the early and the relatively late adopters. Members of the early majority provide interconnectedness in the system's interpersonal networks and they comprise one third of the members of the system. It takes a while, after some time for deliberations, for the early majority to completely buy into and adopt a new idea. They are willing to adopt but not lead others. Their innovative-decision period is relatively longer than that of innovators and early adopters.

#### Late Majority

This group makes up one third of the members in a system, similar to the early majority, but they adopt new ideas just after the average member of a system. Normally, adoption for this group is based on economic necessity and pressure from peers. They tend to be skeptical and will only be convinced after the weight of the system norms favors an innovation. Peer pressure is a necessary element to motivate adoption and most of the uncertainty about an innovation must be removed prior to their adoption.

## Laggards

This group possesses no opinion leadership and is the last in the social system to adopt an innovation. They have the most localite outlook of all adopter categories. They could be considered isolates in the social network system. Laggards tend to be suspicious of innovations and change agents, and their point of reference is the past. They tend to interact with others who also have relatively traditional values. Their innovation decision process tends to be the lengthiest, with adoption and use lagging behind awareness and knowledge of a new idea. Resistance to innovations on the part of laggards may be entirely rational from their perspective because of their limited resources. Furthermore, they have to be certain that a new idea will not fail before they decide to adopt it.

## Characteristics of Adopter Categories

Rogers' (1995) summary of variables related to innovativeness was based on hundreds of studies, and it will be discussed under three main headings. The headings are socioeconomic status, personality values, and communication behavior.

### Socioeconomic Characteristics

According to Rogers (1995), from the more than 228 studies he reviewed in most cases earlier adopters are not different from later adopters in age. However, there was some evidence that showed earlier adopters to be younger and other studies that indicated they were older, so age has varied between these groups.

Earlier adopters are more likely to be literate and have more years of formal education than later adopters. Earlier adopters also have higher social status as compared to the later adopters. Variables such as income, level of living, possession of wealth, occupational prestige, and self-perceived identification with social class can be used as indicators for social status.

The upward social mobility of earlier adopters is greater than the later adopters and

earlier adopters tend to move in the direction of still higher levels of social status. It is possible that earlier adopters are using adoption of innovations as the means to increase their social status. Socioeconomic status and innovativeness are related. The question that needs to be answered is "Do innovators innovate because they are richer, or are they richer because they innovate?"

### Personality Variables

Rogers (1995) points out that personality variables associated with innovativeness have not yet received full research attention because of the difficulties in measuring personality dimensions in field interviews. Earlier adopters have greater empathy than later adopters. Earlier adopters might be less dogmatic than later adopters. Dogmatism is the degree to which an individual has a relatively closed belief system, where a set of beliefs is held very strongly. Therefore, a highly dogmatic person would not welcome new ideas but instead prefer to hold on to the past.

The ability to deal with abstraction seems to be a strong trait of the earlier adopters. Innovators are able to adopt new ideas largely based on rather abstract stimuli. Later adopters need less ability to deal with abstractions because they can observe their peers who have already adopted new ideas.

Earlier adopters tend to have greater rationality than their peers, the later adopters. To be rational is to use the most effective means to realize a given end. Earlier adopters have greater intelligence (Rogers, 1995), have a more favorable attitude toward change, and are better able to cope with uncertainty compared to later adopters.

Earlier adopters have a more favorable attitude toward science than later adopters because most innovation originates from scientific development. Therefore, it is logical that innovators favor science more than the later groups. Earlier adopters tend to aspire more than later adopters, especially in formal education and occupations.

Earlier adopters are less fatalistic than later adopters. Fatalism is the degree to which an

individual perceives a lack of ability to control his or her future. A person is more likely to adopt an innovation if the person is efficacious and believes that he or she is in control. The later adopters tend to think that the future is determined by fate.

#### Communication Behavior

Earlier adopters are more interconnected through interpersonal networks in their social systems, and they have more social participation than the later adopters. Earlier adopters are more cosmopolite than later adopters. Innovators tend to travel widely and their interpersonal networks are more likely to be outside, rather than within their social system. Earlier adopters have more change agent contacts, greater exposure to mass media and interpersonal communications channels, and have a higher degree of opinion leadership than later adopters do. Earlier adopters tend to seek information about innovations more actively than later adopters.

#### Background of Product Orientation, and Attributes in the Forest Products Industry

##### Product and Product Quality

A product concept is helpful when systematically analyzing products to find ways of improving product quality or developing new products. In several definitions a product is described as composed of various components that may be hierarchical (Levitt, 1980; Kotler, 2000). A couple of other product concept definitions divide a product at least into tangible and intangible or physical and service components (Levitt, 1980; Shostack, 1977). A market/customer-oriented definition emphasizes the customer viewpoint: a product is a bundle of benefits satisfying customer needs and helping them solve their problems. Levitt (1980) defined the product as follows (examples by Kalafatis, Glass, & Evison, 1996):

1. Core product (the basic product, building material, such as sawn wood)
2. Generic product (softwood lumber)

3. Expected product (minimum purchase condition, lumber of certain dimensions and species, packaged and delivered as agreed)
4. Augmented product (attributes that differentiate the product; may include special extra services or product characteristics increasing customer satisfaction. It is necessary that the customer be informed about factors that augment the product.)
5. Potential product (everything potential that can be done to develop the product).

The product definitions based on hierarchical levels and components do not exclude but complement each other. Forest products are not an exception (Weinwurter & Hansen, 1999). Customers perceive wood products as including both physical and intangible dimensions. Organizational (company) types of customers are claimed to assess quality based on all product dimensions (Kalafatis, Glass, & Evison, 1996). In practice, gaps may exist between what the wood industry and its customers regard as critical product characteristics and how buyers and manufacturers perceive the products to perform.

Bush and Hansen (1996) and Weinwurter and Hansen (1999) have shown that U.S. lumber producers tend to concentrate on the physical product while the buyers evaluate lumber products as a whole package of benefits, consisting of the physical product, services, producer characteristics, and so on. A new product's success depends on the relevance of the firm's offerings to the consumer's needs (Kotler, 2000). Undeveloped preference structures of new products typically require the firm to establish the relationship between the capabilities of the new technology and the existing needs of target consumers (Roberts, 2000).

Understanding how customers and influencers perceive a product on important attributes relative to competing products is referred to as a product's position (Kotler, 2000). Products can be positioned on the needs they fill or the benefits they offer to a certain class of users in relation to competitors (Stalling & Sinclair, 1989). As shown by Smith, Bush, and Bowe (1999) and Smith, Spradlin, Alderman, and Cesa (2000a; b), market research into the perceptions of

industrial end-users and specifiers on the relative attribute importance of alternative materials can provide valuable information for developing new products and/or product positioning strategies.

Businesses and individuals differ in their openness to new ideas and technologies (Mitropoulos & Tautum, 2000). The construction industry is generally perceived as conservative in adopting new technologies (Mitropoulos & Tautum, 1999). Innovation, adoption, and diffusion of new products, defined as the process by which an innovation “is communicated through certain channels over time among the members of a social system” (Rogers, 1995), has been the subject of considerable attention since innovation diffusion theory was introduced into marketing in the 1960s. Most of the empirical research into the adoption and diffusion of building materials has focused on the home building industry (Fell & Hansen 1999; Eastin, Shook & Simon 1999; Mitropoulos & Tautum, 1999; Shook, 1999; Damery & Fisette, 2001; Fell, Hansen & Panches, 2002). A few studies have examined commercial construction and industrial applications (Deckard & McCurdy, 1999; Smith & Bright, 2002; Smith, Bush & Bowe 1999; Smith et al., 2000a).

The degree to which target consumers perceive the new product to have a relative advantage compared to the product it supercedes is more important to the actual rate of adoption and new product success than any “objective” advantage the new product may have (Rogers, 1995). The adopter’s perceived attributes of an innovation are one important explanation of the rate of adoption of an innovation. From 49 to 87 percent of the variance in rate of adoption is explained by five attributes: relative advantage, compatibility, complexity, trialability, and observability (Rogers, 1995). Understanding the importance of the perceptions on substitute materials and attribute importance by target consumers is crucial to developing new products with customer-orientations based on factors considered most significant to the end-user. Therefore, new product development should be evaluated externally, from the customers’ perspective.

### *Earlier Studies on Wood Products and Their Characteristics*

A number of previous research studies have focused on products and/or their quality in the wood industry. For example, Toivonen and Ahola (1996) introduced a component model for forest products (sawn wood, paper, and paperboard) and performed some preliminary testing of the model with empirical data in Finland. The model comprised physical, service, information, and environmental components. The results suggested that the physical product dominated the total product within all sectors in the forest products industry, but it was most dominant within the lumber industry. A shortcoming of the study was that the empirical data did not focus on customers of the wood products industry but instead focused on persons working within the lumber industry and thus provided an internal rather than external view of products and their development.

Cooper, Kalafatis and Tsogas (1996) analyzed end-consumers perceptions of wood furniture. They concluded that information is an integral part of their products (wood furniture).

Toivonen and Laurila (1997) attempted to theoretically analyze round wood and dimension lumber from an industrial customer's perspective. The analysis focused on the problem of marketing SDU material and concluded that mechanical (such as durability and strength), biological, aesthetic (such as color and figure) and ecological factors are important when buying decisions are made for wood and wood products. Information on these product dimensions was determined to be an important part of the final marketable product. Several indicators of each product dimension were named.

Bush and Hansen (1996) formulated a four-dimensional quality description of lumber based on empirical data that included performance, lumber, supplier, and service characteristics. Lumber buyers ranked supplier characteristics and lumber characteristics as most important. Weinwurter and Hansen (1999) confirmed the result.

Bush and Hansen (1996) showed that lumber buyers ranked "overall lumber appearance" and "lumber straightness" as more important characteristics than the producers had assumed.

Overall, accuracy and consistency of grading, overall lumber appearance, supplier understanding of buyer's needs, neat and undamaged lumber packaging, and lumber straightness were the most important characteristics for lumber buyers. This conclusion demonstrates that visual characteristics are an important dimension of wood products.

Developing the intangible product characteristics and services is the key to creating competencies. Overall, several authors argue that the more tangible the product is, the more intangible characteristics should be emphasized in marketing and vice versa (Sinclair, 1992; Shostack, 1977; and Levitt, 1980).

#### Earlier Studies on Image and Attributes of Building Materials

The image and attributes of construction materials have been analyzed in a few studies. For instance, Cohen and Kozak (1996) assessed the perceptions of architects and structural engineers of wood, steel, concrete, and masonry as a structural material in commercial construction in North America. Their results indicate that environmental issues are important in the specification of structural materials. Wood products were considered to be the most "environmentally friendly" material.

Burrow and Sanness (1998) compared various construction materials and concluded that cost is the essential factor for substitution of forest products. As the costs of wood and wood fiber increase, or are perceived to increase, market share is lost to other materials. Regarding environmental competencies of wood, consumers show minimal interest in paying more for environmentally superior products, but rather expect these to be comparable in cost. However, as costs for competing material approach equality, consumers may prefer more environmentally friendly products.

Trinka, Sinclair, and Marcin (1992) point out that for guiding product development, efforts should be concentrated on the characteristics that most influence purchase decisions. These characteristics have become known as "determinant attributes." Determinant attributes are

those characteristics of a product that are not only important to the purchaser of the product, but also vary enough between substitute products and/or suppliers to differentiate them from each other. In other words, if price is important but all substitutes are priced essentially the same, then price is not a differentiating characteristic and is, therefore, not determinant. Service life, on the other hand, may not be as important as price, but may vary greatly between substitutes and, consequently, has a greater influence or “determinance” on the purchase decision. Competitive advantage may be gained through understanding the determinant attributes for products in a given market.

#### *Framework Guiding the Study*

The theoretical framework for this study consists of a product concept identifying the determinant attributes of wood products. The concept follows the idea that a product is a bundle of benefits for a customer, and these benefits are created by both tangible and intangible characteristics. The overall quality of a product is a combination of the quality of these product components.

The description of product-related characteristics and their quality, and the measurement (operationalization) of these characteristics are based on the studies of Weinwurter and Hansen (1999), Toivonen and Laurila (1997), Toivonen and Ahola (1996) and Bush and Hansen (1996), described in the previous sections.

The main product components are physical (tangible) and intangible. The tangible product component has the following dimensions: technical characteristics (including physical and mechanical properties), aesthetic (visual) characteristics, and ecological characteristics. The intangible component includes three dimensions: product information (general image, emotional, and cultural value), supplier information (“level of marketing activity”), and importance of quality of life principles.

A major difference between this study and the work of others is that this study includes ecological factors. The “green component” is included in this study based on several studies that conclude the environment has clear importance as a quality dimension. It is even argued that the importance of ecological characteristics may vary more between market areas and customer groups than the importance of price (Cooper, Kalafatis & Tsogas, 1996). Therefore, ecological characteristics may be especially important for diversification and market segmentation of wood products. Other issues emphasized in this study are aesthetics and other “subjective value dependent” product dimensions based, for instance, on the observation of Weinwurter and Hansen (1999). They have detected that producers usually underestimate the importance of aesthetics to customers. In addition, they have found that the intangible product characteristics might provide the best chances to differentiate physical products such as wood.

A systematic scientific approach was advocated to reveal useful information about audience segments of interest. Therefore, obtaining information on audiences' personality characteristics, situational issues, demographics, and cognitive characteristics will be important and useful during the planning and implementation of various marketing programs and activities. By segmenting the audience into groups and knowing the characteristics of each group, marketing managers will be able to develop strategies and tactics that best suit the targeted segments.

The grouping or categorization of homebuilders according to their innovativeness and tendencies toward environmental issues would facilitate a better understanding of the group characteristics. The literature describes various methods that can be used to predict group memberships or segments. These include various multivariate statistical methods and the utilization of existing theories. Homebuilders can be segmented on how many innovations have been adopted over time. A preferred strategy would be to segment homebuilders based on how innovative the homebuilders believe that they are. This can be accomplished by asking the homebuilders a grounded question that relates to a hypothetical situation involving the use of “green” building materials salient to an environmental issue. Then, the researcher would obtain

responses from the people that will identify their adopter categories.

Most traditional diffusion studies use the measurement of the rate of adoption of an innovation, which involves the adoption of an innovation over some length of time. This study utilizes previously identified characteristics (Rogers, 1995) to determine the group membership and classification validation. The key objective of the study is to maximize group differences and predict the strength of the discriminator variables selected to identify the groups. There is not a concern about the number of categories selected for the study as long as the groups includes all cases in the study sample.

The adopter groups were discriminated based on the socioeconomic and personality characteristics as described by Rogers (1995). Test variables included importance of “green” building materials, importance of conventional wood products and substitute materials, knowledge of building materials, price premiums willing to pay for “green” building materials, importance of environmental issues related to lumber, and importance to quality of life principles to test items and demographics.

#### The Proposed Theoretical Model

The theoretical model proposed for this study (see Figure 7) has three sections. The first section contains discriminator variables, which are broken down into personality and socioeconomic scales and single item indicators. The middle section is Rogers (1995) adopter categories. The third section contains the test variables, which include scales and single item indicators related to image of wood, attributes of lumber, importance of “green” building materials, price premiums willing to pay for “green” building materials, and importance to quality of life principles to test items and demographics.

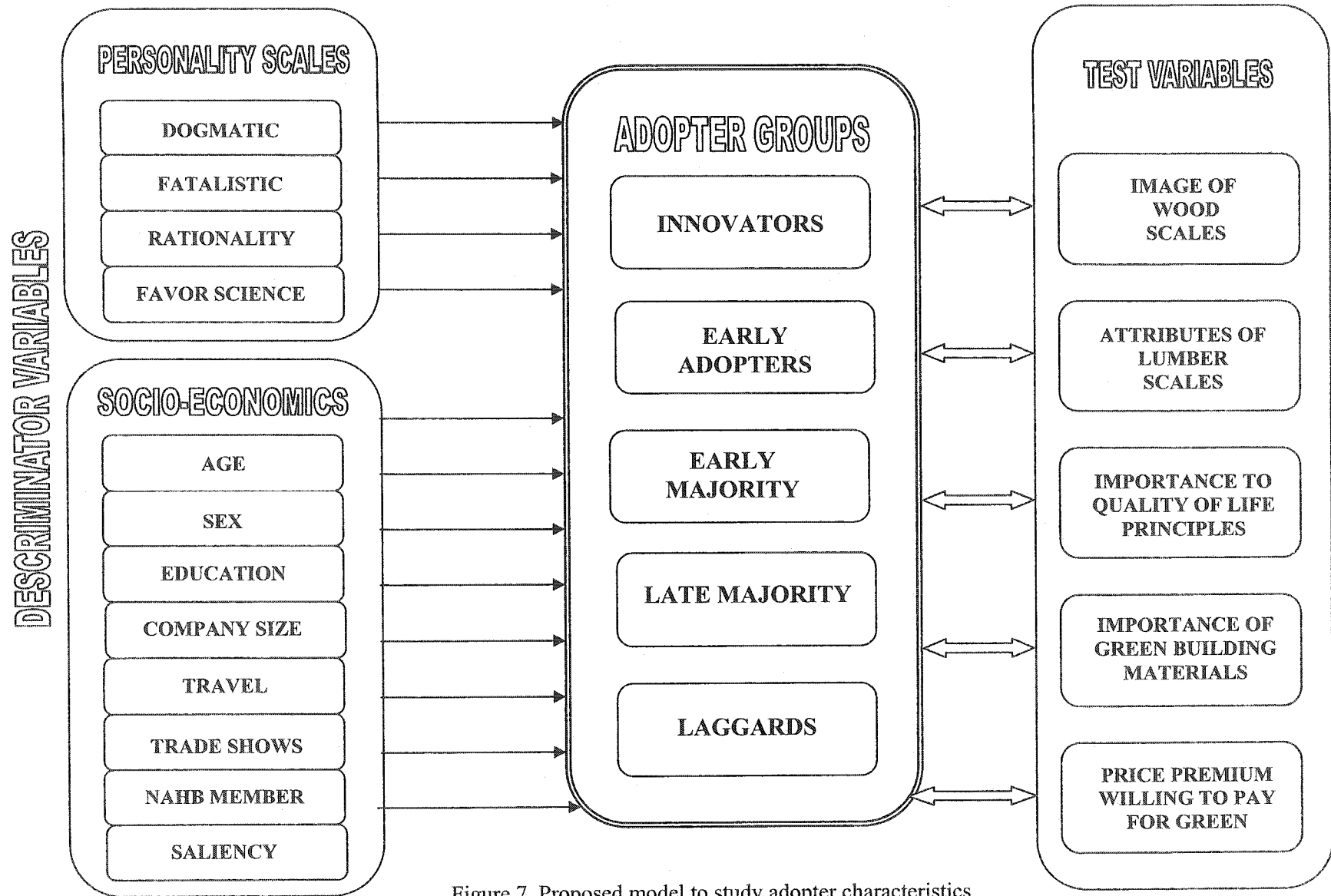


Figure 7. Proposed model to study adopter characteristics

## Hypotheses

Rogers (1995) segments the adopter groups on a time continuum based on when each group adopts an innovation. The adopter groups are named based on their ranking on a time-scale of when the groups adopted an innovation. The earliest to adopt are the innovators and the last to adopt are the laggards. Therefore, innovators adopt earlier than early adopters, early adopters adopt earlier than the majority, and the majority adopt earlier than the laggards. All the hypotheses listed below are directional hypotheses except for hypotheses 3, 4, 10, and 11 that were hypothesized to have similar group means.

1. Early adopters place more importance on the environmental image of wood than laggards.
2. Early adopter place more importance on information and the social image of wood than laggards.
3. Early adopters place the same importance on the practical image of wood as all other adopters.
4. Early adopters place the same importance on the fashionable image of wood as all other adopters.
5. Early adopters place more importance on the physical attributes of lumber than laggards.
6. Early adopter place more importance on the use attributes of lumber than laggards.

7. Early adopters place more importance on the cost/quality attributes of lumber than laggards.
8. Early adopters place more importance on the environment to their quality of life principles than laggards.
9. Early adopters place more importance on recycling to their quality of life principles than laggards.
10. Early adopters place the same amount of importance on time spent with family to their quality of life principles as all other adopters.
11. Early adopters place the same amount of importance on money to their quality of life principles as all other adopters.
12. Early adopters place more importance on products that reduce waste than laggards.
13. Early adopters place more importance on alternatives to ozone-depleting substances than laggards.
14. Early adopters believe that more of their customers will be willing to pay for green building materials derived from Colorado's forests than laggards.

### CHAPTER III

#### RESEARCH METHODOLOGY

This chapter describes the procedures used in this research. The first section covers research design. The next section provides information regarding the sampling design. The third section focuses on the survey instrument while the final section explains the method of data analyses and test statistics used in the study.

##### Research Design

A one-shot post-hoc field research design was used for this study, [X-----O] (McClintock, 1972). The X normally represents a quasi-experimental manipulation, but in this case it represents a naturalistic treatment, and O represents an observation. The manipulation X precedes the observation O. The naturalistic treatment X of the respondents was all the events, conditions, values, beliefs, attitudes, and other life defining characteristics or experiences that they have had prior to the point of data collection. O represents the observation or measurement of the subjects in the study, which was conducted through a structured mail questionnaire. There is no control group and no pre-post comparison in this research design.

##### Sampling Design

The population for this study included all Colorado, new single-family residence homebuilders (SIC 1251). An exclusive list of new single-family residence homebuilders was unavailable since many of the smaller firms are family owned, claim to be both remodelers and new homebuilders, or report construction activity in more than one category. For instance, some residential contractors build single-family residences, town homes, condominiums, and apartment

complexes or are a subsidiary of a larger construction firm. Even though an exclusive list of new single-family builders was not available, a number of commercial lists including all categories of residential contractors was available. The sample frame was comprised of two of these commercial lists (Meyers Group n=785 and Phone Disc n=737). The lists were merged and duplicate records purged, resulting in a sample pool containing 1132 unique records.

These records were then ordered by arranging contact names alphabetically. A systematic sample with a random start was then used to select participants. Beginning at record seven, every third record was discarded resulting in the selection of 750 participants. Because the list was ordered or “randomized” before sampling, it can be argued that this method is in fact a simple random sample (Babbie, 2002, p. 198).

#### Pre-testing

A group of judges reviewed the initial survey instrument to eliminate ambiguous questions. The judges included the head of the Manufacturing Technology and Construction Management Department, a Wood Utilization and Marketing professor, a Journalism and Technical Communication professor specializing in usability, and a Wood Engineering professor at Colorado State University. The survey was also reviewed by representatives of APA-The Engineered Wood Association and the Western Wood Products Association for further refinement.

To test for ease of use, 15 students studying construction project management at Red Rocks Community College in Lakewood, CO completed the survey. These were adult students currently working in the residential construction industry. Their comments and responses were used to further refine the survey instrument.

## Data Collection

The study is based on survey data that was collected through a structured mail questionnaire (see Appendix C). Dillman's (2000) Tailored Design Method was utilized to maximize the survey response rate. The original questionnaire was sent first-class mail using a Colorado State University envelope accompanied by a cover letter printed on Colorado State University letterhead explaining the purpose of the survey and a preaddressed postage paid return envelope. A reminder letter was mailed 10 days after the initial survey mailing. This process (a second questionnaire with a cover letter) was repeated for non-respondents 3 weeks after the initial mailing and another set of reminder letters was sent 10 days after the second questionnaire mailing. A copy of all four letters can be found in Appendix D.

Dillman (2000) recommends the use of individual monetary incentives to increase response rates. However, because of limited funding individual monetary inducements were not possible. However, entry into a drawing for a \$75 gift certificate at the CSU bookstore was used as an incentive to help increase the response rate to this survey.

## Research Instrument

The research instrument was developed not only for this study but also as part of a project for the Colorado Wood Utilization and Marketing Assistance Center at Colorado State University. For the purposes of this study, seven sets of survey questions mirroring the proposed measurement model of "Adopter Characteristics" shown in Figure 7 were selected. The first set (1), which consists of two questions, was used to determine the adopter groups. The second set (2) was used to construct the personality scales that were used to discriminate and validate the adopter groups. The next five sets of questions, including (3) image and attributes of wood and lumber, (4) importance of green building materials, (5) price premiums willing to pay for green designation, and (6) importance to quality of life principles, were used to construct indices and as test variables to compare differences between adopter groups. The final set (7) of questions are

basic demographic items that were used both as group discriminators and as test variables for group comparisons. The nature of each set, the individual questions under each set, and their attributes follow.

(1) Adopter categorization

Question 4 (a) is a practical hypothetical scenario presented to the respondent. " Please answer the following questions based on how you feel about making changes to your existing construction practices. Please take into account that this change will help to reduce the wildfire hazard and ecologically restore Colorado's forests. Please be sincere when choosing the statement that best describes how your company would react to using wood-based building materials derived from forest restoration thinning."

The respondents were required to choose one of the five statements that best described how they would react to the hypothetical request as stated above. Without the respondents' knowledge, each of the five responses corresponded to an adopter category: (A) Innovators - My company will be the first one to use these products, since it helps Colorado's forests: (B) Early adopters - My company will use these products after we study the details: (C) Early Majority - My company will use these products if most of the homebuilders are already using the products: (D) Late Majority - My company most likely will not use these products unless nothing else was available: Laggards - My company would refuse to use these products even if nothing else was available.

The design of the five responses was based on the adopter categories' key characteristics as described by Rogers (1995). This variable was used to determine self reported group membership, which served as the dependent variable for the discriminant function analysis of the data in this study.

Question 22 was designed to avoid the problem of incomplete adoption or inability of respondents to self classify their level of innovativeness. This question was designed to provide a

composite innovative scale and measured the extent of the respondents' experience with various building material innovations, including: "finger-jointed studs (FJS)", "galvanized steel studs", and "structural insulated panels (SIP)." Respondents were asked "Did your company use the following products in 2003?" The responses were coded as nominal, either "yes" or "no." If respondents answered yes, the respondent was also asked to provide the year that the product was first used.

## (2) Personality scales

Question 11 was designed to assess the attitude of the respondents towards specific environmental problems and their possible solutions. The responses for all sixteen variables were coded on a seven-point scale ranging from 1 "strongly disagree with the statement" to 7 "strongly agree with the statement" and 4 "neutral, neither agree nor disagree with the statement". All sixteen variables were used in the construction of four concepts.

The personality concept of rationality was composed of three variables: Recycling construction waste will help the solid waste problems; If my company reduces the amount of construction waste it produces, it will make a difference in the solid waste problem; and My company can influence the forces that cause pollution.

The personality concept of dogmatism was composed of four variables: Whether my company builds homes with "green" building materials has no impact on whether or not other homebuilders will; My company can influence government to help solve many environmental problems; The amount of construction waste that my company produces is so small compared to the total that it does not matter; and Recycling my company's construction waste is significant in the total environmental picture.

The personality concept of fatalism was composed of four variables: Sometimes my company cannot control how its actions contribute to environmental problems; As only one of many homebuilders in the U.S., my company's business practices has no real effect on the

environment; Many problems, such as air pollution, require too much money to solve for my company to have any impact; and Many environmental problems require too much power to solve for my company to have any impact.

The personality concept of favorable attitude toward science was composed of four variables: By understanding the forces that cause pollution, my company can help solve problems; If my company knows that some behavior is wasteful, it can usually control it; Because there is really no such thing as luck, most environmental problems will be solved by the efforts of concerned people; and By understanding the forces that cause pollution, my company can solve the problems.

### (3) Image and Attributes Scales

Question 12 was designed to assess the importance by respondents on a number of environmental issues related to lumber. The responses for all seven variables (“lumber originates from sustainably managed forests,” “environmental impact of lumber manufacturing,” “lumber can be recycled,” “lumber is packaged in recyclable materials,” “lumber is safe and poses no health risks,” “lumber is socially acceptable,” and “information on environmental impact of lumber”), were coded on a seven-point scale ranging from 1 “not at all important” to 7 “extremely important.”

Question 13 was designed to assess the importance by respondents of a number of abstract statements concerning wood as a home building material. The responses for all fifteen variables (“wood is recyclable,” “wood is environmentally safe,” “wood is good looking,” “wood is of consistent quality,” “wood is easy to repair,” “wood is appreciated,” “wood is fashionable,” “wood is youthful,” “wood is impractical,” “wood is a material of the future,” “wood is timeless,” “wood is expensive,” “wood is durable,” “wood is safe,” and “wood is old-fashioned), were coded on a seven-point scale ranging from 1 “not at all important” to 7 “extremely important.”

The environmental image of wood scale was composed of six variables: Lumber

originates from sustainably managed forests; Lumber can be recycled; Wood is recyclable; Wood is environmentally safe; Environmental impact of lumber manufacturing; and Lumber is safe and poses no health risks.

The information & social image of wood scale was composed of three variables: Lumber is packaged in recyclable materials; Lumber is socially acceptable; and Information on environmental impact of lumber.

The practical image of wood scale was composed of four variables: Wood is easy to repair; Wood is durable; Wood is safe; and Wood is appreciated.

The fashionable image of wood scale was composed of five variables: Wood is fashionable; Wood is youthful; Wood is a material of the future; Wood is timeless; and Wood is good looking.

Question 15: was designed to assess the importance for respondents of a number of attributes in selecting lumber as a home building material. The responses for all fifteen variables ("reliable strength," "resistant to impact," "resistant to decay," "low life cycle cost," "low maintenance cost," "structural design flexibility," "high-energy absorption," "resistant to ultraviolet light," "resistant to fire," "easy installation," "low replacement cost," "free of toxic chemicals," "low initial cost," "attractive appearance," and "consistent quality"), were coded on a seven-point scale ranging from 1 "not at all important" to 7 "extremely important."

The physical attributes of lumber scale was composed of six variables: Resistance to impact; Resistance to decay; High energy absorption; Resistance to ultraviolet light; Resistance to fire; and Free of toxic chemicals.

The use attributes of lumber scale was composed of four variables: Reliable strength; Structural design flexibility; Easy installation; and Attractive appearance.

The cost/quality attributes of lumber was composed of five variables: Low life cycle cost; Low maintenance cost; Low replacement cost; Low initial cost; and Consistent quality.

(4) Importance of green building materials

Question 10 was designed to determine how important “green” building materials are to the respondents’ business. The responses for of the variables (alternatives to ozone-depleting substances ” and “products that reduce waste”), were coded on a seven-point scale ranging from 1 "not at all important" to 7 "extremely important".

(5) Price premium willing to pay for “green” designation

Question 20 is an open-ended question that was designed to determine the percentage of the respondent’s customers that would be willing to pay some price premium for “green” building materials derived from Colorado’s forests.

(6) Importance to quality of life principles

Question 26 was designed to determine the degree of importance that respondents placed on each of the twelve statements related to their quality of life principles. The responses were coded on a seven-point scale from 1 "not at all important," to 7 "very Important." The statements that the respondents rated included (A) Air quality, (B) Time spent with family, (C) Clean rivers, (D) Education for children, (E) Transportation needs, (F) Religion, (G) Natural environment, (H) Money, (I) Recycling practices, (J) Time spent on internet, (K) Wildlife, and (L) Wealth / being wealthy.

Question 27 was designed to determine the respondents' choice for the one most important quality of life element from the list of twelve elements in question 26. The responses were coded as unique alphabetical values that represented each of the twelve items.

(7) Demographic variables

Questions 1-3 were designed to determine the saliency of the forest fire hazard in Colorado to the respondents interests in using building materials derived from forest restoration

thinning activities. Question 1 asks the respondents if they were aware of current wildfire hazard in Colorado's forests. The responses were coded as nominal, either as "yes" or "no." Question 2 asks the respondents if they build homes in areas affected by wildfire in Colorado. The responses were coded as nominal, either as "yes" or "no." Question 3 attempts to determine if respondents ability to build homes in Colorado has been affected by wildfire in Colorado. The responses were coded as nominal, either as "yes" or "no."

Questions 28A – R were used to collect demographic information. Question 28A asked the sex of the respondents. The responses were coded as either male or female. Question 28B asked respondents their age and was coded in years. Question 28F asked respondent's to estimate their company's sales volume in Colorado during 2003 and was coded in dollars.

Question 28G asked the respondents to identify the segment that most closely described the industry in which the company was most active in 2003. Segments included "single-family," "condominiums," "room additions," "apartment," and "duplexes." This information was designed to help identify the single-family homebuilder from all other residential contractors.

Question 28I was designed to determine the highest level of education that the respondents had attained. The responses were coded as "grade school," "some high school," "high school degree," "technical/vocational school," "some college," "college degree," "some graduate school," or "graduate degree."

Question 28M asked respondents how many domestic pleasure trips they took during 2003. Question 28N asked respondents how many industry trade shows they attended in 2003.

Question 28R was designed to determine the level of social participation that respondents had in the residential construction industry. This was accomplished by asking the respondents to indicate if they were members of the National Association of Homebuilders (NAHB).

## Data Analyses

This section is divided into three parts to facilitate an orderly understanding of the progression of all the analyses conducted for the study. The first part lists the different strategies of analysis that were used in this study. Part 2 explains the analysis strategies that were used to achieve each of the three study objectives described earlier in Chapter I. The final part of this section contains detailed information pertaining to the use of "Coefficient Alpha or  $\alpha$ " and "Discriminant function analysis," which were the two major multivariate analyses used in this study.

### Analysis Strategies

The data set was analyzed by utilizing the Statistical Package for the Social Sciences (SPSS) for windows, version 12.0, standard version (SPSS, 2003). The data analyses for this study included various descriptive statistics, reliability analysis, cross tabulations, analysis of variance (ANOVA), and discriminant function analysis. Descriptive statistics were computed to describe the characteristics of the variables in the measurement model and to describe the socio-demographic characteristics of the respondents. The reliability analyses were conducted to assess the internal consistency reliability for the constructed scales using "Cronbach's Reliability Coefficient Alpha or  $\alpha$ ." Cross-tabulation was used to test for significance and map the associations between nominal level variables. Analyses of variance (ANOVA) with the Scheffe post hoc tests were used to compare the means of various continuous dependent variables for the adopter groups. Discriminant function analysis was used to classify adopter groups across various discriminator variables and validate self-reported adopter group membership

### Achievement of Objectives:

#### *Development of a descriptive profile for the adopter groups*

Descriptive statistics, including frequencies, means, standard deviations, and relative

percentages, were computed for the "self reported" adopter groups. Cross-tabulation analyses were conducted to explain the relationships and statistical significance between the adopter groups and various nominal level demographic and product attribute variables.

#### Discrimination and validation of the self-reported adopter group memberships

This objective was achieved by first testing the internal consistency reliability for the four, scaled indices used to discriminate the adopter groups. The scales were personality variables, which included the concepts of "dogmatism," "fatalism," "rationality," and "favorable attitude towards science."

Discriminant function analysis was employed to analyze the effects of independent variables on group discrimination (see Kleca (1980) for a detailed explanation of this procedure). In addition to the four personality indices, other independent variables used in this analysis, included age, sex, level of education, company size, number of domestic pleasure trips, industry trade show attendance, NAHB membership, and saliency to the fire hazard.

Cross-validation in SPSS discriminant analysis was performed by dividing the sample into two sub samples. The first sub sample was used to derive the discriminant function and the second was used in validating the functions. The next step was to conduct another discriminant analysis with function and validation groups switched. This validation procedure was important because discriminant analysis is by nature a maximization procedure, selecting the first and each succeeding function to maximize the substantial variance between groups. Since the functions are so well tailored to fit the idiosyncrasies of the sample, the generalizability powers of the functions to other samples might be weak unless cross-validation results prove otherwise.

Another validation analysis strategy that was used in this study was the comparison of the percentage correctly classified to the maximum-chance criterion and the proportional-chance criterion (Hair, Anderson, & Tatham, 1987). The maximum-chance criterion is the percentage correctly classified if all cases were allocated to the group with the greatest probability of

occurrence. The proportional-chance criterion was calculated by squaring the proportions of each group.

Comparison of the four adopter groups across various dependent variables

One-way ANOVA's and the Scheffe post hoc tests were used to compare the mean differences and statistical significance of the groups on various scales and single item indicators.

### Primary Multivariate Strategies

#### Cronbach's Reliability Coefficient Alpha

Internal consistency describes estimates of reliability of indices based on the average correlation among items within a test. The coefficient alpha reflects both the number of items and their average correlation. This may be thought of as the internal consistency (Nunnally & Bernstein, 1994). The coefficient alpha usually provides a good estimate of reliability, because sampling of content is the major source of measurement error for constructs and also because it is sensitive to the sampling of concepts as well as item content.

Cronbach's alpha is based on the average correlation of items within a group of survey questions or variables if the items are standardized to a standard deviation of 1 or on the average covariance among items on a scale if the items are not standardized. All the items in a scaled index are assumed to positively correlate with each other because they should be measuring the same theoretical concept.

The coefficient alpha can be viewed as the correlation between a scaled index and all other possible scaled indices containing the same number of items that measure the characteristics of interest. Coefficient alpha can also be interpreted as the squared correlation between the score a person obtains on a particular scale and the score the individual would have obtained if questioned on all possible items in the universe.

Alpha ranges from 0 to 1. A negative alpha value can occur when items are not positively

correlated among themselves and the reliability model is violated. Coefficient alpha sets an upper limit for reliability of tests constructed in terms of the domain sampling model based upon observed correlations. If the alpha is very low, the test is either too short or items have very little in common. If the alpha is high, the items grouped together may indicate a common underlying concept.

Although a satisfactory level of reliability depends on how a measure is being used, as well as the type of research being conducted, Nunnally and Bernstein (1994) suggest that in the early stages of construct development indices with even modest reliability (e.g., 0.65) are acceptable. Social science researchers often accept a reliability coefficient below 0.80 in their measurements (Carmines & Zeller, 1982). In true experimental research dealing with individuals (e.g. testing IQ in children), a reliability of 0.80 may not be high enough to make decisions about an individual. A researcher may need a coefficient of 0.90 or higher (Gliner, Morgan & Harmon, 2001).

#### Discriminant Function Analysis

In this study, existing theory was used to classify respondents into one of five groups based on how they answered question 4A of the survey instrument (see Appendix C). The five groups are based on the levels of innovativeness or the five adopter categories described in Rogers (1995). Discriminant function analysis was used to validate respondent's self-reported group membership. It is a useful tool for testing theory by observing whether cases are classified as predicted.

Discriminant function analysis is a technique that allows the researcher to examine and describe simultaneously the differences between two or more mutually exclusive groups with respect to several continuous variables. It is a technique for identifying the relationships between a categorical dependent variable and a number of interval or dummy predictor variables. The key variable in discriminant analysis is the group variable, which is the dependent or criterion

variable. In this study, the group variable is level of innovativeness.

A discriminator variable is a measure of some characteristics on which the groups of individuals under study are expected to differ. In one-dimensional analysis such as t-test or ANOVA, these independent measures are known as predictor variables. The effective use of discriminant analysis depends on the relevance of the discriminant variables to group differences. Maximum discriminative efficiency is achieved when the discriminant variables have been determined based on past research or theory to be relevant to group discrimination and each variable represents a unique characteristic on which groups are expected to differ (Brown & Tinsley, 1983).

In this study, the discriminator variables include the personality scales of "dogmatism," "fatalism," "rationality," and "favorable attitude towards science" and the socio-economic variables of age, sex, level of education, company size, number of domestic pleasure trips, industry trade show attendance, NAHB membership, and saliency to the fire hazard contained in the model to study adopter characteristics (see Figure 7).

Discriminant analysis is designed to weight and linearly combine (add) scores on the discriminator variables in such a manner as to force groups to be as mathematically distinct as possible. To accomplish this, a weight, called a discriminant coefficient, is calculated for each discriminator variable. The magnitude of the discriminant coefficient is dependent on the relationship between group differences and scores on the discriminator variable (Tatsuoka, 1970).

Discriminant analysis is designed to answer the following questions: (1) What dimension (i.e., characteristics) are most important in representing the multivariate group differences? (2) How might the dimensions be interpreted or described? (3) What are the contributions of the variables to these underlying dimensions? (4) How can the groups be spatially represented to make group differences available to the direct observation of the investigator? and (5) How can new (e.g., unclassified) persons or elements be assigned to the group to which they are most similar (Borgen & Selig, 1978; Huberty, 1975; Tatsuoka & Tiedeman, 1954)?

Assignment concerns the placement of new individuals to a group when their membership is unknown. This is done by comparing the target person's profile with the average profile for people known to belong to the various groups. Placements may use either the observed or the discriminant scores for the assignment of new individuals into groups (Bernstein, 1988; Cooley & Lohnes, 1971). For the purpose of this study, discriminant scores were used. Discriminant scores or coefficients are usually correlated within a particular group even though they are uncorrelated across groups.

Discriminant analysis will produce a more parsimonious result when large numbers of groups and/or discriminant variables are analyzed because the interrelatedness of the variables is considered. Discriminant analysis will also reduce the likelihood of a type I error (i.e., that differences which occurred by chance will be judged statistically significant) than if one performed multiple t-test or ANOVA to compare differences between groups.

When multiple measures are taken of members belonging to mutually exclusive groups, no single characteristic (measure) of the members will best differentiate the groups (Tatsuoka, 1970). Instead, some combination of information from all of the measures will determine the dimension(s) most helpful in distinguishing groups. If groups differ to a small degree on a number of dimensions and these small group differences are added across all dimensions, the groups are maximally discriminated and the group differences are more discernable (Kleca, 1975; Sananthanan, 1975; Tatsuoka, 1970).

## CHAPTER IV

### RESULTS

Chapter IV presents the results from the data analyses described in the previous chapter. This chapter is divided into five sections. The first section describes survey response rate and problems faced during sampling and data collection. Section two describes the profiles of respondents, adopter groups, and characteristics of variables measured in the model. The third section presents the results of reliability tests of the constructed indices. Section four presents the discriminant function analysis of the adopter groups. The final section reports the results of adopter groups' comparisons on various test variables, which consist of scaled indices and single item indicators.

#### Survey Response Rate

Of the 750 surveys mailed to Colorado homebuilders, 144 were returned as undeliverable including wrong addresses and companies that were no longer in business. Of the remaining 606 surveys, 112 surveys were returned resulting in an adjusted response rate of approximately 19 percent. While this response rate is low for social science research (Babbie, 2002), it is typical for industrial type surveys in general (Rawnsley, 1979; Walker, Kirchman, & Conant, 1987), and contractor surveys, specifically. For example, Stalling and Sinclair (1989) reported a 14.6 percent response rate for contractors, Shook and Eastin (1995) had an 18.8 percent rate for contractors, and Damery and Fisette (2001) reported a response rate for contractors of 19.2 percent.

To assess non-response bias, the Armstrong and Overton (1977) method for analyzing time trend responses was utilized. In this method, those who responded to the initial mailing

(early respondents) are compared to those who responded after the follow-up steps are taken (late respondents). The later respondents are believed to be more like non-respondents (Armstrong & Overton, 1977; Pearl & Fairley, 1985; Green, 1991; Dalecki, Whitehead & Blomquest, 1993). Early respondents (n=91) were compared to later respondents (n=21) across a number of key demographic variables. The Chi-square goodness-of-fit test detected no significant differences ( $p \leq 0.05$ ) between the proportion of early and late adopter within any of the demographic variables. Likewise, using analysis of variance (ANOVA), no significant differences ( $p \leq 0.05$ ) were found between the two groups' mean overall perceptions of attribute importance of "green" and other building materials, and quality of life principles.

An additional comparison was made to determine what percent of the single-family residential construction industry the respondents represented. Question 28G (see Appendix C) was used to separate single-family homebuilders from all residential contractors. Eighty-six contractors reported that their company's primary business was single-family construction. Question 28F was used to determine the total sales (\$4.24 billion) in 2003 for all single-family respondents. According to Real Estate Center at Texas A&M University (2004), Colorado's single-family homebuilders built 33,894 single-family residences in 2003 with an average value per dwelling unit of \$170,600 for a total value of \$5.78 billion (see Appendix E). Respondents therefore represented 73 % ( $\$4.24/\$5.78 \times 100$ ) of the total value of single-family residences built in Colorado in 2003. This suggests that respondents truly represent the views of the single-family builder.

### Characteristics of the Respondents

#### *All Respondents*

The average age of the respondents was 48 years and 88 % were male respondents. Over three-fourths (90 %) of the respondents had some college education. Two-thirds (68 %) of the respondents had at least bachelor's degrees and 14 % had graduate degrees. The average annual

sales volume reported by the respondents was \$46 million. However, a majority (81 %) of the respondents worked for small companies with annual sales less than \$27.5 million per year and 7 % of the respondents worked for companies with sales volumes greater than \$100 million per year.

All (100 %) of the respondents reported that they were aware of the wildfire hazard in Colorado's Forests. Forty percent of the respondents build in areas affected by wildfire with 13 % of the respondents reporting that wildfires have impacted their ability to build in Colorado.

Based on the answers to the adopter classification question respondents were initially grouped into one of five adopter groups (see Table 2). The innovator group consisted of 19 individuals (17 %). The largest group was the early adopter group with 73 members (65.2 %). The early adopter group was composed of 17 individuals (15.2 %). The late adopter group had two individuals (1.8 %) and the laggard group consisted of one member (0.9 %). This distribution violated the normal distribution assumptions of Rogers (1995) group classifications and the groups were reorganized to better reflect the traditional normal distribution of adopter categories.

Table 2. Self-reported adopter group membership

	Frequencies	Percentages
INNOVATORS	19	17
EARLY ADOPTERS	73	65.2
EARLY MAJORITY	17	15.2
LATE MAJORITY	2	1.8
LAGGARDS	1	0.9

The results of the reorganization of the adopter groups is shown in Table 3. The innovator group was renamed early adopter group and contained all of its original membership

(19 individuals). The initial groups of early majority, late majority, and laggards were merged into one new group called laggards containing 20 individuals. The original early adopter group was split into two new groups renamed early majority containing 37 individuals and late majority containing 36 individuals. This group separation was accomplished by evaluating the number of innovative products (finger-jointed studs, galvanized steel studs, and structural insulated panels) that individuals had evaluated. Thirty-six individuals had not tried any of the products. These individuals were assigned to the late majority group. The remaining 37 individuals had tried at least one of these products. They were assigned membership to the early majority group.

Single-family Respondents.

Table 3. Reconfigured adopter group membership

	Frequencies	Percentages
EARLY ADOPTER	19	17
EARLY MAJORITY	37	33
LATE MAJORITY	36	32.1
LAGGARDS	20	17.9

Because the intent of the study was to investigate the perceptions of single-family homebuilders, it was necessary to separate those respondents that did not report their primary business as single-family. Of the 112 respondents, 86 (77 %) reported their primary business as being single-family. The results for adopter classification of single-family homebuilders are shown in Table 4. Therefore, the following results are reported for single-family homebuilders. Where appropriate, results for all respondents are also reported.

The respondents were asked to rate the 12 statements in Table 5 in terms of the statements' importance to their quality of life. Respondents rated the items "time spent with family" (76 %) and "education for children (76 %) as being extremely important. Respondents

rated the items “clean rivers” (86 %), “air quality” (83 %), and “natural environment” (75 %) as being “very important” to “extremely important.” Respondents rated “wildlife” (53 %), “transportation needs” (57 %), “money” (62 %), and “recycling practices” (50 %) as being “very important”. Respondents rated the items “religion” (23 %) and “wealth/being wealthy” (53 %) as being “moderately important” to “very important.” Finally, respondents rated “time spent on the internet” (45 %) as being “slightly” to “moderately important.”

Table 4. Single-family reconfigured adopter group membership

	Frequencies	Percentages
EARLY ADOPTER	15	17.4
EARLY MAJORITY	24	27.9
LATE MAJORITY	29	33.7
LAGGARDS	18	20.9

Table 5. Single-family homebuilder percentage response to “How important are each of the following to your quality of life.”

	Percentage of Respondents (n=86)							
	Mean <sup>1</sup>	Not at all Important (1)	Slightly Important (2)	Moderately Important (3)	Moderately Important (4)	Very Important (5)	Extremely Important (6)	Extremely Important (7)
Time spent with	6.7	0	0	0	1	6	17	76
Education for children	6.6	0	1	0	3	5	15	76
Clean rivers	6.3	1	0	1	2	10	30	56
Air quality	6.2	1	0	2	1	13	33	50
Natural environment	6.1	1	0	1	1	22	36	39
Wildlife	5.9	1	0	4	4	23	30	38
Transportation needs	5.6	1	0	0	16	23	34	26
Money	5.6	0	0	2	15	29	33	21
Recycling practices	5.1	2	2	8	19	24	26	19
Religion	4.9	11	11	3	16	7	22	30
Wealth/being wealthy	4.9	1	5	8	20	33	26	7
Time spent on internet	3.3	15	20	16	29	13	6	1

<sup>1</sup> Means were calculated on responses coded as: 1=not at all important to 7=extremely important.

The respondents felt that of the 12 items in Table 5 “time spent with family” (64 %), “religion” (14 %), and “natural environment” (9 %) were the most important item to their quality of life.

#### Characteristics of Single Family Adopter Groups

The average age for the early adopters was 54 years. The average age for the early majority was 49 years and the late majority was 47. The laggards had an average age of 44 years. As shown in table 6, statistically, there were no differences on the mean ages between any of the groups.

Table 6. Average age of respondents by adopter group members

	Average age of respondents, years <sup>1</sup> (n)				df	F	$\eta^3$
	Early Adopters	Early Majority	Late Majority	Laggards			
Single family (86)	54(15) <sup>a</sup>	49(24) <sup>ab</sup>	47(29) <sup>ab</sup>	44(18) <sup>b</sup>	3	2.54*	.29
All respondents (112)	52(19) <sup>a</sup>	49(37) <sup>a</sup>	48(35) <sup>a</sup>	45(20) <sup>a</sup>	3	1.81	.22

<sup>1</sup>All cell entries are means and means with different superscripts across the rows differ significantly at  $p < .05$ . Scheffe was used for the post hoc test.

<sup>2</sup>Example for interpreting the superscripts: means on the item “single family” for early adopters, early majority, and late majority groups did not differ statistically and means for early majority, late majority, and laggards did not differ statistically but the means for early adopters differed statistically to the mean of the laggard group.

<sup>3</sup> $\eta$  or “eta” is a measure of the strength of association or effect size. In Human Dimensions research  $\eta = .1$  represents a minimal relationship,  $\eta = .3$  represents a typical relationship and  $\eta = .5$  represents a substantial relationship (Vaske, in press).

\* $p < .1$ .

The results of cross tabulation between adopter groups and level of education attained are presented in Table 7. While the  $\chi^2$  test indicates that differences between cell percentages were not statistically significant, 1/5<sup>th</sup> (20.8 %) of the early majority had only a high school education and 72.2 % of the laggards had at least a bachelor degree.

Table 7. Level of education by adopter group members

	Percentage of adopter categories				df	$\chi^2$	p
	Early Adopters	Early Majority	Late Majority	Laggards			
<b>Single-family (n=86)</b>	<b>n=15</b>	<b>n=24</b>	<b>n=29</b>	<b>n=18</b>			
High school degree	6.7	20.8	3.4	5.6	12	14.58	.265
Some college	40.0	29.2	51.7	22.2			
Bachelor degree	26.7	37.5	37.9	44.4			
Some graduate school	13.3	4.2	3.4	5.6			
Graduate degree	13.3	8.3	3.4	22.2			
<b>All respondents (n=112)</b>	<b>n=19</b>	<b>n=37</b>	<b>n=36</b>	<b>n=20</b>			
High school degree	10.5	16.2	2.9	5.0	12	15.67	.207
Some college	36.8	24.3	45.7	25.0			
Bachelor degree	21.1	37.8	42.9	40.0			
Some graduate school	15.8	5.4	2.9	5			
Graduate degree	15.8	16.2	5.7	25			

Statistically, there were no differences between adopter categories and membership in the National Association of Home Builders (see Table 8). Approximately one-half of all adopter categories were members of NAHB. Only 46.7 % of the early adopters were members of NAHB while 69 % of the late adopters were NAHB members. Fifty percent (50 %) of the late majority and 55.6 % of the laggards were members of NAHB.

Table 8. Membership in NAHB<sup>1</sup> by adopter group members

	Percentage of adopter categories				df	$\chi^2$	p
	Early Adopters	Early Majority	Late Majority	Laggards			
<b>Single-Family (86)</b>	<b>n=15</b>	<b>n=24</b>	<b>n=29</b>	<b>n=18</b>			
Yes	46.7	50.0	69.0	55.6	3	2.84	.417
No	53.3	50.0	31.0	44.4			
<b>All respondents (112)</b>	<b>n=19</b>	<b>n=37</b>	<b>n=36</b>	<b>n=20</b>			
Yes	42.1	54.1	68.6	50.0	3	4.08	.253
No	57.9	45.9	31.4	50.0			

<sup>1</sup> National Association of Homebuilders

The majority of all respondents in each adopter group were male. Statistically, there were no differences between adopter categories and sex (see Table 9). Ninety-three (93.3 %) percent of the early adopters, 83.3 % of the early majority, 89.7 % of the late majority, and 94.4 % of the laggards were male.

Table 9. Sex by adopter group members

	Percentage of adopter categories				df	$\chi^2$	p
	Early Adopters	Early Majority	Late Majority	Laggards			
<b>Single-Family (86)</b>	<b>n=15</b>	<b>n=24</b>	<b>n=29</b>	<b>n=18</b>			
Male	93.3	83.3	89.7	94.4	3	1.68	.641
Female	6.7	16.7	10.3	5.6			
<b>All respondents (112)</b>	<b>n=19</b>	<b>n=37</b>	<b>n=36</b>	<b>n=20</b>			
Male	89.5	86.5	85.7	95.0	3	1.24	.744
Female	10.5	13.5	14.3	5.0			

On average early adopters ( $M=5.0$ ) took more domestic pleasure trips in 2003 than laggards ( $M=2.33$ ) ( $F=2.98$ ,  $df=3$ ,  $p=.036$ ,  $\eta=.31$ ) (see Table 10). Early adopters ( $M=.27$ ) attended fewer trade shows in 2003 than laggards ( $M=1.17$ ) ( $F=2.67$ ,  $df=3$ ,  $p=.053$ ,  $\eta=.30$ ).

Table 10. Number of domestic pleasure trips and trade shows by adopter group members

	Adopter Categories <sup>1</sup>				df	F	$\eta^3$
	Early Adopters	Early Majority	Late Majority	Laggards			
<b>Single-Family (86)</b>	<b>n=15</b>	<b>n=24</b>	<b>n=29</b>	<b>n=18</b>			
Number of trips <sup>2</sup>	5.00 <sup>a</sup>	2.96 <sup>a</sup>	2.38 <sup>a</sup>	2.33 <sup>a</sup>	3	2.98*	.31
No. of trade shows	.27 <sup>a</sup>	1.0 <sup>ab</sup>	.93 <sup>ab</sup>	1.17 <sup>b</sup>	3	2.67*	.30
<b>All respondents (112)</b>	<b>n=19</b>	<b>n=37</b>	<b>n=34</b>	<b>n=20</b>			
Number of trips	5.05 <sup>a</sup>	3.49 <sup>ab</sup>	2.62 <sup>ab</sup>	2.25 <sup>b</sup>	3	3.32*	.29
No. of trade shows	.32 <sup>a</sup>	.92 <sup>ab</sup>	.91 <sup>ab</sup>	1.25 <sup>b</sup>	3	3.09*	.28

<sup>1</sup>All cell entries are means and means with different superscripts across the rows differ significantly at  $p<.05$ . Scheffe was used for the post hoc test.

<sup>2</sup>Example for interpreting the superscripts: means on the item "no. of trade shows" for early adopters, early majority, and late majority groups did not differ statistically and means for early majority, late majority, and laggards did not differ statistically but the means for early adopters differed statistically to the mean of the laggard group.

<sup>3</sup> $\eta$  or "eta" is a measure of the strength of association or effect size. In Human Dimensions research  $\eta=.1$  represents a minimal relationship,  $\eta=.3$  represents a typical relationship and  $\eta=.5$  represents a substantial relationship (Vaske, in press).

\* $p\leq.05$ .

Early adopters come from small companies, i.e. those companies with annual sales of less than \$27.5 million (see Table 11). The early adopter group, in fact, is composed exclusively of small companies. Only one (4.2 %) of the majority group members is from a large company. All other medium to very large companies belong either in the late majority or laggard groups.

Table 11. Annual sales volume by adopter group members

	Percentage of adopter categories				df	$\chi^2$	p
	Early Adopters	Early Majority	Late Majority	Laggards			
<b>All respondents (n=112)</b>	<b>n=19</b>	<b>n=37</b>	<b>n=36</b>	<b>n=20</b>			
Extremely small < \$1 mil	42.1	18.9	19.4	15.0	18	27.34	.073
Very small \$1 mil to \$4.99 mil	47.4	43.3	27.8	30.0			
Small \$5 mil to \$27.49 mil	10.5	29.7	22.2	20.0			
Medium \$27.5 mil to \$49.99 mil	0	2.7	13.9	10.0			
Large \$50 mil to \$99.99 mil	0	2.7	5.6	10.0			
Very large \$100 mil to \$400 mil	0	0	11.1	5.0			
Extremely large >\$400,000,000	0	2.7	0	10.0			
<b>Single-family (n=86)</b>	<b>n=15</b>	<b>n=24</b>	<b>n=29</b>	<b>n=18</b>			
Extremely small < \$1 mil	40.0	20.8	17.2	16.7	18	24.08	.152
Very small \$1 mil to \$4.99 mil	46.7	50.0	34.5	27.8			
Small \$5 mil to \$27.49 mil	13.3	25.0	17.2	22.2			
Medium \$27.5 mil to \$49.99 mil	0	0	13.8	11.1			
Large \$50 mil to \$99.99 mil	0	4.2	3.4	5.6			
Very large \$100 mil to \$400 mil	0	0	13.8	5.6			
Extremely large >\$400,000,000	0	0	0	11.1			

## Reliability Analyses of Constructed Indices

Three sets of indices were constructed for the purpose of adopter group validation and testing. The first set consists of four personality indices, which are the rationality, fatalism, dogmatism, and favorable attitude toward science scales.

The second set of indices consists of the four concepts related to the importance of environmental issues and wood as a home building material, including environmental image of wood scale, information and social image of wood scale, practical image of wood scale, and fashionable image of wood scale. The third set of indices consists of three scales related to the importance of lumber as a home building material, including physical attributes of lumber scale, use attributes of lumber scale, and cost/quality attributes of lumber scale. These groups of indices along with other variables were used for testing adopter group differences.

### Personality Scales

The reliability analyses that were performed to assess the internal consistency of the four personality indices had acceptable Alpha coefficients greater than or equal to .60 (see Table 12). The rationality scale that was composed of three items had an Alpha coefficient of .79. The scale could have been improved to  $\alpha = .81$  by dropping the item "recycling construction waste will help the solid waste problem." However, the decision was made to keep this item in the scale because it was measuring a different sector of the construct, which was needed for the parsimony of the scale. The inter item correlation for the scale items ranged from .43 to .67.

The original fatalism scale, which was composed of four items, had an Alpha coefficient of .69. By dropping the item "sometimes my company cannot control how its actions contribute to environmental problems" the scale was improved to  $\alpha = .76$ . This was a substantial improvement to scale reliability and was supported by the low (.26) corrected item total correlation for this item. The remaining three items had inter item correlations ranging from .36 to .65

Table 12. Reliability analysis for items in four personality scales.

Item <sup>1</sup>	Corrected item Total Correlation	Alpha if Item Deleted
<b>Rationality</b>		
<b>Cronbach's Alpha = .79</b>		
Recycling construction waste will help the solid waste problem.	.54	.81
If my company reduces the amount of construction waste it produces, it will make a difference in the solid waste problem.	.74	.60
My company can influence the forces that cause pollution.	.63	.72
<b>Fatalism</b>		
<b>Cronbach's Alpha = .76</b>		
Sometimes my company cannot control how its actions contribute to environmental problems <sup>2</sup> .	.26	.76
As only one of many homebuilders in the U.S. my company's business practice has no real effect on the environment.	.52	.60
Many problems such as air pollution require too much money to solve for my company to have any impact.	.62	.53
Many environmental problems require too much power to solve for my company to have any impact.	.54	.59
<b>Favorable Attitude Towards Science</b>		
<b>Cronbach's Alpha = .60</b>		
By understanding the forces that cause pollution, my company can help solve problems.	.41	.51
If my company knows that some behavior is wasteful, it can usually control it.	.46	.49
Because there really is no such thing as luck, most environmental problems will be solved by the efforts of concerned people.	.31	.58
By understanding the forces that cause pollution, my company can solve the problem.	.39	.54
<b>Dogmatism</b>		
<b>Cronbach's Alpha = .67</b>		
Whether my company builds homes with "green" building materials has no impact on whether or not other homebuilders will.	.34	.68
My company can influence government to help solve many environmental problems <sup>3</sup> .	.39	.64
The amount of construction waste that my company produces is so small compared to the total that it does not matter.	.62	.48
Recycling my company's construction waste is significant in the total environmental picture <sup>3</sup> .	.47	.59

<sup>1</sup>Based on the response to "People differ in their opinions concerning environmental problems and possible solution to those problems. Indicate how strongly you agree or disagree with each statement." Response to items were coded as: 1=strongly disagree to 7=strongly agree.

<sup>2</sup>This item was dropped from the scale to increase  $\alpha$  from .69 to .76.

<sup>3</sup>Responses to these items were reverse coded.

The favorable attitude toward science scale was composed of four items and had an Alpha coefficient of .60. All the items were kept for the construction of this scale because the Alpha value could not be improved by omitting any of the items. The inter item correlation for the items in the scale ranged from .16 to .38.

The dogmatism scale consisting of four items had an Alpha coefficient of .67. The scale could have been improved marginally ( $\alpha = .68$ ) by dropping the item “whether my company builds homes with “green” building materials has no impact on whether or not other homebuilders will” from the scale. However, the item was kept in the scale because of its importance to the construct. Inter item correlation ranged from .19 to .52 for this scale.

#### Importance of Environmental Image of Wood and Wood as a Home Building Material Scales

The reliability analysis for the importance of environmental issues and wood as a home building material scales had Alpha coefficient greater than or equal to .72 (see Table 13). The environmental image of wood scale was composed of five items and had an Alpha coefficient of .85 with inter item correlations ranging from .25 to .74. The information and social image of wood scale was composed of three items with an Alpha coefficient of .83 and inter item correlations ranging from .56 to .68. The practical image of wood scale consisted of four items and had an Alpha coefficient of .84 with inter item correlations ranging from .36 to .77. The final scale, fashionable image of wood, had the lowest Alpha coefficient of all the scales in this group with  $\alpha = .72$ . and inter item correlations ranging from .13 to .56.

#### Lumber Attribute Scales

The reliability analyses results for the lumber attribute scales is shown in Table 14. The physical attributes of lumber scales consisted of six items and had an Alpha coefficient of .85. The inter item correlation for this scale ranged from .39 to .63. The use attributes of lumber scale had an Alpha coefficient of .78. This scale could have been improved to  $\alpha = .81$  by dropping the

item “attractive appearance” from the scale. However, the decision was made to keep the item in the scale because its corrected item total correlation was greater than .40. The inter item correlations for this scale ranged from .34 to .63. The cost/quality attribute of lumber scale was the final scale in this series. This scale had an Alpha coefficient of .71 with inter item correlations ranging from .15 to .52.

Table 13. Reliability analysis for items in four wood image scales

Item <sup>1</sup>	Corrected item Total Correlation	Alpha if Item Deleted
<b>Environmental Image of Wood</b>		
<b>Cronbach's Alpha = .85</b>		
Lumber originates from sustainably managed forests.	.51	.84
Lumber can be recycled.	.70	.81
Wood is recyclable.	.65	.82
Wood is environmental safe.	.70	.81
Environmental impact of lumber manufacturing	.71	.80
Lumber is safe and poses no health risks.	.51	.84
<b>Information &amp; Social Image of Wood</b>		
<b>Cronbach's Alpha = .83</b>		
Lumber is packaged in recyclable materials.	.69	.77
Lumber is socially acceptable.	.65	.80
Information on environmental impact of lumber.	.74	.72
<b>Practical Image of Wood</b>		
<b>Cronbach's Alpha = .84</b>		
Wood is easy to repair.	.71	.78
Wood is durable.	.67	.79
Wood is safe.	.76	.75
Wood is appreciated.	.54	.85
<b>Fashionable Image of Wood</b>		
<b>Cronbach's Alpha = .72</b>		
Wood is fashionable.	.60	.63
Wood is youthful.	.55	.65
Wood is a material of the future.	.42	.70
Wood is timeless.	.50	.67
Wood is good looking.	.35	.72

<sup>1</sup>Based on the response to “How important are the following environmental issues to you?” and “How important are the following characteristics of *wood* as a home building material?” Response to items were coded as: 1=not at all important to 7=extremely important.

Table 14. Reliability analysis for items in three attribute scales

Item <sup>1</sup>	Corrected item Total Correlation	Alpha if Item Deleted
<b>Physical Attributes of Lumber</b>		
	<b>Cronbach's Alpha = .85</b>	
Resistance to impact	.66	.82
Resistance to decay	.61	.83
High energy absorption	.67	.82
Resistant to ultraviolet light	.66	.82
Resistant to fire	.57	.83
Free of toxic chemicals	.63	.82
<b>Use Attributes of Lumber</b>		
	<b>Cronbach's Alpha = .78</b>	
Reliable strength	.59	.74
Structural design flexibility	.70	.69
Easy installation	.66	.70
Attractive appearance	.49	.81
<b>Cost/Quality Attributes of Lumber</b>		
	<b>Cronbach's Alpha = .71</b>	
Low life cycle cost	.34	.72
Low maintenance cost	.50	.65
Low replacement cost	.51	.65
Low initial cost	.47	.67
Consistent quality	.55	.63

<sup>1</sup> Based on the response to "In your opinion how important are the following attributes for selecting *Lumber* as a home building material?" Response to items were coded as: 1=not at all important to 7=extremely important.

#### Discriminant Function Analysis

Discriminant analysis was used to explore the discriminating strength of discriminator variables in differentiating the four adopter categories. The discriminator variables used in the analysis were dogmatism scale, fatalism scale, rationality scale, favorable attitude towards science scale, and the socio-economic variables of age, sex, education, company size, number of domestic pleasure trips taken, number of industry trade shows attended, NAHB membership, and saliency of topic.

Of the three discriminant functions that predicted the group differences, only the first function was statistically significant at  $p < .001$  with a Chi-Square value of 131.32 (df=36) (see Table 15).

Eighty-eight percent of the variance in the discriminator variables was accounted for by the first function relative to the other two functions (relative percent<sup>2</sup>). Functions two and three explained 9 % and 3 % of the variance, respectively. These values provide an indication of the relative importance of each function for discriminating among the adopter groups.

Although the values of relative percent are interesting, the absolute amount of variance in the discriminator variables that were accounted for by the functions is also important. All three functions together accounted for 27 % of the absolute variance in the discriminator variables. The absolute percent (variance) was calculated by dividing the sum of the Eigenvalues by the number of predictor variables used in the analysis (e.g.  $3.26/12 = .272$ ). Breaking it down by the functions revealed that the first function accounted for 24 % percent of the absolute variance<sup>3</sup> in the group differences, followed by function two (2 %) and function three (1 %). Since these functions are orthogonal, the absolute percentages of each function should add up to 27 %.

The canonical correlation (see Table 15) indicates the relationship between the variance accounted for by one function and the adopter group differences. The squared canonical correlations indicate the proportion of variance in a function. Therefore, 74 % of the variance in function one is associated with adopter group differences as compared to 23 % for function two and 9 % for function three. Canonical correlations provide another way of evaluating the functions; therefore, functions associated with the larger canonical correlation, in this case, functions one and two, are the most important.

The Wilks' Lambda statistic (see Table 15) is an inverse measure of the discriminating information in the seven discriminator variables. The use of both the Wilks' Lambda and Chi-square statistics to determine the importance of the functions has been highly recommended by Hurberty (1975), Tatsuoka (1970), and Sanathanan (1975). The larger the Lambda value, the less information remains in the discriminator variables that are systematically related to group

---

<sup>2</sup> The relative percent is calculated by dividing each eigenvalue by the sum of the eigenvalues.

<sup>3</sup> Absolute variance accounted for by each function can be calculated by multiplying the relative percent by the overall absolute percent.

differences. The Wilks' Lambda for function one is .18, which has the most discriminator information, as compared to .91 for function three, which has the least discriminator information to contribute in group differentiation.

Table 15. Evaluation of the discriminant functions that predicted adopter groups

Function	Eigenvalue	Relative Percent <sup>1</sup>	Canonical Correlation <sup>2</sup>	Wilks' Lambda <sup>3</sup>	$\chi^2$	Df	p-value
1	2.87	88.0	.86	.18	131.32	36	.000
2	.29	9.0	.48	.70	27.12	22	.207
3	.10	3.0	.30	.91	7.36	10	.691

<sup>1</sup>The proportion of variance in a function, which is related to variance in the discriminators, it's the relative percentage of the Eigenvalue.

<sup>2</sup>Indicates the proportion of variance in a function which is related to differences among groups.

<sup>3</sup>Is an inverse measure of the discriminating information available in the discriminator variables; the larger the Wilks' Lambda value, the less information there is remaining in the discriminator variables.

#### Interpretation of the Functions

There are two ways of interpreting discriminant functions. The first is by examining the standardized canonical coefficients of the functions. The other is through examination of the discriminant function-variable correlations. The standardized canonical coefficients were obtained by multiplying the raw coefficient for each predictor variable by the standard deviation for that variable. The discriminant function-variable correlations are the correlations between each function and each of the discriminator variables. For this report both methods were used. Only the largest coefficients or correlations were used to describe the functions. It should be noted that the two methods might yield very different results, but at the same time, by looking at both methods, redundancies of the contributing discriminator variables can be detected.

A number of researchers advocate the use of discriminant function-variable correlations because there is greater stability of the correlations in small to medium sized samples and the correlations provide a direct indication of which variables are most closely aligned to the discriminant function (Darlington, Weinberg, & Walberg, 1973; Meredith, 1966; Porebski, 1966).

On the other hand, the standardized canonical coefficients are partial coefficients where the effects of the other variables are omitted (Stevens, 1995).

Both the standardized canonical discriminant function coefficients and the discriminant function-variable correlations were obtained in the analysis (see Table 16). These are the correlations for the best linear function of the discriminator variables differentiating the adopter groups. Based on the interpretation of the correlations, the first function relies on mainly the socioeconomic variable, age. The second function relies heavily on the three personality variables of rationality, fatalism, and dogmatism and on the socioeconomic variables of education level and number of domestic pleasure trips. The third function is defined by the socioeconomic variables of company size, NAHB membership, and saliency to fire.

Table 16. Discriminant function analysis to predict adopter groups

Discriminator Variables	Standardized Canonical Discriminant Function Coefficients			Discriminant Function-Variable Correlations <sup>1</sup>		
	Functions			Functions		
	1	2	3	1	2	3
Rationality	1.675	-.201	.381	.502	<b>-.660*</b>	-.083
Fatalism	.670	.206	.378	-.041	<b>.568*</b>	.168
Favorable attitude toward science	.157	.572	.490	.227	<b>-.248*</b>	-.086
Dogmatism	.757	.702	.611	-.071	<b>.744*</b>	.209
Member NAHB	.140	-.151	.435	-.041	-.125	<b>.497*</b>
Company size	-.020	.142	.525	-.212	-.044	<b>.530*</b>
Age	.412	.197	-.045	<b>.174*</b>	.177	-.146
Education level	-.034	.488	-.283	-.069	<b>.420*</b>	-.170
Sex	.050	-.180	-.155	.022	<b>-.230*</b>	-.175
Number of domestic pleasure trips	.317	.195	-.426	.161	<b>.322*</b>	-.210
Saliency of fire	.211	.088	-.461	.167	.070	<b>-.425*</b>
Number of industry trade shows	-.283	-.066	-.142	-.159	<b>-.276*</b>	-.149

<sup>1</sup>Pooled within group correlations between discriminating variables and standardized canonical discriminant functions.

\*Significant at  $p < .05$

The centroids for the adopter group are shown in Table 17. Because the first two functions explain the greatest proportion of the group variance, they are the most appropriate functions for plotting the individuals and group centroids. Figure 7 presents the plot of the individuals' discriminant scores and shows that the four adopter groups are clearly discriminated from one another on the two functions. The group centroids were used in the prediction of group membership of the individuals, where the individual's discriminant scores are compared to the centroids of the adopter groups. Individuals are assigned to the adopter group whose centroid has the most similar value to the individual's discriminant scores.

Table 17. Discriminant functions at adopter group centroids

Adopter Groups <sup>2</sup>	FUNCTION <sup>1</sup>		
	1	2	3
EARLY ADOPTERS	2.623	.787	-.002
EARLY MAJORITY	.525	-.535	-.373
LATE MAJORITY	-.157	-.299	.396
LAGGARDS	-2.633	.539	-.139

<sup>1</sup>Centroids are unstandardized canonical discriminant functions evaluated at Adopter group means.

<sup>2</sup>73.3 % of the original grouped cases were correctly classified in the full discriminant model.

#### Validation of Adopter Groups

The classification of individuals into adopter groups was carried out by a procedure that is set up to maximize the number of correct classifications of the cases originally classified. Since discriminant function analysis is a maximization procedure, it predicts the sample data analyzed well but might have problems on other samples. In other words, it might be difficult to generalize the functions to other populations. In order to assure that the functions obtained from the discriminant analysis were generalizable and valid, a cross validation procedure was carried out.

## Canonical Discriminant Functions

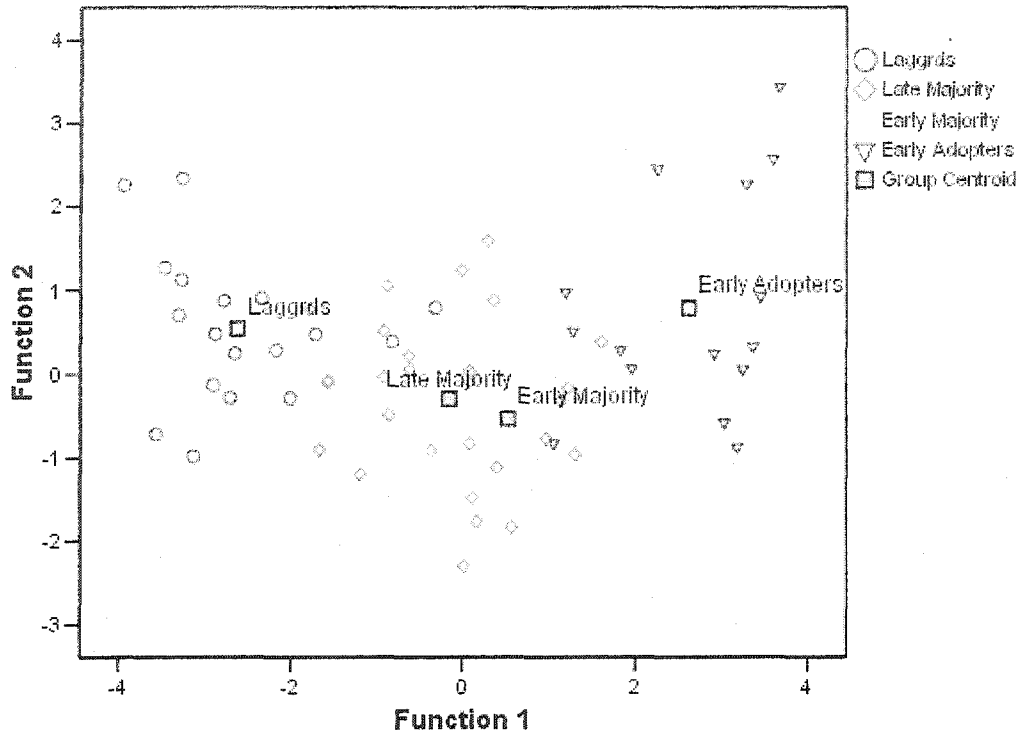


Figure 7. Plot of Group Centroids and Individual Discriminant Scores on Functions 1 and 2

Table 18 presents the results for the double-split cross validation method. The total sample was divided in half and separate discriminant analysis was carried out on each half, where both sub-samples served as the developmental sample and the validation sample. In the first analysis 97.7 % of the analysis group cases were correctly classified as compared to the 86.0 % of the validation group cases that were correctly classified. In the second analysis, where groups were switched, 95.3 % of the analysis group cases were correctly classified as compared to the 81.4 % of the validation group cases that were correctly classified. Seventy three (73.3 %) percent of the originally grouped cases were correctly classified in the full discrimination model.

Table 18 "Double-split cross-validation" adopter groups classification results

	PREDICTED ADOPTER GROUP MEMBERSHIP							
	EARLY ADOPTERS		EARLY MAJORITY		LATE MAJORITY		LAGGARDS	
	%	n	%	n	%	n	%	N
<b>Analysis Group1<sup>1</sup></b>								
Early adopters	100	5	0	0	0	0	0	0
Early Majority	6.2	1	93.8	15	0	0	0	0
Late Majority	0	0	0	0	100	10	0	0
Laggards	0	0	0	0	0	0	100	12
<b>Validation Group2<sup>2</sup></b>								
Early adopters	100	6	0	0	0	0	0	0
Early Majority	0	0	95.7	22	0	0	4.3	1
Late Majority	0	0	60	3	40.0	2	0	0
Laggards	0	0	0	0	22.2	2	77.8	7
DOUBLE SPLIT CROSS VALIDATION SWITCHING OF ANALYSIS AND VALIDATION GROUPS								
<b>Analysis Group2<sup>3</sup></b>								
Early adopters	100	6	0	0	0	0	0	0
Early Majority	0	0	95.7	22	0	0	4.3	1
Late Majority	0	0	20.0	1	80.0	4	0	0
Laggards	0	0	0	0	0	0	100	9
<b>Validation Group1<sup>4</sup></b>								
Early adopters	100	5	0	0	0	0	0	0
Early Majority	6.3	1	81.2	13	0	0	12.5	2
Late Majority	0	0	20.0	2	70.0	7	10.0	1
Laggards	0	0	0	0	16.7	2	83.3	10

<sup>1</sup>97.7 % of the analysis group 1 cases were correctly classified.

<sup>2</sup>86.0 % of the validation group 2 cases were correctly classified.

<sup>3</sup>95.3 % of the analysis group 2 cases were correctly classified.

<sup>4</sup>81.4% of the validation group 1 cases were correctly classified.

Table 19 reports the calculations of the chance criteria for the adopter group classifications. The maximum-chance criterion is the percentage correctly classified if all cases were allocated to the group with the greatest probability of occurrence, which in this case is the

late majority group (34 %). The proportional-chance criterion is calculated by squaring the proportions of each group. These criteria were compared to the percentage of correctly classified original cases in the full model, which was 73.3 %. Since  $C_{\max}$  (34 %) is greater than  $C_{\text{pro}}$  (37 %), the maximum-chance criterion is the criterion to exceed. The correct classification of 73.3 % surpasses the  $C_{\max}$  criterion considerably and supports the validity of the discriminant model.

Table 19. Calculation of chance criteria for adopter group classification

Adopter Groups <sup>1</sup>		Calculation
Early Adopter	$C_{e.adopters}$	$= (15 / 86) \times 100 \% = 17 \%$
Early Majority	$C_{e.majority}$	$= (24 / 86) \times 100 \% = 28 \%$
Late Majority	$C_{l.majority}$	$= (29 / 86) \times 100 \% = 34 \%$
Laggards	$C_{laggards}$	$= (18 / 86) \times 100\% = 21 \%$
Maximum Chance Criteria	$C_{\max}$	$= 34 \%$
Proportional Chance Criteria <sup>2</sup>	$C_{\text{pro}}$	$= (p_1)^2 + (p_2)^2 + (p_3)^2 + (p_4)^2$ $= (.17)^2 + (.28)^2 + (.34)^2 + (.21)^2$ $= .27 \text{ or } 27 \%$

<sup>1</sup>73.3% of the original grouped cases were correctly classified in the full discriminant model.

<sup>2</sup>p = the probability of cases being classified into groups just by chance.

### Hypothesis Testing

One-way ANOVA was used to test all hypotheses. The results for this section are explained in five subsections consisting of adopter groups by importance of (1) wood image scales, (2) lumber attribute scales, (3) quality of life principles, (4) green building materials, and (5) price premium willing to pay for green building materials.

## Wood Image

All four hypotheses in this section were supported. The two directional hypotheses tested had statistically significant differences ( $p < .001$ ) on their mean score across adopter groups. Comparison of the adopter groups by importance of wood image scales, are presented in Table 20.

***H1: Early adopters place more importance on the environmental image of wood than laggards.*** The hypothesis was supported ( $F=9.21$ ,  $p < .001$ ,  $\eta = .50$ ). Early adopters ( $M=6.32$ ) differed significantly from the laggards ( $M=4.81$ ) on the variable “environmental image of wood.” All four groups rated the importance of the environmental image of wood as being important.

***H2: Early adopters place more importance on information and the social image of wood than laggards.*** The hypothesis was supported ( $F=8.24$ ,  $p < .001$ ,  $\eta = .48$ ). Early adopters ( $M=6.07$ ) differed significantly from the laggards ( $M=4.24$ ) on the variable “information and social image of wood.” All four groups rated the importance of information and social image of wood as being important.

***H3: Earlier adopters place the same importance on the practical image of wood as later adopters.*** The hypothesis was supported ( $F=1.51$ ,  $p = .219$ ,  $\eta = .23$ ). Early adopters ( $M=6.12$ ), early majority ( $M=5.76$ ), late majority ( $M=5.65$ ), and laggards ( $M=5.54$ ) did not differ significantly on the variable “practical image of wood.” All four groups rated the importance of the practical image of wood as being important.

***H4: Earlier adopters place the same importance on the fashionable image of wood as later adopters.*** The hypothesis was supported ( $F=1.45$ ,  $p = .234$ ,  $\eta = .22$ ). Early adopters ( $M=5.11$ ), early majority ( $M=4.92$ ), late majority ( $M=4.78$ ), and laggards ( $M=4.49$ ) did not differ significantly on the variable “fashionable image of wood.” All four groups rated the importance of the fashionable image of wood as being important.

Table 20. Comparison of adopter groups by importance of wood image scales

Variable <sup>1</sup>	Adopter Categories <sup>2</sup>				df	F	P	$\eta^3$
	Early Adopters	Early Majority	Late Majority	Laggards				
Environmental image	6.32 <sup>a</sup>	5.88 <sup>ab</sup>	5.50 <sup>bc</sup>	4.81 <sup>c</sup>	3	9.21	.001	.50
Info . & social image	6.07 <sup>a</sup>	5.63 <sup>a</sup>	5.21 <sup>ab</sup>	4.24 <sup>b</sup>	3	8.24	.001	.48
Practical image	6.12 <sup>a</sup>	5.76 <sup>a</sup>	5.65 <sup>a</sup>	5.54 <sup>a</sup>	3	1.51	.219	.23
Fashionable image	5.12 <sup>a</sup>	4.92 <sup>a</sup>	4.78 <sup>a</sup>	4.49 <sup>a</sup>	3	1.45	.234	.22

<sup>1</sup>Variables for the scales were coded on a seven point scale from 1=not at all important to 7=extremely important.

<sup>2</sup>All cell entries are means and means with different superscripts across the rows differ significantly at  $p < .05$ . Scheffe was used for the post hoc test.

<sup>3</sup> $\eta$  or "eta" is a measure of the strength of association or effect size. In Human Dimensions research  $\eta = .1$  represents a minimal relationship,  $\eta = .3$  represents a typical relationship and  $\eta = .5$  represents a substantial relationship (Vaske, in press).

### Lumber Attributes

All three hypotheses in this section were supported with statistically significant differences ( $p < .001$ ) on their mean score across adopter groups. Comparison of the adopter groups by importance of lumber attributes scales are presented in Table 21. More detailed results on the comparison of adopter categories to the importance of various building materials can be found in Appendix F.

***H5: Early adopters place more importance on the physical attributes of lumber than laggards.*** The hypothesis was supported ( $F = 4.09$ ,  $p > .01$ ,  $\eta = .36$ ). Early adopters ( $M = 5.54$ ) differed significantly from the laggards ( $M = 4.52$ ) on the variable "physical attributes of lumber." All four groups rated the importance of the physical attributes of lumber as being important.

***H6: Early adopters place more importance on the use attributes of lumber than laggards.*** The hypothesis was supported ( $F = 3.94$ ,  $p > .01$ ,  $\eta = .36$ ). Early adopters ( $M = 6.68$ ) differed significantly from the laggards ( $M = 5.88$ ) on the variable "use attributes of lumber." All four groups rated the importance of the use attributes of lumber as being important.

***H7: Early adopters place more importance on the cost/quality attributes of lumber than laggards.*** The hypothesis was supported ( $F = 4.32$ ,  $p > .01$ ,  $\eta = .37$ ). Early adopters ( $M = 6.09$ ) differed significantly from the laggards ( $M = 5.34$ ) on the variable "cost/quality attributes of

lumber.” All four groups rated the importance of the cost/quality attributes of lumber as being important.

Table 21. Comparison of adopter groups by importance of lumber attribute scales

Variable <sup>1</sup>	Adopter Categories <sup>2</sup>				df	F	p	$\eta^3$
	Early Adopters	Early Majority	Late Majority	Laggards				
Physical attributes	5.54 <sup>a</sup>	5.29 <sup>ab</sup>	5.01 <sup>ab</sup>	4.52 <sup>b</sup>	3	4.09	.009	.36
Use attributes	6.68 <sup>a</sup>	6.13 <sup>ab</sup>	5.95 <sup>b</sup>	5.88 <sup>b</sup>	3	3.94	.011	.36
Cost/quality attributes	6.01 <sup>a</sup>	5.86 <sup>ab</sup>	5.49 <sup>ab</sup>	5.34 <sup>b</sup>	3	4.32	.007	.37

<sup>1</sup>Variables for the scales were coded on a seven point scale from 1=not at all important to 7=extremely important.

<sup>2</sup>All cell entries are means and means with different superscripts across the rows differ significantly at  $p < .05$ . Scheffe was used for the post hoc test.

<sup>3</sup> $\eta$  or “eta” is a measure of the strength of association or effect size. In Human Dimensions research  $\eta = .1$  represents a minimal relationship,  $\eta = .3$  represents a typical relationship and  $\eta = .5$  represents a substantial relationship (Vaske, in press).

### Quality of Life Principles

A comparison of adopter groups by variables important to respondents’ quality of life principles are presented in Table 22. Two of the four items tested were statistically significant at  $p < .001$ . The two significant variables were related to the environment. Earlier adopters consistently placed more importance on environmental variables than the laggards (see Appendix G).

***H8: Early adopters place more importance on the natural environment to their quality of life principles than laggards.*** The hypothesis was supported ( $F=9.07$ ,  $p > .001$ ,  $\eta = .50$ ). Early adopters ( $M=6.80$ ) differed significantly from the laggards ( $M=5.22$ ) on the importance of the natural environment to their quality of life principles.

***H9: Early adopters place more importance on recycling to their quality of life principles than laggards.*** The hypothesis was supported ( $F=14.06$ ,  $p > .001$ ,  $\eta = .58$ ). Early adopters ( $M=6.02$ ) differed significantly from the laggards ( $M=3.67$ ) on the importance of recycling to their quality of life principles.

***H10: Earlier adopters place the same importance on time spent with family to their quality of life principles as later adopters.*** The hypothesis was supported ( $F=0.39$ ,  $p = .763$ ,

$\eta=.12$ ). Early adopters ( $M=6.67$ ), early majority ( $M=6.79$ ), late majority ( $M=6.62$ ), and laggards ( $M=6.61$ ) did not differ significantly on the importance of time spent with family to their quality of life principles.

***H11: Earlier adopters place the same importance on money to their quality of life principles as later adopters.*** The hypothesis was supported ( $F=0.27$ ,  $p=.845$ ,  $\eta=.10$ ). Early adopters ( $M=5.73$ ), early majority ( $M=5.46$ ), late majority ( $M=5.59$ ), and laggards ( $M=5.44$ ) did not differ significantly on the importance of money to their quality of life principles.

Table 22. Comparison of adopter groups by importance to quality of life principles

Variable <sup>1</sup>	Adopter Categories <sup>2</sup>				df	F	p	$\eta^3$
	Early Adopters	Early Majority	Late Majority	Laggards				
Natural environment	6.80 <sup>a</sup>	6.29 <sup>ab</sup>	5.97 <sup>bc</sup>	5.22 <sup>c</sup>	3	9.07	.001	.50
Recycling	6.20 <sup>a</sup>	5.58 <sup>ab</sup>	5.07 <sup>b</sup>	3.67 <sup>c</sup>	3	14.06	.001	.58
Time spent with family	6.67 <sup>a</sup>	6.79 <sup>a</sup>	6.62 <sup>a</sup>	6.61 <sup>a</sup>	3	.39	.763	.12
Money	5.73 <sup>a</sup>	5.46 <sup>a</sup>	5.59 <sup>a</sup>	5.44 <sup>a</sup>	3	.27	.845	.10

<sup>1</sup>Variables for the scales were coded on a seven point scale from 1=not at all important to 7=extremely important.

<sup>2</sup>All cell entries are means and means with different superscripts across the rows differ significantly at  $p<.05$ . Scheffe was used for the post hoc test.

<sup>3</sup> $\eta$  or "eta" is a measure of the strength of association or effect size. In Human Dimensions research  $\eta=.1$  represents a minimal relationship,  $\eta=.3$  represents a typical relationship and  $\eta=.5$  represents a substantial relationship (Vaske, in press).

### Green Building Materials

Both hypotheses in this section were supported with statistically significant differences ( $p<.001$ ) on their mean score across adopter groups. Comparison of the adopter groups by importance of green building materials, are presented in Table 23. The laggards consistently placed less importance on all "green " building materials than any of the other groups (see Appendix H for a more detailed comparison).

***H12: Early adopters place more importance on products that reduce waste than laggards.*** The hypothesis was supported ( $F=13.16$ ,  $p<.001$ ,  $\eta=.57$ ). Early adopters ( $M=6.53$ )

differed significantly from the laggards (M=4.22) on the importance of “products that reduce waste.”

**H13: Early adopters place more importance on alternatives to ozone-depleting substances than laggards.** The hypothesis was supported (F=17.78, p<.001, η=.63). Early adopters (M=6.20) differed significantly from the laggards (M=3.22) on the importance of “alternatives to ozone-depleting substances.”

Table 23. Comparison of adopter groups by importance of green building materials

Variable <sup>1</sup>	Adopter Categories <sup>2</sup>				Laggard	F	η <sup>3</sup>
	Mean <sup>3</sup>	Early Adopter	Early Majority	Late Majority			
Products that reduce waste	5.52	6.53 <sup>a</sup>	5.75 <sup>a</sup>	5.62 <sup>a</sup>	4.22 <sup>b</sup>	13.16 <sup>†</sup>	.57
Alternatives to ozone-depleting substances	4.98	6.20 <sup>a</sup>	5.25 <sup>a</sup>	5.21 <sup>a</sup>	3.22 <sup>b</sup>	17.78 <sup>†</sup>	.63

<sup>1</sup>Variables for the scales were coded on a seven point scale from 1=not at all important to 7=extremely important.

<sup>2</sup>All cell entries are means and means with different superscripts across the rows differ significantly at p<.05. Scheffe was used for the post hoc test.

<sup>3</sup>η or “eta” is a measure of the strength of association or effect size. In Human Dimensions research η=.1 represents a minimal relationship, η=.3 represents a typical relationship and η=.5 represents a substantial relationship (Vaske, in press).

<sup>†</sup>p<.001.

#### Premium Willing to Pay for Green Building Materials

**H14: Early adopters believe that more of their customers will be willing to pay for green building materials derived from Colorado’s forests than laggards.** The hypothesis was supported (F=2.75, p<.05, η=.33). Early adopters estimated 32 % of their customers would be willing to pay more for green building materials derived from Colorado’s forest (see Appendix I for a more detailed comparison). The laggards on the other hand estimated that 9 % of their customers would be willing to pay more for green building materials derived from Colorado’s forests.

#### Summary of Findings

The overall response rate for the study was 18.5 % (N=112). Single-family respondents (n=86) sold approximately \$4.24 billion of new single-family home in Colorado during 2003. This represents approximately 73 % of sales for Colorado’s 2003 new single-family homes. The

average age of the respondents was 48 years, 88% were male. Over three-fourths (90 %) of the respondents had some college education. Two-thirds (68 %) of the respondents had at least bachelor's degrees and 14 % had graduate degrees. The average annual sales volume reported by the respondents was \$46 million. However, a majority (81 %) of the respondents worked for small companies with annual sales less than \$27.5 million per year and 7 % of the respondents worked for companies with sales volumes greater than \$100 million per year.

All (100 %) of the respondents reported that they were aware of the wildfire hazard in Colorado's Forests. Forty percent of the respondents build in areas affected by wildfire with 13 % of the respondents reporting that wildfires have impacted their ability to build in Colorado.

About 90 % of the respondents rated time spent with family, education for their children, clean rivers, and air quality as very important to extremely important to their quality of life principles. Overall, respondents felt that "time spent with family" (64 %), "religion" (14 %), and "natural environment" (9 %) were the most important item to their quality of life.

#### Development of a Descriptive Profile for the Four Adopter Groups

As predicted by the theory of Diffusion of Innovation (Rogers, 1995), most of the respondents represented the majority group. For the single-family segment (n=86), this group was composed of the early majority 24 (27.9 %) cases and the late majority 29 (33.7 %) cases, followed by the laggards with 18 cases (20.9 %), and early adopters with 15 (17.4 %) cases. The sample emulated a normal distribution, an important criteria of the theory.

#### Discrimination of the Adopter Groups

The personality scales constructed as predictor variables to discriminate adopter groups exhibited acceptable levels of internal consistency reliability (Cronbach's Alpha's were between .60 and .79 for all four scales). The discriminant functions passed all the traditional evaluation requirements (see Table 15 for details of evaluations) with a high degree of confidence. Function

1 had a canonical correlation of .86 and a Wilk's Lambda of .18 ( $\chi^2 = 131.32$ ,  $df = 36$ ,  $p = .001$ ). Function 1 accounted for 88 % of the relative variance in the discriminator variables that predicted the groups and 24 % of the absolute variance in the predictor variables. Both the "double split Cross-validation" and the "chance criteria" strategies provided the discriminant function model with positive validations. The full discriminant model correctly classified 73.3 % of the originally grouped cases.

#### Comparison of the Four Adopter Groups Across Various Study Variables

The lumber attribute scales, including environmental image of wood (Cronbach's Alpha = .85), information and social image of wood (Cronbach's Alpha = .83), practical image of wood (Cronbach's Alpha = .84), and fashionable image of wood (Cronbach's Alpha = .728), had good internal consistency reliability. The lumber attribute scales of physical attributes of lumber, use attributes of lumber, and cost/quality attributes of lumber had Cronbach's Alpha values of .85, .78, and .71, respectively.

All of the study hypotheses were supported. As predicted by theory, the early adopters consistently placed more importance than did laggards on the environmental and social images of wood, the natural environment to their quality of life principles, and the importance of green building materials to their business practices.

## CHAPTER V

### IMPLICATIONS

This study focused on environmental and wood related opinions of the single-family homebuilder in Colorado. The image and attributes of wood are described, and the critical product characteristics of green building materials are identified. The results of the study have a variety of implications. This chapter discusses the implications for (1) marketing, (2) planning and policy, (3) limitations of research, and (4) future research.

#### Marketing

The average public does not exist. The study revealed that for a given sample, segments or groups of the homebuilding industry could be identified based on selected characteristics that were important to an issue. This study segmented Colorado's single-family homebuilders using the adopter characteristics of the diffusion of innovation model related to environmental issues in Colorado's forests. Segmentation of Colorado's single-family homebuilders into adopter categories has provided valuable information about each group's personality characteristics, their tendencies on environmental issues and quality of life principles, and the importance that they place on "green" building materials. Knowledge about the various segments of the homebuilding industry can be used to market effectively wood products as "green" building materials. As discussed previously in the review of literature (Chapter II), traditional marketing of consumer products tends to target segments that most likely could afford a product or segments that are willing to try new products in the market place. Because the average public does not exist, the implication for marketers is to consider the various adopter groups when devising an effective

marketing mix. The marketing mix includes various forms of communication strategies, such as personal and non-personal strategies. Marketers need to understand the needs and ability of the various adopter groups when positioning various method of communication. Because each adopter group has their own unique characteristics, products need to be positioned differently for each group.

The implication for communication strategies is that adopter groups behave differently in response to different media channels. For example, according to Rogers (1995), earlier adopters tend to place higher importance on mass media channels than interpersonal channels. Since earlier adopters are more cosmopolite than later adopters, cosmopolite channels are relatively more important than localite channels for earlier adopters. Earlier adopters possess a more venturesome orientation, so the mass media message stimulus is enough to move them over the mental threshold to the adoption of a new product. The less change oriented later adopters require a stronger and immediate influence, like that produced from interpersonal networks to.

This study also points out that visual properties and social acceptance are other clear attributes of wood. These attributes may have received too little attention in past marketing activities so far. In fact, this "*social-aesthetic quality*" may be at least equally strong attribute of wood as the environmental quality, because these product characteristics may appeal to a larger and perhaps different consumer groups than the environmental aspects.

However, remembering that the most important environmental dimension of wood is connected with health, environmental, and aesthetic-social qualities may even represent the same phenomenon: values related to pleasure and status - - a kind of prestige for an individual. Therefore, *marketing of wood products should be based more clearly on all these strengths, including the "aesthetic-social-environmental quality."* In practice, increasing the demand for Colorado wood products requires building a new high "brand image" for wood products. This would address aesthetic taste and style, but also refer to a lifestyle of respecting the environment and pursuing social responsibility.

In fact, marketers need to develop a brand-image for Colorado wood representing a certain kind of life style. The mix of uniqueness and conformism creates consumer groups with different life styles. At the same time consumers want to be individual and distinguish themselves from other people but also and belong to a group where they can feel being similar with other people. Belonging to a group helps consumers gain security through shared norms and values. The visual properties of wood offer a way to be unique, and the environmental and social aspects help consumers to belong to a certain group. This life style group could be called "green aesthetician" or something similar.

#### Planning and Policy

This study's grouping of cases into adopter categories also revealed that it is possible to predict homebuilder's group affiliation based on their answers to a few relevant questions. This means that the discriminant function facilitates the classification of new members. Knowing homebuilder's group affiliation will help managers deal with various situations better, since they can now predict homebuilder's tendencies and likings on issues based on the study's generalizability.

Public involvement is essential in decision-making and policy formulations for environmental issues. Instead of just getting input from innovators and early adopters at public meetings, natural resources managers must also find ways to attract the later adopters to these public hearings. This has been demonstrated by the results of this study where later adopters tend to place less importance on environmental issues.

#### Limitations of Research

As a borrowed theory, innovation diffusion provides the advantage of a rich cumulative tradition. Yet, when borrowing theory, care must be taken to ensure that the context in which the theory is applied matches well with the context in which the theory was developed, or

alternatively, to tailor the theory to account for contextual differences. As with any research endeavor, this study has several limitations.

To begin with, the response rate for this study was only 18.5 % and the results may not generalize to the entire residential construction industry in Colorado. However, 2003 single-family home sales reported by respondents represents over 70 % of the total value of Colorado's 2003 single-family new home sales indicating the study captured most of the sample of interest.

The second limitation is related to the sample frame used in the study. This study took place in Colorado. The results from this study should not be extrapolated to represent expected responses from other geographical regions.

Thirdly, this study only examined one segment of the residential construction industry in Colorado, the single-family homebuilder. There are other major segments in the residential construction industry, including 2 to 4 family homebuilders and 5 or more family homebuilders.

The fourth limitation of the study is the possibility that the questionnaire setup socially desirable responses. It is possible that some respondents answered the questions in a way that did not truly represent the beliefs of their company but rather in a way that they thought the researcher wanted them to respond.

Finally, this study examined self-reported levels of innovativeness that may not truly reflect actual measures of company innovativeness. Furthermore, the unit of measurement was companies, but respondents were individuals reporting their opinions, and this might not truly represent the views of their company.

#### Future Research

Research in the future should consider testing other personality variables. This will enable the discovery of new personality variables that are more sensitive to local conditions and predict adopter groups with greater consistency. Future research should also attempt to identify new adopter group categories, other than the standard adopter group explained by Rogers (1995)

that fit the homebuilding culture. To achieve this, studies targeted at adopter groups should be designed to find out more about the characteristics of each group, asking questions that are more specific on environmental issues related to specific attitudes, values, beliefs, and behaviors. The more specific the information obtained, the more useful the information becomes to planners and managers in the marketing of green building materials for the various groups.

Methodologically, future research should attempt to study other diffusion of innovation elements, such as "innovation decision process," "communications channels," "social structure," and "opinion leaders." These studies would reveal beneficial information to further understand adopter group characteristics and possibly provide better solutions to improving marketing communications to the homebuilding industry.

Future research should also consider true experimental designs that can test for the effectiveness of various communication strategies on the adopter groups. Longitudinal diffusion studies will aid in understanding the rate of diffusion and effectiveness of communication campaigns on the adopter groups.

Overall, research in the future should identify the consumer segments with different preferences. In particular, the willingness to pay a price premium for visual properties or environmental friendliness should be investigated. In general, the health aspect of wood products deserves more attention, first in research and then in marketing.

## Conclusion

The purpose of this study was to (1) develop a descriptive profile of adopter groups, (2) discriminate the adopter groups across predictor variables that best explain the group differences and validate the self-reported adopter group memberships, and (3) compare the adopter groups across various dependent variables related to "green" building materials, substitute building materials, and quality of life principles.

The study found that Colorado single-family homebuilders could be classified into

adopter categories based on both the respondents' self-selection and the discriminant functions. The study identified personality variables that best discriminated for adopter group differences based on environmental issues. The adopter groups differed on the mean scores of various environmental issues, but all four groups placed similar importance on the items religion, family time, and education for children.

The major implication for planners and managers when dealing with marketing green building materials is the value of segmenting homebuilders into adopter categories. This provides a more thorough and accurate view of the different groups and their unique characteristics. This leads to devising a variety of communication strategies and recognizing that each group has different characteristics. In the past, managers and planners have used intuition and experience to make decision concerning audience characteristics and needs. This study and future efforts can help provide useful information into the diverse characteristics and needs of each adopter group and provide a systematic way to understand audiences in order to assure the success of marketing Colorado forest products.

By thinking of the public as markets, managers have a wide variety of tools available for them to segment their audience into homogeneous groups. These tools include bases and methods of segmentation and segment specific variables that have been used routinely by researchers for audience analysis.

Market segmentation techniques can also be applied within a product class to evaluate consumer perceptions on competing brands. Research that examines why individuals are motivated to select one substitute over another would enhance the utility of substitutability findings as well as provide a forum for examining the general motivation theories of social psychology.

Fundamentally, the most significant implication of this study is verification that marketing Colorado forest products based on their environmental, social, and health attributes to early adopters is a sound and promising marketing strategy.

## REFERENCES

- Akinola, A. (1986). An application of the Bass model in the analysis of diffusion of coco-spraying chemicals among Nigerian cocoa farmers. *Journal of Agricultural Economics*, 37 (3), 395-404.
- Armstrong, J. S. & Overton, T. S. (1977). Estimating non-response bias in mail surveys. *Journal of Marketing Research*, 14(8), 396-402.
- Assael, H. (1970). Segmenting markets by group purchasing behavior: An application of the AID technique. *Journal of Marketing Research*, 7, 153-158.
- Assael, H. & Roscoe, A.M. (1976). Approaches to market segmentation analysis. *Journal of Marketing*, 40, 67-76.
- Attewell, P. (1992). Technology diffusion and organizational learning: The case of business computing." *Organization Science*, 3, 1-19.
- Babbie, E. (2002). *The basics of social research*. Belmont, CA: Wadsworth Group.
- Bandura, A. (1986). *Social Foundations of Thought and Actions*. Englewood Cliffs, NJ: Routledge.
- Bass, F. M. (1969). A new product growth model for consumer durables. *Management Science*, 15, 5, 215-227.
- Belk, R. W., Wallendorf, M. & Sherry, J. F. (1989). The sacred and the profane in consumer behavior: Theodicy of the odyssey. *Journal of Consumer Research*, 16, 1-38.
- Bennett, P. D. (1995). *Dictionary of marketing terms*, 2d ed. Chicago, IL: American Marketing Association.

- Bengston, D. N. (1985). Diffusion of innovation in forestry and forest products. In C. Risbrudt, & P. Jakes (Eds.). *Review of the literature. Forestry Research Evaluation: Current progress, future direction*. USDA General Technical Report NC-104.
- Bernstein, I. H. (1988). *Applied multivariate analysis*. New York: Springer-Verlag.
- Borgen, F. & Seling, M. (1978). Uses of discriminant analysis following MANOVA: Multivariate statistics for multivariate purposes. *Journal of Applied Psychology*, 63, 689-697.
- Brown, M. T., & Tinsley, H. E. A. (1983). Discriminant analysis. *Journal of Leisure Research*, 15(4), 290-310.
- Building Design & Construction (2003). *White Paper on Sustainability*. Oak Brook, IL: Reed Business Information.
- Buongiorno, J., & Oliveria, R. A. (1977). A growth of particleboard share of production of wood-based panels in industrialized countries. *Canadian Journal of Forestry Research*, 7(2), 383-391.
- Burrows, J. & Sanness, B. (Eds.) (1998). The competitive climate for wood products and paper packaging: *The factors causing substitution with emphasis on environmental promotions*. The Joint FAO/ECE Team of Public Relations Specialist in the Forest and Forest Products Industries.
- Bush, R. & Hansen, E. (1996). Consumer perceptions of softwood lumber quality. *Forest Products Journal*, 46(10), 29-34.
- Calantone, R. I., & Sawyer, A. G. (1978). The stability of benefit segments. *Journal of Marketing Research*, 15, 81-105.
- Campbell, D.T., & Fiske, D.W. (1959). Convergent and discriminant validation by multitrait-multimethod matrix. *Psychological Bulletin*, 30, 81-105.
- Carmine, E. G., Zeller, R. A. (1982). *Reliability and validity assessment*. New Berry Park, CA: Sage Publications, Inc.

- Chase, D. (1991). The green revolution: P&G gets top marks in AA survey. *Advertising Age*, 62, 8-10.
- Coddington, W. (1993). *Environmental Marketing*. New York: McGraw-Hill, Inc.
- Cohen, D. H. & Kosak, R. A. (1996). Environmental attitudes of North American engineers and architects on material selection. In H. Juslin, & M. Pesonen (Eds.), *Environmental Issues and Market Orientations* (pp. 181-188). Current Topics in Forest Products Marketing. Proceeding of the Forest Products Marketing Group, IUFRO XX World Congress, 6-12 August, 1995.
- Cohen, W. M., and Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation." *Administrative Science Quarterly*, 35, 128-152.
- Cooley, W. W., & Lohnes, P. R. (1971). *Multivariate Data Analysis*. New York: Wiley.
- Cooper, R. J., Kalafatis, S. P., & Tsogas, M. M. H. (1996). The impact of green issues on the development of timber based furniture: A comparison of two EU countries. In H. Juslin, & M. Pesonen (Eds.), *Environmental Issues and Market Orientations* (pp. 137-166). Current Topics in Forest Products Marketing. Proceeding of the Forest Products Marketing Group, IUFRO XX World Congress, 6-12 August, 1995.
- Cox, W. E. Jr. (1967). Product life cycles as marketing models, *Journal of Business*, 40, 375-384.
- Dalecki, M. G., Whitehead, J. C., & Blomquist, G. C. (1993). Sample nonresponse bias and aggregate benefits in contingent valuation: An examination of early, late and nonrespondents. *Journal of Environmental Management*, 38, 133-143.
- Damery, D. T., & Fisette, P. (2001). Decision making in the purchase of siding: A survey of architects, contractors, and homeowners in the U.S. northeast. *Forest Products Journal*, 51(7/8), 29-36.
- Darlington, R. B., Weinberg, S., & Walberg, H. (1973). Canonical variate analysis and related techniques. *Review of Educational Research*, 43, 433-454.

- Day, G. S. (1990). *Market driven strategy. Process for creating value*. New York: Free Press.
- Deckard, D. L., & McCurdy, D. R. (1999). An empirical test of the materials supply strategy construct with application to the U.S. railroad crosstie industry. *Forest Products Journal*, 49(11/12), 45-50.
- Denzin, N. K. (1989). *Interpretive Interactionism: Applied Social Research Methods Series, Vol. 6*. Newbury Park, CA: Sage.
- Desarbo, W. S., & Cron, W. L. (1988). A maximum likelihood methodology for clusterwise linear regression. *Journal of Classification*, 5, 249-282.
- Desphande, R., Farley, J. U., & Webster, F. E. (1993). Corporate culture, customer orientation, and innovativeness in Japanese firms: A quadrad analysis. *Journal of Marketing*, 57(1), 23-37.
- Dillman, D.A. (2000). *The Tailored Design Method*. New York: John Wiley & Sons.
- Dodds, W. (1973). An application of the Bass model in long term new product forecasting. *Journal of Marketing Research*, 10 (August) 308-11.
- Drucker, P. (1973). *Management: Tasks, responsibilities, practices*. New York: Harper and Row.
- Eastin, I., Shook, S., & Simon, D. (1999). Softwood lumber substitution in the U.S. residential construction industry in 1994. *Forest Products Journal*, 49(5), 21-27.
- Fell, D., & Hansen, E. (1999). Target engineered products to builders most likely to innovate. *Wood Technology*, 126(4), 22-25.
- Fell, D., Hansen, E., & Becker, B. (2003). Measuring innovativeness for the adoption of industrial products. *Industrial Marketing Management*, 32, 347-353.
- Fell, D., Hansen, E. N., & Panches, J. (2002). Segmenting single-family homebuilders on a measure of innovativeness. *Forest Products Journal*, 52(6), 28-34.
- Fernandez, J. W. (1986). *Persuasions and Performance: The Paly of Tropes in Culture*. Bloomington, IN: University of Indiana.

- Fishbein, M., & Ajzens, I. (1975). *Beliefs, attitudes, intentions, and behavior: An introduction to theory and research*. Reading, MA: Addison-Wesley.
- Floyd, D. W., Seyfang, H. E., & Vonhoff, S. L. (2001). Forest sustainability: A discussion guide for professional resource managers. *Journal of Forestry*, 99(2), 8-27.
- Frank, R. E., Massy, W. F., & Wind, Y. (1972). *Market Segmentation*. Englewood Cliffs, NJ: Prentice Hall.
- Gatignon, H., & Robertson, T. S. (1985). A propositional inventory for new diffusion research. *Journal of Consumer Research*, 11, 849-867.
- Gliner, J. A., Morgan, G. A., & Harmon, R. (2001). Measurement reliability. *American Academy of Child Adolescent Psychiatry*, 40, 486-488.
- Globerman, S. (1976). New technology adoption in the Canadian paper industry. *Industrial Organization Review*, 4(1), 5-12.
- Green, K.E. (1991). Reluctant respondents: Differences between early, late, and nonresponders to a mail survey. *Journal of Experimental Education*, 59, 268-276.
- Green, P. E. (1978). A new approach to market segmentation. *Business Horizons*, 20, 61-73.
- Green, P. E., & Desarbo, W. S. (1979). Componential segmentation in the analysis of consumer trade-offs. *Journal of Marketing*, 43, 83-91.
- Grunig, J. E. (1989). Publics, audiences and market segments: Segmentation principals for campaigns. In T. Salmon (Ed.), *Information campaigns: Balancing social values and social change*. Newsbury Park, CA: Sage.
- Gunter, B., & Furnham, A. (1992). *Consumer profiles: An introduction to psychographics*. London: Routledge.
- Hair, J. F., Anderson, R. E., & Tatham, R. L. (1987). *Multivariate data analysis with readings*. New York: Macmillan.

- Hakanson, S. (1974). Special presses in papermaking. In L. Nasbeth, & G. F. Ray (Eds.), *The diffusion of new industrial processes*. London: Cambridge University Press.
- Haley, Russell I. (1968), "Benefit segmentation: A decision-oriented research tool," *Journal of Marketing*, 32 (July), 30-35.
- Hansen, E., & Adair, C. (1996). *Homebuilder perceptions of engineered wood products*. Tacoma, WA: APA-the Engineered Wood Association.
- Harner, S. W., & Zimmerman, T. G. (2002). *Technical marketing communication*. New York: Longman.
- Hawkins, D. I., Best, R. J., & Coney, K. A. (1989). *Consumer behaviour: Implications for marketing strategy*. Homewood, Boston: BPI/IRWIN.
- Huberty, C. (1975). Discriminant Analysis. *Review of Education Research*, 45, 543-598.
- Institute for the Built Environment (2002). <http://ibe.colostate.edu>.
- Jeuland, A. (1994). *Empirical generalizations in marketing*. Draft Proceedings, February 16- 18, SEI Center for Advanced Studies in Management. The Wharton School of the University of Pennsylvania.
- Kahle, L. R., Beatty, S. E., & Holmer, P. (1986). Alternative measurement approaches to consumer values: The list of values (LOV) and values and lifestyles (VALS). *Journal of Consumer Research*, 13(December), 405-409.
- Kalafatis, S. P., Glass, B. P. & Evison, D. C. (1996). A model for evaluating vendor and customer perceptions of solid wood products. In H. Juslin, & M. Pesonen, M. (Eds.), *Environmental Issues and Market Orientations* (77-94). Current Topics in Forest Products Marketing. Proceeding of the Forest Products Marketing Group, IUFRO XX World Congress, 6-12 August, 1995.
- Kalish, S., & Lillien, G. L. (1986). A market entry timing model for new technologies. *Management Science*, 32, 194-205.

- Kamakura, W. A., & Russell, G. J. (1992). Measuring brand value with scanner data. *International Journal of Research in Marketing*, 10, 9-22.
- Kass, G. (1980). An exploratory technique for investigating large quantities of categorical data. *Applied Statistics*, 29(2), 119-127.
- Katz, M. L., and Shapiro, C. (1986). Technology adoption in the presence of network externalities. *Journal of Political Economy*, 94, 822-41.
- Kirkpatrick, D. (1990). Environmentalism: the new crusade. *Fortune*, 121, 44-51.
- Kleca, W. R. (1975). Discriminant analysis. In N. Nie, C. Hull, J. Jenkins, K. Steinbrenner, & D. Brent, D. (Eds.), *SPSS* (2<sup>nd</sup> Edition ed.). New York: McGraw-Hill Book Company.
- Kleca, W. R. (1980). *Discriminant analysis*. Beverly Hills, CA: Sage Publication.
- Kotler, P. (1989). From mass marketing to mass customization. *Planning Review*, 10-47.
- Kotler, P., (2000). *Marketing management*. Upper Saddle River, NJ: Prentice Hall.
- Kwon, T. H., and Zmud, R. W. (1987). Unifying the fragmented models of information systems implementation. In J. R. Boland, and R. Hirshheim (Eds.), *Critical Issues in Information Systems Research* (pp. 227-251). New York: John Wiley.
- Lawton, S. B., & Lawton, W. H. (1979). An autocatalytic model for the diffusion of educational innovations. *Educational Administration Quarterly*, 15, 19-53.
- Lazer, K., & Kelley, E. J. (1962). *Managerial marketing: Perspectives and viewpoints*. Homewood, IL: Irwin.
- Levitt, T. (1980). Marketing success through differentiation – of anything. *Harvard Business Review*, 2(1), 83-91.
- Levitt, T. (1986). *The marketing imagination*. New York: Free Press.
- Leefers, L. A. (1981). *Innovation and product in the woodbased panel industry*. Ph.D. thesis, Michigan State University.
- Leonard-Barton, D. (1987). Implementing structured software methodologies: A Case of innovation in process technology. *Interfaces*, 17, 6-17.

- Leonard-Barton, D. (1988). Implementation characteristics of organizational innovations. *Communication Research, 15*, 603-631.
- Leonard-Barton, D., and Deschamps, I. (1988). Managerial influence in the implementation of new technology. *Management Science, 34*, 1252-1265.
- Leslie, J. (1990). Green about the tills: Markets discover the eco-consumer. *Management Review, 79*, 24-29.
- LeVan-Green, S. L., & Livingston, J. (2001). Exploring the uses for small-diameter trees. *Forest Products Journal, 51*(9), 10-21.
- Lynch, D., & Mackes, K. (2002). *Opportunities for making wood products from small diameter trees in Colorado*. Research Paper RMRS-RP-37. Fort Collins, CO: United States Department of Agriculture, Forest Service, Rocky Mountain Research Station.
- Lynch, D., Romme, W., & Floyd, M. (2000). Forest restoration in southwestern ponderosa pine. *Journal of Forestry, 98*(8), 17-24.
- Lynch, D., Romme, W., Kemp, P., & Garrison, C. (1998). *Ecology and economics of ponderosa pine forest restoration on the Mancos-Dolores district of the San Juan National Forest*. Summary report for the ponderosa pine partnership, Montezuma County, CO.
- MacLachlan, D. L. & Johansson, J. K. (1981). Marketing segmentation with multivariate AID. *Journal of Marketing, 45*, 74-84.
- Mahajan, V., & Muller, E. (1998). When is it worthwhile targeting the majority instead of the innovators in a new product launch? *Journal of Marketing Research, 35*(November), 488-495.
- Mahajan, V., Muller, E. & Bass, F. M. (1990). New product diffusion models in marketing: A review and directions for research. *Journal of Marketing, 54*, 1-26.
- Mahajan, V., & Peterson, R. A. (1978). Innovation diffusion in a dynamic potential adopter population. *Management Science, 24*, 1589-97.

- Markus, M. L. (1987). Toward a 'critical mass' theory of interactive media: Universal access, interdependence and diffusion. *Communications Research, 14*, 491-511.
- Martin, F., Swan, N., Banks, I., Barker, G., & Beaudry, R. (1979). The case of wood trusses. In: *The Inter-regional Diffusion of Innovation in Canada*. Economic Council of Canada Research Study. Catalog #EC 2264/1979. Ottawa: Ministry of Supply and Services, 63-81.
- Maslow, A. (1954). *Motivation and personality*. New York: Harper.
- McCarthy, J. E. (1996). *Basic marketing: A managerial approach*, 12<sup>th</sup> ed. Homewood, IL: Irwin.
- McClintock, C. G. (1972). *Experimental social psychology*. New York: Holt, Rinehart and Winston.
- McDonald, M., & Dunbar, I. (1995). *Market segmentation: A step by step approach to creating profitable market segments*. Philadelphia: Transatlantic Publications.
- McIntyre, R. M., & Blashfield, R. K. (1980). A nearest-centroid technique for evaluating the minimum-variance clustering procedure. *Multivariate Behavior Research, 15*, 225-238.
- Mendelsohn, H. (1973). Some reasons why information campaigns can succeed. *Public Opinion Quarterly, 37*, 50-61.
- Meredith, W. (1966). Canonical correlation with fallible data. *Psychometrika, 26*, 55-65.
- Mitropoulos, P., & Tatum, C. B. (1999). Technology adoption decisions in construction organizations. *Journal of Construction Engineering Management, 125*(5), 330-338.
- Mitropoulos, P., & Tatum, C. B. (2000). Forces driving adoption of new information technologies. *Journal of Construction Engineering Management, 126*(5), 340-348.
- Moore, G. C., and Benbasat, I. (1991). Development of an instrument to measure the perceptions of adopting an information technology innovation. *Information Systems Research, 2*, 192-222.
- Nevers, J. V. (1972). Extensions of a new product model. *Sloan Management Review, 13* (Winter), 78-9.

- Narver, J. C., & Slater, S. F. (1990). The effect of market orientation on business profitability. *Journal of Marketing*, 54(4), 20-35.
- Nunnally, J. C., & Bernstein, I. H. (1994). *Psychometric Theory* (3 ed.). New York: McGraw-Hill.
- Pearl, D. & Fairley, D. (1985). Testing for the potential for nonresponse bias in sample surveys. *Public Opinion Quarterly*, 49, 553-560.
- Pearsall, T. E. (1969). *Audience analysis for technical writing*. Beverly Hills, CA: Glencoe Press.
- Polli, R., & Cook, V. (1969). Validity of the product life cycle. *Journal of Business*, 42, 385- 400.
- Porebski, O.R. (1966). Discriminatory and canonical analysis of technical college data. *Journal of Mathematical and Statistical Psychology*, 19, 215-236.
- Punj, G., & Stewart, G. W. (1983). Cluster analysis in marketing research: Review and suggested applications. *Journal of Marketing Research*, 20, 134-148.
- Rainbow, P. (1986). Representations are social facts: Modernity and post modernity in anthropology. In J. Clifford, & G. E. Marcus (Eds.), *Writing Culture: The Poetics and Politics of Ethnography*. Berkley, CA: University of California Press.
- Rawnsley, A., Ed. (1978). *Manual of Industrial Marketing Research*. New York: Wiley.
- Real Estate Center. (2004). *Colorado single-family building permits*. College Station, TX: Texas A&M University.
- Rink, D. R. & Swan, J. E. (1979). Product life cycle research: A literature review. *Journal of Business Research*, 7, 219-242.
- Roberts, J. (2000). Developing new rules for new markets. *Academy of Marketing Science*, 28(1), 31-44.
- Robertson, T. S. (1971). *Innovative Behavior and Communication*. New York: Holt, Reinhart, and Winston.

- Robertson, T. S., and Gatignon, H. (1986). Competitive effects on technology diffusion." *Journal of Marketing*, 50, 1-12.
- Rogers, E. (1995). *Diffusion of innovation*. New York: The Free Press.
- Rokeach, M. (1973). *The nature of human values*. New York: The Free Press.
- Rosenberg, N., Ince, P., Skog, K., & Plantinga, A. (1990). Understanding the adoption of new technology in the forest products industry. *Forest Products Journal*, 40(10), 15-22.
- Rydz, J. S. (1986). *Managing innovation*. Cambridge, MA: Ballinger Publishing Company, p. 122.
- Sanathanan, L. (1975). Discriminant analysis. In D. Amic, & H. Walberg, (Eds.), *Introductory multivariate analysis*. Berkley, CA: McCutchen Publishing Corporation.
- Sherry, J. F. (1990). A sociocultural analysis of a Mid-western American flea market. *Journal of Consumer Research*, 17, 13-30.
- Shook, S. (1997). *Innovation and the U.S. residential construction industry*. Ph.D. dissertation. University of Washington, Seattle, WA.
- Shook, S. (1999). Forecasting adoption and substitution of successive generations of structural wood panel products in the United States. *Forest Science*, 45(2), 232-248.
- Shook, S. R., and Eastin, I. L. (1995). Survey of the Puget Sound residential siding market. *Research Report for the Western Red Cedar Lumber Association*, Vancouver, BC, Canada.
- Shostack, L. G. (1977). Breaking free from product marketing. *Journal of Marketing*, 41(2), 73-80.
- Shrum, L. J., McCarty, J. A., & Lowrey, T. M. (1995). Buyer characteristics of the green consumers and their implications for advertising strategy. *Journal of Advertising*, 121, 71-82.
- Sinclair, S. A. (1992). *Forest Products Marketing*. New York: McGrawHill, Inc.

- Slater, M., & Flora, J. A. (1991). Health lifestyles: Audience segmentation analysis of public health interventions: *Health Education Quarterly*, 18, 221-233.
- Smith, R. L., Bush, R., & Bowe, S. (1999). A perceptual investigation into the adoption of timber bridges: A national comparative study. *Wood and Fiber Science*, 31(2), 204-216.
- Smith, R. L., & Bright, K. D. (2002). Perceptions of new and established waterfront materials. *Wood and Fiber Science*, 34(1), 28-41.
- Smith, R. L., Spradlin, W., Alderman, D. Jr., & Cesa, E. (2000a). A perceptual comparison of wood in separate infrastructure markets. *Wood and Fiber Science*, 32(2), 204-216.
- Smith, R. L., Spradlin, W., Alderman, D. Jr., & Cesa, E. (2000b). Perceptions of wood in the highway infrastructure market. *Forest Products Journal*, 50(6), 23-31.
- Smith, W. R. (1956). Product differentiation and market segmentation as alternative marketing strategies. In C.G. Walters and D.P. Robins (Eds.), *Classics in Marketing*. Santa Monica, CA: Goodyear.
- Spall, H. (1971). *Factors influencing the receptiveness of homebuilders to cost reducing innovations in greater lansing*. Ph.D. thesis. Michigan State University.
- Spinazze, M. C., & Kant, S. (1999). Market potential for certified forest (wood) products in Ontario, Canada. *The Forestry Chronicle*, 74(1), 39-47.
- SPSS. (2003). *SPSS for Windows, Standard Version (Version 12.0)*: SPSS Inc.
- Stalling, E. C., & Sinclair, S. A. (1989). The competitive position of wood as a residential siding material. *Forest Products Journal*, 39(4), 8-14.
- Stevens, J. (1995). *Applied multivariate for the social sciences* (3 ed.). New Jersey: Lawrence Earlbaum Associates, Inc.
- Strassman, W. P. (1978). Assessing the knowledge of innovation in neglected sectors: The case for residential construction. In P. Kelly, & M. Kranzberg (Eds.), *Technological innovation: A critical review of current knowledge*. San Francisco, CA: San Francisco Press.

- Stier, J. C. (1983). Technological substitution in the United States pulp and paper industry: The sulfate pulping process. *Technology Forecasting and Social Change*, 23(3), 237-245.
- Tatsuoka, M. (1970). *Discriminant analysis*. Champaign, IL: The Institute for Personality and Ability Testing.
- Tatsuoka, M., & Tiedeman, D. (1954). Discriminant analysis. *Review of Educational Research*, 24, 402-420.
- Tedlock, D. (1983). *The spoken word and the word of interpretation*. Philadelphia: University of Pennsylvania Press.
- Tigert, D., & Farivar, B. (1981). The Bass new product growth model: A sensitivity analysis for a high technology product. *Journal of Marketing*, 45 (Fall), 81-90.
- Trinka, M., Sinclair, S., & Marcin, T. (1992). Determinant attribute analysis: A tool for new product development. *Wood and Fiber Science*, 24(4), 385-391.
- Troivonen, R., & Ahola, P. (1996). Market oriented product concept: Focusing information in forest industry products. In H. Juslin, & M. Pesonen (Eds.) *Environmental Issues and Market Orientations* (pp. 39-52). Current Topics in Forest Products Marketing. Proceeding of the Forest Products Marketing Group, IUFRO XX World Congress, 6-12 August, 1995.
- Troivonen, R., & Laurila, R. (1997). Tree species information in marketing of solid wood products. *World Forest Congress Proceedings*, 4, 137-143.
- USDA Forest Service (1996). *Probability of catastrophic disturbance events*. Denver, CO: Region 2, Forest Service USDA.
- US Green Building Council (2002). *Leadership in Energy and Environmental Design*. [http://www.usgbc.org/LEED/LEED\\_main.asp](http://www.usgbc.org/LEED/LEED_main.asp).
- Walker, B. J., Kirchman, W., and Conant, J. S. (1987). A method to improve response to industrial mail surveys. *Industrial Marketing Management*, 16(4), 305-314.
- Walters, C. G., & Robins, D. P. (1956). *Classics in marketing*. Santa Monica, CA: Goodyear.

- Webster, F. E. (1991). *Industrial marketing strategy*. New York: John Wiley & Sons.
- Webster, F. E. Jr. (1994). Executing the new marketing concept. *Marketing Management*, 2(4), 22-31.
- Wedel, M. (1995). Market segmentation research: A review of bases and methods with special emphasis on latent class models. *Information based decision making in marketing*. Paris: ESOMAR.
- Wedel, M., and Kamakura, W. A. (1998). *Market Segmentation: Conceptual and Methodological Foundations*. Boston: Kluwer Academic Publishers.
- Weinwurter, S. & Hansen, E. (1999). Softwood lumber quality requirements: Examining the supplier/buyer perception gap. *Wood and Fiber Science*, 31(1), 83-94.
- West, C. D., & Sinclair, S. A. (1992). A measure of Innovativeness for sample firms in the wood household furniture industry. *Forest Science*, 38(3), 509-524.
- Wind, Y. (1978). Issues and advances in segmentation research. *Journal of Marketing Research*, 15, 317-337.
- Wright, M., & Esslemont, D. (1994). The logical limitations of target marketing. *Marketing Bulletin*, 5, 13-20.
- Van de Ven, A. H. (1991). Managing the process of organizational innovation." In G. P. Huber (Ed.), *Changing and Redesigning Organizations*, New York: Oxford University Press.
- Vaske, J. J. (in press). *Survey Research and Analysis: Applications in Human Dimensions and Recreation*. State College, PA: Venture Publishing, Inc.
- Ventre, F. T. (1979). Innovation in residential construction. *Technology Review*, 82(2), 50-59.
- Ventre, F. T. (1980). On the blackness of kettles: Inter-industry comparisons in rates of technological innovation. *Policy Sciences*, 11(3), 309-328.

## Appendix A

### Environmental Wood Product Distribution

#### Home Depot Vendors Respond to Company's Environmental Agenda October 27, 1999 10:45 AM

ATLANTA, Oct. 27 /PRNewswire/ – The Home Depot (NYSE: HD), the world's largest distributor of wood products, announced today that several of its vendors have responded enthusiastically to its new wood purchasing policy. The company is using the policy to phase in wood and wood products that are independently certified as derived from responsibly-managed forests.

The company also announced that it has awarded commendations to two vendors, J.D. Irving and Columbia Forest Products, for leadership in gaining independent certification. Lumber from both companies is certified by the Oaxaca, Mex.-based Forest Stewardship Council, and is now available at several Home Depot stores.

"The certification process is exhaustive and scientific," said Suzanne Apple, Home Depot vice president, community affairs and environmental programs. "To gain the 'certified' label, our vendors must demonstrate a very high level responsible forest management, including soil and water management, biodiversity, harvesting practices and replenishment of trees."

Home Depot president and CEO Arthur M. Blank announced on Aug. 26 an effort in which the company would give preference to certified wood products and over the next three years stop selling wood products from environmentally sensitive areas.

"We're telling our vendors that our company will vote with its purchasing dollars for wood products that are environmentally sound," Blank said.

The company's announcement was warmly greeted with congratulatory remarks from numerous environmental groups who have sought to promote the use of certified wood products.

Home Depot is working closely with the World Wildlife Fund and the World Resources Institute to develop subsequent steps the company will take in its environmental efforts. The company said its immediate goals are to ensure uninterrupted product availability, product quality and low prices.

"As the largest retailer in our industry, we recognize our responsibility to provide environmentally friendly alternatives for our customers," Blank said. "We're proud to lead the industry in changing the way wood products are produced and sold and to lead the charge in promoting the use of certified wood products."

In addition, the company is stocking an increasing variety of products that conserve energy and water, or are made from organic or alternative materials.

For energy conservation, Home Depot now carries a line of energy-efficient lighting products and devices that control power consumption by appliances. Also in stock are low-flow shower heads that conserve water and reduce septic waste.

The company carries a line of environmentally friendly lawn and garden chemicals, such as fertilizers and pesticides, in addition to organic cleaning agents and water-soluble paints.

Several products are made from recycled materials, including "Isoboard," a high-performance wood substitute made from waste straw, and an array of plastic products – such as carpets and tubing – made from recovered waste plastics.

Appendix C  
Survey Instrument

**PERCEPTIONS OF WOOD  
AS A BUILDING MATERIAL**

A Survey to Determine the Importance Placed on  
Environmental and Physical Attributes of Building Materials  
By Colorado Homebuilders



**All answers will be kept strictly confidential.**  
Thank you for your participation in this survey

Colorado Wood Utilization and  
Marketing Assistance Center  
F-123 Forestry Building  
Colorado State University  
Fort Collins, CO 80523

Remember there are no right or wrong answers; just respond sincerely and circle only one answer.

**Question 1:** Are you aware of the wildfire hazard in Colorado's Forests? **(Circle only one answer)**

Yes No

**Question 2:** Does your company build homes in areas affected by wildfire in Colorado? **(Circle only one answer)**

Yes No

**Question 3:** Has wildfire impacted your company's ability to build homes in Colorado? **(Circle only one answer)**

Yes No

Please answer the following questions based on how you feel about making changes to your existing construction practices. Please take into account that this change will help to reduce the wildfire hazard and ecologically restore Colorado's forests.

**Question 4a:** Please be sincere when choosing the statement that best describes how your company would react to using wood-based building materials derived from forest restoration thinning. **(Circle only one statement letter)**

- A. My company will be the first one to use these products, since it helps Colorado's forests.
- B. My company will use these products after we study the details.
- C. My company will use these products if most of the homebuilders are already using the products.
- D. My company most likely will not use these products unless nothing else was available.
- E. My company would refuse to use these products even if nothing else was available.

**Question 4b:** How sure are you of your answer to Question 4a? **(Circle only one answer)**

Not at all sure      Somewhat sure      Very sure      Extremely sure      Don't know

**Question 5:** Have you ever heard about forest product certification? **(Circle only one answer)**

No, not at all      Yes, some      Yes, a lot      Not sure

**Question 6:** How frequently do your customers ask about the origin of the wood used to build your houses? **(Circle only one answer)**

Never      Seldom      Sometime      Often      Not sure

Increased environmental awareness and the search for "sustainable" living patterns have produced a great deal of discussion of "green" technologies. Although some people use the term to refer to low impact on the natural environment, while others may use it for recyclable materials, there are no generally accepted definitions or measures of "greenness." It clearly includes considerations such as the use of less energy, the reliance on renewable resources, the preservation of wildlife habitat, and the broad compatibility with the "natural" environment. Keeping this in mind:

**Question 7:** Does your company use "green" building materials? **(Circle only one answer)**

No, not at all      Yes, some      Yes, a lot      Not sure

**Question 8:** If more "green" building materials were available, would your company use them? **(Circle only one answer)**

No      Yes      Not sure

**Question 9** Please estimate the percentage of your customers that pay attention to the environmental aspects of the products your company uses.

\_\_\_\_\_ %

**Question 10:** Builders vary in their opinions concerning what categories of “green” building materials are important to their business. Please provide your opinion by circling the one number that most closely reflects your view.

	Not at all Important			Neutral			Extremely Important
Products that reduce the impacts of renovation	1	2	3	4	5	6	7
Products that reduce the impacts of new construction	1	2	3	4	5	6	7
Products that reduce the impacts of demolition	1	2	3	4	5	6	7
Products that reduce pesticide treatments	1	2	3	4	5	6	7
Conventional preservative-treated wood alternatives	1	2	3	4	5	6	7
Equipment that conserves energy	1	2	3	4	5	6	7
Fixtures and equipment that conserve water	1	2	3	4	5	6	7
Natural or minimally processed products	1	2	3	4	5	6	7
Products that reduce manufacturing pollution	1	2	3	4	5	6	7
Products that reduce manufacturing waste	1	2	3	4	5	6	7
Products made from agricultural waste material	1	2	3	4	5	6	7
Products that block the spread of indoor contaminants	1	2	3	4	5	6	7
Products that improve light quality	1	2	3	4	5	6	7
Certified wood products	1	2	3	4	5	6	7
Building components that reduce HVAC loads	1	2	3	4	5	6	7
Alternatives to products made from PVC	1	2	3	4	5	6	7
Alternatives to ozone-depleting substances	1	2	3	4	5	6	7
Alternatives to components considered hazardous	1	2	3	4	5	6	7
Salvaged products	1	2	3	4	5	6	7
Renewable energy and fuel cell equipment	1	2	3	4	5	6	7
Rapidly renewable products	1	2	3	4	5	6	7
Products with post-industrial recycled content	1	2	3	4	5	6	7
Products with post-consumer recycled content	1	2	3	4	5	6	7
Products with minimal off-gassing of pollutants	1	2	3	4	5	6	7
Products with low maintenance requirements	1	2	3	4	5	6	7
Products with exceptional durability	1	2	3	4	5	6	7
Products that warn of health hazards in buildings	1	2	3	4	5	6	7
Products that remove indoor pollutants	1	2	3	4	5	6	7
Products that reduce waste	1	2	3	4	5	6	7

**Question 11:** People differ in their opinions concerning environmental problems and possible solution to those problems. (Indicate how strongly you agree or disagree with each statement by circling the number that most closely reflects your view.)

	Strongly Disagree			Neutral			Strongly Agree
Recycling construction waste will help the solid waste problem.	1	2	3	4	5	6	7
Whether my company builds homes with "green" building materials has no impact on whether or not other homebuilders will.	1	2	3	4	5	6	7
Sometimes my company cannot control how its actions contribute to environmental problems.	1	2	3	4	5	6	7
By understanding the forces that cause pollution, my company can help solve problems.	1	2	3	4	5	6	7
My company can influence government to help solve many environmental problems.	1	2	3	4	5	6	7
As only one of many homebuilders in the U.S. my company's business practice has no real effect on the environment.	1	2	3	4	5	6	7
The amount of construction waste that my company produces is so small compared to the total that it does not matter.	1	2	3	4	5	6	7
Many problems such as air pollution require too much money to solve for my company to have any impact.	1	2	3	4	5	6	7
If my company reduces the amount of construction waste it produces, it will make a difference in the solid waste problem.	1	2	3	4	5	6	7
My company can influence the forces that cause pollution.	1	2	3	4	5	6	7
If my company knows that some behavior is wasteful, it can usually control it.	1	2	3	4	5	6	7
Many environmental problems require too much power to solve for my company to have any impact.	1	2	3	4	5	6	7
Recycling my company's construction waste is significant in the total environmental picture.	1	2	3	4	5	6	7
Because there really is no such thing as luck, most environmental problems will be solved by the efforts of concerned people.	1	2	3	4	5	6	7
Many environmental problems have too many unpredictable elements for effective solutions to be found.	1	2	3	4	5	6	7
By understanding the forces that cause pollution, my company can solve the problem	1	2	3	4	5	6	7

**Question 12:** How important are the following environmental issues to you?

	Not at all Important			Neutral			Extremely Important
Lumber originates from sustainably managed forests	1	2	3	4	5	6	7
Environmental impact of lumber manufacturing	1	2	3	4	5	6	7
Lumber can be recycled	1	2	3	4	5	6	7
Lumber is packaged in recyclable materials	1	2	3	4	5	6	7
Lumber is safe and poses no health risks	1	2	3	4	5	6	7
Lumber is socially acceptable	1	2	3	4	5	6	7
Information on environmental impact of lumber	1	2	3	4	5	6	7

**Question 13:** How important are of the following characteristics of *wood* as a home building material?

	Not at all Important			Neutral			Extremely Important
Wood is recyclable.	1	2	3	4	5	6	7
Wood is environmentally safe.	1	2	3	4	5	6	7
Wood is good looking.	1	2	3	4	5	6	7
Wood is of consistent quality.	1	2	3	4	5	6	7
Wood is easy to repair.	1	2	3	4	5	6	7
Wood is appreciated.	1	2	3	4	5	6	7
Wood is fashionable.	1	2	3	4	5	6	7
Wood is youthful.	1	2	3	4	5	6	7
Wood is impractical.	1	2	3	4	5	6	7
Wood is a material of the future.	1	2	3	4	5	6	7
Wood is timeless.	1	2	3	4	5	6	7
Wood is expensive.	1	2	3	4	5	6	7
Wood is durable.	1	2	3	4	5	6	7
Wood is safe.	1	2	3	4	5	6	7
Wood is old-fashioned.	1	2	3	4	5	6	7

14. When you compare solid wood to other materials used to build houses (galvanized steel, plastic, wood-cement composites, etc.), what do you like or dislike about wood? Please explain in the space below.

---



---



---

**Question 15:** In your opinion how important are the following attributes for selecting *Lumber* as a home building material? (Circle the one number that most closely represents your opinion).

<i>Lumber</i>	Not at all Important			Neutral			Extremely Important
	1	2	3	4	5	6	7
Reliable strength	1	2	3	4	5	6	7
Resistant to impact	1	2	3	4	5	6	7
Resistant to decay	1	2	3	4	5	6	7
Low life cycle cost	1	2	3	4	5	6	7
Low maintenance cost	1	2	3	4	5	6	7
Structural design flexibility	1	2	3	4	5	6	7
High-energy absorption	1	2	3	4	5	6	7
Resistant to ultraviolet light	1	2	3	4	5	6	7
Resistant to fire	1	2	3	4	5	6	7
Easy installation	1	2	3	4	5	6	7
Low replacement cost	1	2	3	4	5	6	7
Free of toxic chemicals	1	2	3	4	5	6	7
Low initial cost	1	2	3	4	5	6	7
Attractive appearance	1	2	3	4	5	6	7
Consistent quality	1	2	3	4	5	6	7

**Question 16:** In your opinion how important are the following attributes for selecting *Wood I-joists* as a home building materials? (Circle the one number that most closely represents your opinion).

<i>Wood I-joists</i>	Not at all Important			Neutral			Extremely Important
	1	2	3	4	5	6	7
Reliable strength	1	2	3	4	5	6	7
Resistant to impact	1	2	3	4	5	6	7
Resistant to decay	1	2	3	4	5	6	7
Low life cycle cost	1	2	3	4	5	6	7
Low maintenance cost	1	2	3	4	5	6	7
Structural design flexibility	1	2	3	4	5	6	7
High-energy absorption	1	2	3	4	5	6	7
Resistant to ultraviolet light	1	2	3	4	5	6	7
Resistant to fire	1	2	3	4	5	6	7
Easy installation	1	2	3	4	5	6	7
Low replacement cost	1	2	3	4	5	6	7
Free of toxic chemicals	1	2	3	4	5	6	7
Low initial cost	1	2	3	4	5	6	7
Attractive appearance	1	2	3	4	5	6	7
Consistent quality	1	2	3	4	5	6	7

**Question 17:** In your opinion how important are the following attributes for selecting *wood-plastic composites* as a home building material? (Circle the one number that most closely represents your opinion).

<i>Wood-Plastic Composites</i>	Not at all Important			Neutral			Extremely Important
	1	2	3	4	5	6	7
Reliable strength	1	2	3	4	5	6	7
Resistant to impact	1	2	3	4	5	6	7
Resistant to decay	1	2	3	4	5	6	7
Low life cycle cost	1	2	3	4	5	6	7
Low maintenance cost	1	2	3	4	5	6	7
Structural design flexibility	1	2	3	4	5	6	7
High-energy absorption	1	2	3	4	5	6	7
Resistant to ultraviolet light	1	2	3	4	5	6	7
Resistant to fire	1	2	3	4	5	6	7
Easy installation	1	2	3	4	5	6	7
Low replacement cost	1	2	3	4	5	6	7
Free of toxic chemicals	1	2	3	4	5	6	7
Low initial cost	1	2	3	4	5	6	7
Attractive appearance	1	2	3	4	5	6	7
Consistent quality	1	2	3	4	5	6	7

**Question 18:** In your opinion how important are the following attributes for selecting *galvanized steel studs* as a home building material? (Circle the one number that most closely represents your opinion).

<i>Galvanized Steel Studs</i>	Not at all Important			Neutral			Extremely Important
	1	2	3	4	5	6	7
Reliable strength	1	2	3	4	5	6	7
Resistant to impact	1	2	3	4	5	6	7
Resistant to decay	1	2	3	4	5	6	7
Low life cycle cost	1	2	3	4	5	6	7
Low maintenance cost	1	2	3	4	5	6	7
Structural design flexibility	1	2	3	4	5	6	7
High-energy absorption	1	2	3	4	5	6	7
Resistant to ultraviolet light	1	2	3	4	5	6	7
Resistant to fire	1	2	3	4	5	6	7
Easy installation	1	2	3	4	5	6	7
Low replacement cost	1	2	3	4	5	6	7
Free of toxic chemicals	1	2	3	4	5	6	7
Low initial cost	1	2	3	4	5	6	7
Attractive appearance	1	2	3	4	5	6	7
Consistent quality	1	2	3	4	5	6	7

Question 19: How strongly do you agree or disagree with the following statements?

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Neutral	Slightly Agree	Moderately Agree	Strongly Agree
Structurally, steel has greater fire endurance than wood.	1	2	3	4	5	6	7
On a weight basis, wood is stronger than steel.	1	2	3	4	5	6	7
Wood is easier to paint than galvanized steel.	1	2	3	4	5	6	7
Clear finishes should be avoided on wood exposed to sunlight.	1	2	3	4	5	6	7
Wood-plastic composites sag less over time than solid wood.	1	2	3	4	5	6	7
Wood-cement composite siding requires minimal maintenance.	1	2	3	4	5	6	7
Plywood sheathing is stiffer than lumber sheathing.	1	2	3	4	5	6	7
Wood is a green building material.	1	2	3	4	5	6	7
Galvanized steel studs bend easily.	1	2	3	4	5	6	7
Preservative-treated wood is decay resistant.	1	2	3	4	5	6	7
Plastic has better resistance to ultraviolet light than wood.	1	2	3	4	5	6	7
Steel is manufactured from renewable resources.	1	2	3	4	5	6	7
Cement is manufactured from renewable resources.	1	2	3	4	5	6	7
Lumber studs are straighter than galvanized steel studs.	1	2	3	4	5	6	7
The quality of framing lumber is excellent.	1	2	3	4	5	6	7
2x4 studs warp less than wood-plastic composites.	1	2	3	4	5	6	7
Wood is manufactured from a renewable resource.	1	2	3	4	5	6	7
Galvanized steel studs are easier to install than wood studs.	1	2	3	4	5	6	7
Wood-plastic composites are decay resistant.	1	2	3	4	5	6	7
Galvanized steel corrodes in the environments that decays wood.	1	2	3	4	5	6	7
More wood is grown every year than is harvested for products.	1	2	3	4	5	6	7

**Question 20:** Please estimate the percentage of your customers that would be willing to pay some price premium for "green" building materials derived from Colorado's forests.

\_\_\_\_\_ %

**Question 21:** For each item below, please estimate the premium in percent of material sales price that your customers would be willing to pay for that particular building material if it had a "green" designation. (Circle the one percentage that best represents your estimate or specify another in the space provided.)

	Percent						Other
Exterior deck material (deck boards, stair treads hand rails, etc.)	0	5	10	15	20	25	_____
Framing lumber (standard 2x4 and 2x6)	0	5	10	15	20	25	_____
Wood flooring	0	5	10	15	20	25	_____
Lumber lap siding	0	5	10	15	20	25	_____
Cabinetry	0	5	10	15	20	25	_____
Architectural millwork (trim, interior paneling, etc.)	0	5	10	15	20	25	_____
Fencing	0	5	10	15	20	25	_____
Furniture	0	5	10	15	20	25	_____
Wood I-joists	0	5	10	15	20	25	_____
Wood burning appliance (stove, furnace, fireplace)	0	5	10	15	20	25	_____
Structural wood sheathing (plywood, oriented strand board)	0	5	10	15	20	25	_____

**Question 22:** Did your company use the following products in 2003. (Please respond by circling the appropriate Yes or No answer). If you answered yes please fill in the year the product was first used.

Product				
Finger-jointed studs (FJS)	No	Yes	If yes, what year was the product first used?	_____
Glue-laminated timber (glulam)	No	Yes	If yes, what year was the product first used?	_____
Wood I-joists	No	Yes	If yes, what year was the product first used?	_____
Laminated strand lumber (LSL)	No	Yes	If yes, what year was the product first used?	_____
Laminated veneer lumber (LVL)	No	Yes	If yes, what year was the product first used?	_____
Oriented strand board (OSB)	No	Yes	If yes, what year was the product first used?	_____
Parallel strand lumber (PSL)	No	Yes	If yes, what year was the product first used?	_____
Galvanized steel studs	No	Yes	If yes, what year was the product first used?	_____
Structural insulated panels (SIP)	No	Yes	If yes, what year was the product first used?	_____

**Question 23:** Please estimate the square feet of floor area that your company built in 2003 that used:

solid lumber joists \_\_\_\_\_ sq. ft.      wood I-joists \_\_\_\_\_ sq. ft.

**Question 24:** Please indicate how active Colorado building material dealers are in marketing the following materials:

	Not at all Active			Neutral			Very Active
Solid sawn lumber	1	2	3	4	5	6	7
Structural wood panels	1	2	3	4	5	6	7
Engineered wood products	1	2	3	4	5	6	7
Wood-plastic composites	1	2	3	4	5	6	7
Galvanized steel	1	2	3	4	5	6	7

**Question 25:** What is your opinion of the environmental marketing efforts of the wood products manufacturers?

	Strongly Disagree			Neutral			Strongly Agree
Their activity is on a suitable level	1	2	3	4	5	6	7
They should be somewhat more active	1	2	3	4	5	6	7
They should be clearly more active	1	2	3	4	5	6	7
They could be even less active	1	2	3	4	5	6	7

**Question 26:** How important are each of the following items in your life?

	Not at all Important			Neutral			Very Important
A. Air quality	1	2	3	4	5	6	7
B. Time spent with family	1	2	3	4	5	6	7
C. Clean rivers	1	2	3	4	5	6	7
D. Education for children	1	2	3	4	5	6	7
E. Transportation needs	1	2	3	4	5	6	7
F. Religion	1	2	3	4	5	6	7
G. Natural environment	1	2	3	4	5	6	7
H. Money	1	2	3	4	5	6	7
I. Recycling practices	1	2	3	4	5	6	7
J. Time spent on Internet	1	2	3	4	5	6	7
K. Wildlife	1	2	3	4	5	6	7
L. Wealth/ being wealthy	1	2	3	4	5	6	7

**Question 27:** Please select just one item from the list above (Question 26, statements A through L) that you feel would be the most important "quality of life" element for you. Write the Item Letter: \_\_\_\_\_

28. This last set of questions will help us better understand you and your company, and compare your answers with those of other people. All the answers to these questions will remain confidential, and will be used only in a general way – such as “40 percent of the respondents are 25-30 years old.”

- A. Are you?  Male  Female
- B. How old are you?  years
- C. How many years have you been employed in the residential construction industry?  years
- D. How many years has your company been building homes in Colorado?  years
- E. How many years has your company been in business?  years
- F. Please estimate your company's total sales in Colorado for 2003? \$
- G. Circle the one segment that most closely describes the industry your company was most active in 2003.  
 Single Family  Condominiums  Room Additions  Apartments  Duplexes
- H. What is the Zip Code for the city that your company is located in?
- I. About how much formal education have you completed? (**Check the one box that best applies**)  
 Grade school  Some college  
 Some high school  College degree, in what field?   
 High school degree  Some graduate school  
 Technical / Vocational school  Graduate degree
- J. During 2003, how many international business trips did you take?
- K. During 2003, how many international pleasure trips did you take?
- L. During 2003, how many domestic business trips did you take?
- M. During 2003, how many domestic pleasure trips did you take?
- N. During 2003, how many industry tradeshow did you attend?
- O. During 2003, how many industry association meetings did you attend?
- P. During 2003, how many workshops/seminar did you attend?
- Q. How often do other homebuilders contact your company about the new products or building techniques that your company has adopted? (**Circle the statement that applies**).  
 Very often  Often  Sometimes  Seldom  Never
- R. Which of the following Associations do you belong? (**Please check all that apply**)  
 National Association of Home Builders  Colorado Association of Home Builders  
 Energy Efficient Building Association  Forest Products Society  
 National Association of the Remodeling Institute  Better Business Bureau  
 Northern Colorado Home Builders Association  HBA of Metro Denver  
 Other, please specify

**Question 29:** Is there anything else you would like to tell us about your usage of green building materials? If so, please use the space below to write your comments.

---

Your effort is sincerely appreciated and the information you provided will help us understand the importance of environmental and physical attributes of building materials. If you would like a summary of the results, please print your name and address on the back of the return envelope (not this questionnaire). We will send you a copy. If you have any questions about this survey, please contact:

David Bueche  
Department of Forest, Range Land and Watershed Stewardship  
Colorado State University  
Telephone: (303) 808-6175  
E-mail: [david.bueche@colostate.edu](mailto:david.bueche@colostate.edu)

Control No. \_\_\_\_\_

*Thanks for your help. Please fold and return in the enclosed envelope.*



*Knowledge to Go Places*

Department of Forest, Rangeland, & Watershed Stewardship  
Fort Collins, Colorado 80523-1472 USA  
Telephone (970) 491-6911  
FAX (970) 491-6754  
<http://www.cnr.colostate.edu/frws/>

March 8, 2004

«COMPANY»  
«NAME»  
«ADDRESS»  
«CITY», «STATE» «ZIP»

Dear «NAME»:

The Colorado State Forest Service has asked The Wood Utilization and Marketing Assistance Center at Colorado State University to obtain opinions about wood and other “green” building materials. This research project titled “Perceptions of Wood as a Building Material” will assist industry in understanding how Colorado homebuilders view both the environmental and physical attributes of building materials used in residential construction.

We need your help. Your company is one of a small sample of Colorado homebuilders being asked to participate in this survey. The sample was randomly selected from all residential construction companies in Colorado. The information you provide will be held in strict confidentiality. In order that the results truly represent the thinking of Colorado homebuilders, it is very important that you or another person responsible for material selection and purchasing decisions in your company participate. The survey should take approximately 15 minutes of your time to complete. If you do not wish to participate, please pass this survey along to someone else in your company who has sufficient knowledge of the building materials that your company uses.

Your participation in this research is voluntary. There are no known risks in participating in this survey. If you decide to participate in the study, you may withdraw your consent and stop participating at any time without penalty or loss of benefits to which you are otherwise entitled. Questions about participants' rights may be directed to Celia S. Walker at (970) 491-1563.

Please return your response to the survey to us by March 26, 2004. We appreciate your time and your response to this survey. A prepaid addressed envelope is enclosed for your convenience. If your company would like a summary of the results, please print your company name and address on the back of the return envelope (not the questionnaire).

Thank you for your assistance.  
Sincerely,

David Bueche  
Graduate Student  
Colorado State University

Dr. Kurt Mackes  
Assistant Professor  
Colorado State University

Dr. Tony Cheng  
Assistant Professor  
Colorado State University

Appendix D2  
First Reminder Letter



*Knowledge to Go Places*

Department of Forest, Rangeland, & Watershed Stewardship  
Fort Collins, Colorado 80523-1472 USA  
Telephone (970) 491-6911  
FAX (970) 491-6754  
<http://www.cnr.colostate.edu/frws/>

March 18, 2004

«COMPANY»  
«NAME»  
«ADDRESS»  
«CITY», «STATE» «ZIP»

Dear «NAME»:

About a week ago we sent you a questionnaire to learn your opinions concerning wood and other “green” building materials. If you have not already done so, we hope you will respond soon.

Your response is very important. The conclusions of this survey will assist Colorado’s forest product industry in understanding how Colorado homebuilders view both the environmental and physical attributes of building materials used in residential construction.

David Bueche  
Graduate Student  
Colorado State University

Dr. Kurt Mackes  
Assistant Professor  
Colorado State University

Appendix D3  
Second Cover Letter



*Knowledge to Go Places*

Department of Forest, Rangeland, & Watershed Stewardship  
Fort Collins, Colorado 80523-1472 USA  
Telephone (970) 491-6911  
FAX (970) 491-6754  
<http://www.cnr.colostate.edu/frws/>

March 29, 2004

«COMPANY»  
«NAME»  
«ADDRESS»  
«CITY», «STATE» «ZIP»

Dear «NAME»:

We need your help. A few weeks ago we asked a randomly selected sample of residential construction companies in Colorado to participate in a survey that will assist the Colorado Forest Products Industry in understanding how Colorado homebuilders view both the environmental and physical attributes of building materials used in residential construction. In order that the results truly represent the thinking of Colorado homebuilders, it is very important that you or someone else in your company participates in this study. If you have already returned your survey, thank you for your time and consideration.

If you have not had a chance to respond or have misplaced the first survey, a copy of the survey has been enclosed with this letter for your convenience. The information you provide will be held in strict confidentiality. Once again, in order that the results truly represent the thinking of Colorado homebuilders, it is very important that you or another person responsible for material selection and purchasing decisions in your company participate. Many surveys are not representative because some people fail to return questionnaires. Without your help, the conclusions we draw from the returned questionnaires may be wrong.

The survey should take approximately 15 minutes of your time to complete. If you do not wish to participate, please pass this survey along to someone else in your company who has sufficient knowledge of the building materials that your company uses.

Your participation in this research is voluntary. There are no known risks in participating in this survey. If you decide to participate in the study, you may withdraw your consent and stop participating at any time without penalty or loss of benefits to which you are otherwise entitled. Questions about participants' rights may be directed to Celia S. Walker at (970) 491-1563.

Please return your response to the survey to us by April 21, 2004. We appreciate your time and your response to this survey. A stamped addressed envelope is enclosed for your convenience. If your company would like a summary of the results, please print your company name and address on the back of the return envelope (not the questionnaire).

Thank you for your assistance.  
Sincerely,

David Bueche  
Graduate Student  
Colorado State University

Dr. Kurt Mackes  
Assistant Professor  
Colorado State University

Appendix D4  
Final Reminder Letter



*Knowledge to Go Places*

Department of Forest, Rangeland, & Watershed Stewardship  
Fort Collins, Colorado 80523-1472 USA  
Telephone (970) 491-6911  
FAX (970) 491-6754  
<http://www.cnr.colostate.edu/frws/>

April 8, 2004

«COMPANY»  
«NAME»  
«ADDRESS»  
«CITY», «STATE» «ZIP»

Dear «NAME»:

A few weeks ago we sent you a questionnaire to learn your opinions concerning wood and other “green” building materials. While we have received responses from many companies, we are still missing information from your company. We realize that you are very busy and this survey may not be important to you personally. However, the results from this survey will be used to assist Colorado’s forest product industry in providing product for Colorado homebuilders.

Your response is very important. Please take a moment to complete the survey or track down what happened to the questionnaire if you passed it on to someone else at your company.

Thank you for your help!

David Bueche  
Graduate Student  
Colorado State University

Dr. Kurt Mackes  
Assistant Professor  
Colorado State University

Appendix E

**Colorado Single-Family Building Permits**

Year	Number of Dwelling Units		Average Value per Dwelling Unit (\$)	
	Units	Percent Change	Value	Percent Change
1980	19,371	-	44,600	-
1981	18,764	-3	52,000	17
1982	19,444	4	48,700	-6
1983	30,190	55	51,000	5
1984	23,359	-23	57,600	13
1985	19,211	-18	59,500	3
1986	20,413	6	64,400	8
1987	12,907	-37	81,500	27
1988	9,748	-24	87,500	7
1989	9,032	-7	105,200	20
1990	10,128	12	105,600	0
1991	13,045	29	112,500	7
1992	20,807	60	110,900	-1
1993	26,007	25	111,800	1
1994	29,302	13	116,700	4
1995	28,404	-3	116,200	0
1996	30,361	7	119,300	3
1997	31,941	5	124,400	4
1998	36,107	13	134,500	8
1999	38,410	6	138,100	3
2000	38,588	0	146,400	6
2001	36,437	-6	144,800	-1
2002	35,042	-4	154,900	7
2003	33,894	-3	170,600	10

Source: U.S. Bureau of Census and Real Estate Center at Texas A&M University  
 Email your questions and comments to [Mark Baumann](mailto:Mark.Baumann)

© 2004. Real Estate Center at Texas A&M University. All rights reserved.

Appendix F  
Importance of Various Building Materials by Adopter Groups

Table F1. Comparison of adopter groups by importance of lumber as a building material

Variable <sup>1</sup>	Adopter Categories <sup>2</sup>					F	p	η
	Mean <sup>3</sup>	Early Adopter	Early Majority	Late Majority	Laggard			
Reliable strength	6.16	6.60a	6.13a	6.14a	5.89a	1.81	.151	.25
Resistant to impact	5.41	6.13a	5.46ab	5.36ab	4.83b	3.61	.017	.34
Resistant to decay	5.36	5.73a	5.50a	5.36a	4.89a	1.54	.211	.23
Low life cycle cost	5.45	6.00a	5.92a	5.32ab	4.53b	7.13	.000	.46
Low maintenance cost	5.35	5.93a	5.54a	5.14a	4.94a	2.55	.061	.29
Structural design flexibility	6.25	6.73a	6.25ab	6.14ab	6.00b	2.63	.056	.30
High-energy absorption	4.89	5.27a	5.04a	4.78a	4.56a	1.04	.379	.20
Resistant to ultraviolet light	4.61	5.40a	4.83ab	4.26ab	4.17b	3.40	.022	.34
Resistant to fire	4.48	4.40a	4.96a	4.57a	3.71a	2.72	.050	.30
Easy installation	6.09	6.60a	6.13a	5.79a	6.11a	2.49	.066	.29
Low replacement cost	5.74	6.27a	5.79ab	5.36b	5.83ab	2.80	.045	.31
Free of toxic chemicals	5.74	6.33a	5.92ab	5.71ab	5.00b	3.39	.022	.34
Low initial cost	5.83	6.00a	6.00a	5.75a	5.59a	.69	.563	.16
Attractive appearance	5.94	6.80a	6.00ab	5.71b	5.50b	4.32	.007	.37
Consistent quality	5.96	6.27a	6.04a	5.89a	5.72a	.72	.545	.16

<sup>1</sup>Variables for the scales were coded on a seven point scale from 1=not at all important to 7=extremely important.

<sup>2</sup>All cell entries are means and means with different superscripts across the rows differ significantly at p<.05. Scheffe was used for the post hoc test.

Table F2. Comparison of adopter groups by importance of wood I-joist as a building material

Variable <sup>1</sup>	Adopter Categories <sup>2</sup>					F	p	η
	Mean <sup>3</sup>	Early Adopter	Early Majority	Late Majority	Laggard			
Reliable strength	6.65	6.87 <sup>a</sup>	6.79 <sup>ab</sup>	6.66 <sup>ab</sup>	6.28 <sup>b</sup>	3.16	.029	.32
Resistant to impact	5.83	6.33 <sup>a</sup>	5.83 <sup>a</sup>	5.86 <sup>a</sup>	5.33 <sup>a</sup>	1.71	.171	.24
Resistant to decay	5.56	5.53 <sup>a</sup>	5.67 <sup>a</sup>	5.69 <sup>a</sup>	5.22 <sup>a</sup>	.52	.669	.14
Low life cycle cost	5.60	6.20 <sup>a</sup>	5.83 <sup>ab</sup>	5.48 <sup>ab</sup>	5.00 <sup>b</sup>	3.23	.027	.33
Low maintenance cost	5.80	6.13 <sup>a</sup>	6.13 <sup>a</sup>	5.45 <sup>a</sup>	5.67 <sup>a</sup>	2.32	.081	.28
Structural design flexibility	6.52	6.80 <sup>a</sup>	6.46 <sup>a</sup>	6.52 <sup>a</sup>	6.39 <sup>a</sup>	1.08	.362	.20
High-energy absorption	5.19	5.20 <sup>a</sup>	5.29 <sup>a</sup>	5.48 <sup>a</sup>	4.61 <sup>a</sup>	1.52	.215	.23
Resistant to ultraviolet light	4.25	4.87 <sup>a</sup>	4.67 <sup>ab</sup>	4.14 <sup>ab</sup>	3.33 <sup>b</sup>	3.55	.018	.34
Resistant to fire	4.41	4.33 <sup>ab</sup>	4.88 <sup>a</sup>	4.62 <sup>ab</sup>	3.50 <sup>b</sup>	3.20	.028	.32
Easy installation	6.34	6.87 <sup>a</sup>	6.42 <sup>ab</sup>	6.07 <sup>b</sup>	6.22 <sup>ab</sup>	4.10	.009	.36
Low replacement cost	5.64	6.33 <sup>a</sup>	5.46 <sup>a</sup>	5.41 <sup>a</sup>	5.67 <sup>a</sup>	2.49	.066	.29
Free of toxic chemicals	5.42	6.27 <sup>a</sup>	5.50 <sup>ab</sup>	5.50 <sup>ab</sup>	4.50 <sup>b</sup>	5.06	.003	.40
Low initial cost	5.81	6.07 <sup>a</sup>	5.83 <sup>a</sup>	5.62 <sup>a</sup>	5.89 <sup>a</sup>	.77	.517	.17
Attractive appearance	4.36	4.47 <sup>a</sup>	4.58 <sup>a</sup>	4.48 <sup>a</sup>	3.78 <sup>a</sup>	.85	.470	.17
Consistent quality	6.57	5.80 <sup>a</sup>	6.67 <sup>a</sup>	6.55 <sup>a</sup>	6.28 <sup>a</sup>	2.16	.100	.27

<sup>1</sup>Variables for the scales were coded on a seven point scale from 1=not at all important to 7=extremely important.

<sup>2</sup>All cell entries are means and means with different superscripts across the rows differ significantly at p<.05. Scheffe was used for the post hoc test.

Table F3. Comparison of adopter groups by importance of wood-plastic composites as a building material

Variable <sup>1</sup>	Adopter Categories <sup>2</sup>					F	p	η
	Mean <sup>3</sup>	Early Adopter	Early Majority	Late Majority	Laggard			
Reliable strength	5.28	5.00 <sup>a</sup>	5.57 <sup>a</sup>	5.15 <sup>a</sup>	5.33 <sup>a</sup>	.68	.566	.16
Resistant to impact	5.24	5.07 <sup>a</sup>	5.52 <sup>a</sup>	5.19 <sup>a</sup>	5.11 <sup>a</sup>	.61	.609	.15
Resistant to decay	5.88	6.00 <sup>a</sup>	5.96 <sup>a</sup>	5.85 <sup>a</sup>	5.72 <sup>a</sup>	.18	.909	.08
Low life cycle cost	5.24	5.57 <sup>a</sup>	5.57 <sup>a</sup>	4.96 <sup>a</sup>	5.00 <sup>a</sup>	1.35	.263	.22
Low maintenance cost	5.84	6.14 <sup>a</sup>	5.96 <sup>a</sup>	5.56 <sup>a</sup>	5.89 <sup>a</sup>	1.02	.387	.20
Structural design flexibility	5.18	5.29 <sup>a</sup>	5.26 <sup>a</sup>	4.89 <sup>a</sup>	5.44 <sup>a</sup>	.67	.575	.16
High-energy absorption	4.75	4.57 <sup>a</sup>	4.91 <sup>a</sup>	4.52 <sup>a</sup>	5.06 <sup>a</sup>	.97	.414	.19
Resistant to ultraviolet light	5.33	5.57 <sup>a</sup>	5.61 <sup>a</sup>	4.81 <sup>a</sup>	5.56 <sup>a</sup>	2.28	.086	.29
Resistant to fire	5.14	5.71 <sup>a</sup>	5.52 <sup>ab</sup>	4.88 <sup>ab</sup>	4.56 <sup>b</sup>	4.43	.006	.38
Easy installation	5.68	6.14 <sup>a</sup>	5.83 <sup>a</sup>	5.37 <sup>a</sup>	5.61 <sup>a</sup>	1.64	.186	.24
Low replacement cost	5.04	5.36 <sup>a</sup>	5.09 <sup>a</sup>	4.81 <sup>a</sup>	5.06 <sup>a</sup>	.59	.621	.15
Free of toxic chemicals	5.25	5.71 <sup>a</sup>	5.43 <sup>a</sup>	5.23 <sup>a</sup>	4.67 <sup>a</sup>	1.92	.134	.26
Low initial cost	5.20	5.54 <sup>a</sup>	5.17 <sup>a</sup>	4.96 <sup>a</sup>	5.33 <sup>a</sup>	.65	.588	.16
Attractive appearance	5.50	5.57 <sup>a</sup>	5.57 <sup>a</sup>	5.44 <sup>a</sup>	5.44 <sup>a</sup>	.06	.980	.05
Consistent quality	5.88	5.93 <sup>a</sup>	6.00 <sup>a</sup>	5.74 <sup>a</sup>	5.89 <sup>a</sup>	.23	.874	.09

<sup>1</sup>Variables for the scales were coded on a seven point scale from 1=not at all important to 7=extremely important.

<sup>2</sup>All cell entries are means and means with different superscripts across the rows differ significantly at p<.05. Scheffe was used for the post hoc test.

Table F4. Comparison of adopter groups by importance of galvanized steel studs as a building material

Variable <sup>1</sup>	Adopter Categories <sup>2</sup>					F	p	η
	Mean <sup>3</sup>	Early Adopter	Early Majority	Late Majority	Laggard			
Reliable strength	4.96	4.21 <sup>a</sup>	5.21 <sup>a</sup>	5.16 <sup>a</sup>	4.94 <sup>a</sup>	1.18	.325	.21
Resistant to impact	4.63	4.29 <sup>a</sup>	4.96 <sup>a</sup>	4.56 <sup>a</sup>	4.56 <sup>a</sup>	.55	.650	.15
Resistant to decay	5.05	4.93 <sup>a</sup>	5.08 <sup>a</sup>	5.12 <sup>a</sup>	5.00 <sup>a</sup>	.04	.988	.04
Low life cycle cost	4.70	4.50 <sup>a</sup>	5.08 <sup>a</sup>	4.60 <sup>a</sup>	4.44 <sup>a</sup>	.64	.589	.16
Low maintenance cost	4.87	4.57 <sup>a</sup>	5.13 <sup>a</sup>	4.84 <sup>a</sup>	4.81 <sup>a</sup>	.34	.796	.12
Structural design flexibility	4.95	4.64 <sup>a</sup>	5.33 <sup>a</sup>	4.84 <sup>a</sup>	4.81 <sup>a</sup>	.60	.619	.15
High-energy absorption	4.43	3.93 <sup>a</sup>	4.71 <sup>a</sup>	4.48 <sup>a</sup>	4.38 <sup>a</sup>	.75	.528	.17
Resistant to ultraviolet light	4.32	3.93 <sup>a</sup>	4.38 <sup>a</sup>	4.60 <sup>a</sup>	4.13 <sup>a</sup>	.52	.667	.14
Resistant to fire	5.04	5.21 <sup>a</sup>	5.33 <sup>a</sup>	4.88 <sup>a</sup>	4.69 <sup>a</sup>	.57	.635	.15
Easy installation	4.94	4.93 <sup>a</sup>	5.29 <sup>a</sup>	4.64 <sup>a</sup>	4.88 <sup>a</sup>	.59	.626	.15
Low replacement cost	4.82	4.71 <sup>a</sup>	5.25 <sup>a</sup>	4.68 <sup>a</sup>	4.50 <sup>a</sup>	.86	.464	.18
Free of toxic chemicals	4.94	4.79 <sup>a</sup>	5.26 <sup>a</sup>	5.00 <sup>a</sup>	4.44 <sup>a</sup>	.82	.488	.18
Low initial cost	4.85	4.71 <sup>a</sup>	5.33 <sup>a</sup>	4.64 <sup>a</sup>	4.56 <sup>a</sup>	1.00	.399	.20
Attractive appearance	3.90	3.14 <sup>a</sup>	4.17 <sup>a</sup>	4.52 <sup>a</sup>	3.19 <sup>a</sup>	3.91	.012	.37
Consistent quality	5.33	4.86 <sup>a</sup>	5.79 <sup>a</sup>	5.32 <sup>a</sup>	5.06 <sup>a</sup>	1.06	.372	.201

<sup>1</sup>Variables for the scales were coded on a seven point scale from 1=not at all important to 7=extremely important.

<sup>2</sup>All cell entries are means and means with different superscripts across the rows differ significantly at p<.05. Scheffe was used for the post hoc test.

Appendix G  
Quality of Life Principles

Table G1. Comparison of adopter groups by importance to quality of life principles

Variable <sup>1</sup>	Adopter Categories <sup>2</sup>				df	F	p	$\eta^3$
	Early Adopters	Early Majority	Late Majority	Laggards				
Air quality	6.67 <sup>a</sup>	6.54 <sup>a</sup>	6.24 <sup>a</sup>	5.39 <sup>b</sup>	3	6.21	.001	.43
Time spent with family	6.67 <sup>a</sup>	6.79 <sup>a</sup>	6.62 <sup>a</sup>	6.61 <sup>a</sup>	3	.39	.763	.12
Clean rivers	6.73 <sup>a</sup>	6.63 <sup>a</sup>	6.38 <sup>a</sup>	5.50 <sup>b</sup>	3	6.46	.001	.44
Education for children	6.53 <sup>a</sup>	6.83 <sup>a</sup>	6.59 <sup>a</sup>	6.33 <sup>a</sup>	3	1.13	.341	.20
Transportation needs	6.13 <sup>a</sup>	5.58 <sup>a</sup>	5.66 <sup>a</sup>	5.28 <sup>a</sup>	3	1.58	.201	.23
Religion	4.53 <sup>a</sup>	4.67 <sup>a</sup>	5.03 <sup>a</sup>	5.11 <sup>a</sup>	3	.34	.800	.11
Natural environment	6.80 <sup>a</sup>	6.29 <sup>ab</sup>	5.97 <sup>bc</sup>	5.22 <sup>c</sup>	3	9.07	.001	.50
Money	5.73 <sup>a</sup>	5.46 <sup>a</sup>	5.59 <sup>a</sup>	5.44 <sup>a</sup>	3	.27	.845	.10
Recycling	6.20 <sup>a</sup>	5.58 <sup>ab</sup>	5.07 <sup>b</sup>	3.67 <sup>c</sup>	3	14.06	.001	.58
Time spent on internet	3.80 <sup>a</sup>	2.96 <sup>a</sup>	3.31 <sup>a</sup>	3.17 <sup>a</sup>	3	1.00	.399	.198
Wildlife	6.73 <sup>a</sup>	6.08 <sup>ab</sup>	5.69 <sup>b</sup>	5.39 <sup>b</sup>	3	4.73	.004	.38
Wealth/being wealthy	5.20 <sup>a</sup>	4.79 <sup>a</sup>	4.69 <sup>a</sup>	4.88 <sup>a</sup>	3	.52	.667	.148

<sup>1</sup>Variables for the scales were coded on a seven point scale from 1=not at all important to 7=extremely important.

<sup>2</sup>All cell entries are means and means with different superscripts across the rows differ significantly at  $p < .05$ . Scheffe was used for the post hoc test.

<sup>3</sup> $\eta$  or "eta" is a measure of the strength of association or effect size. In Human Dimensions research  $\eta = .1$  represents a minimal relationship,  $\eta = .3$  represents a typical relationship and  $\eta = .5$  represents a substantial relationship (Vaske, in press).

Appendix H

Table H1. Detailed comparison of adopter groups by importance of green building materials

Variable <sup>1</sup>	Adopter Categories <sup>2</sup>					F	$\eta^3$
	Mean <sup>3</sup>	Early Adopter	Early Majority	Late Majority	Laggard		
Products with exceptional durability	6.26	6.60 <sup>a</sup>	6.17 <sup>a</sup>	6.31 <sup>a</sup>	6.00 <sup>a</sup>	1.87	.25
Products with low maintenance requirements	6.08	6.57 <sup>a</sup>	5.96 <sup>a</sup>	6.00 <sup>a</sup>	6.00 <sup>a</sup>	1.75	.25
Fixtures and equipment that conserve water	5.88	6.47 <sup>a</sup>	5.96 <sup>ab</sup>	5.83 <sup>ab</sup>	5.39 <sup>b</sup>	3.54*	.34
Building components that reduce HVAC loads	5.74	6.47 <sup>a</sup>	5.54 <sup>ab</sup>	5.93 <sup>ab</sup>	5.11 <sup>b</sup>	3.97*	.36
Alternatives to components considered hazardous	5.71	6.47 <sup>a</sup>	5.88 <sup>a</sup>	5.97 <sup>a</sup>	4.44 <sup>b</sup>	10.73 <sup>†</sup>	.53
Equipment that conserves energy	5.61	6.33 <sup>a</sup>	5.46 <sup>ab</sup>	5.68 <sup>ab</sup>	5.11 <sup>b</sup>	2.90*	.31
Products that reduce waste	5.52	6.53 <sup>a</sup>	5.75 <sup>a</sup>	5.62 <sup>a</sup>	4.22 <sup>b</sup>	13.16 <sup>†</sup>	.57
Products that block the spread of indoor contaminants	5.48	6.00 <sup>a</sup>	5.33 <sup>ab</sup>	5.69 <sup>ab</sup>	4.89 <sup>b</sup>	3.34*	.33
Products that remove indoor pollutants	5.43	6.27 <sup>a</sup>	5.25 <sup>ab</sup>	5.79 <sup>a</sup>	4.39 <sup>b</sup>	9.42 <sup>†</sup>	.51
Products that improve light quality	5.31	5.93 <sup>a</sup>	5.46 <sup>ab</sup>	5.31 <sup>ab</sup>	4.61 <sup>b</sup>	3.47*	.34
Products with minimal off-gassing of pollutants	5.29	6.27 <sup>a</sup>	5.38 <sup>a</sup>	5.48 <sup>a</sup>	4.06 <sup>b</sup>	10.42 <sup>†</sup>	.53
Products that reduce the impacts of new construction	5.27	5.73 <sup>a</sup>	5.46 <sup>a</sup>	5.21 <sup>a</sup>	4.72 <sup>a</sup>	1.83	.25
Products that reduce manufacturing waste	5.23	6.00 <sup>a</sup>	5.54 <sup>a</sup>	5.45 <sup>a</sup>	3.83 <sup>b</sup>	11.28 <sup>†</sup>	.54
Rapidly renewable products	5.15	6.07 <sup>a</sup>	5.21 <sup>a</sup>	5.48 <sup>a</sup>	3.78 <sup>b</sup>	12.23 <sup>†</sup>	.56
Conventional preservative-treated wood alternatives	5.08	5.53 <sup>a</sup>	5.38 <sup>a</sup>	4.90 <sup>a</sup>	4.61 <sup>a</sup>	2.33	.28
Certified wood products	5.07	5.80 <sup>a</sup>	5.13 <sup>a</sup>	4.97 <sup>a</sup>	4.53 <sup>a</sup>	2.61*	.30
Products that reduce manufacturing pollution	5.05	5.67 <sup>a</sup>	5.25 <sup>a</sup>	5.31 <sup>a</sup>	3.83 <sup>b</sup>	6.76 <sup>†</sup>	.45
Products that warn of health hazards in buildings	5.01	5.87 <sup>a</sup>	5.46 <sup>a</sup>	5.03 <sup>a</sup>	3.67 <sup>b</sup>	7.56 <sup>†</sup>	.47
Alternatives to ozone-depleting substances	4.98	6.20 <sup>a</sup>	5.25 <sup>a</sup>	5.21 <sup>a</sup>	3.22 <sup>b</sup>	17.78 <sup>†</sup>	.63
Products with post-consumer recycled content	4.76	5.67 <sup>a</sup>	4.88 <sup>a</sup>	4.93 <sup>a</sup>	3.61 <sup>b</sup>	6.60 <sup>†</sup>	.44
Products that reduce pesticide treatments	4.74	5.80 <sup>a</sup>	5.17 <sup>a</sup>	4.79 <sup>a</sup>	3.22 <sup>b</sup>	10.36 <sup>†</sup>	.52
Products with post-industrial recycled content	4.69	5.40 <sup>a</sup>	4.83 <sup>ab</sup>	4.82 <sup>ab</sup>	3.72 <sup>b</sup>	4.49*	.38
Renewable energy and fuel cell equipment	4.64	6.27 <sup>a</sup>	4.71 <sup>b</sup>	4.62 <sup>b</sup>	3.22 <sup>c</sup>	9.90 <sup>†</sup>	.52
Natural or minimally processed products	4.55	5.40 <sup>a</sup>	4.75 <sup>a</sup>	4.62 <sup>a</sup>	3.44 <sup>b</sup>	8.04 <sup>†</sup>	.48
Products made from agricultural waste material	4.40	4.87 <sup>a</sup>	4.54 <sup>a</sup>	4.45 <sup>a</sup>	3.71 <sup>a</sup>	1.86	.25
Alternatives to products made from PVC	4.40	4.80 <sup>ab</sup>	4.79 <sup>a</sup>	4.39 <sup>ab</sup>	3.56 <sup>b</sup>	3.56*	.34
Salvaged products	4.22	5.47 <sup>a</sup>	4.79 <sup>a</sup>	4.31 <sup>a</sup>	2.28 <sup>b</sup>	18.40 <sup>†</sup>	.63
Products that reduce the impacts of renovation	4.07	4.80 <sup>a</sup>	4.54 <sup>a</sup>	4.10 <sup>a</sup>	2.78 <sup>b</sup>	7.32 <sup>†</sup>	.46
Products that reduce the impacts of demolition	4.03	4.93 <sup>a</sup>	4.58 <sup>a</sup>	4.07 <sup>a</sup>	2.50 <sup>b</sup>	11.32 <sup>†</sup>	.54

<sup>1</sup>Variables for the scales were coded on a seven point scale from 1=not at all important to 7=extremely important.

<sup>2</sup>All cell entries are means and means with different superscripts across the rows differ significantly at  $p < .05$ . Scheffe was used for the post hoc test.

<sup>3</sup> $\eta$  or "eta" is a measure of the strength of association or effect size. In Human Dimensions research  $\eta = .1$  represents a minimal relationship,  $\eta = .3$  represents a typical relationship and  $\eta = .5$  represents a substantial relationship (Vaske, in press). \* $p < .05$ . <sup>†</sup> $p < .001$ .

Appendix I

Table II. Detailed comparison of adopter groups by percent price premium willing to pay for green building materials derived from Colorado's forests

Variable <sup>1</sup>	Adopter Categories <sup>2</sup>					F	$\eta^3$
	Mean <sup>3</sup>	Early Adopter	Early Majority	Late Majority	Laggard		
Percent of customers willing to pay some price premium for green building materials	20.7	31.8 <sup>a</sup>	21.8 <sup>ab</sup>	20 <sup>ab</sup>	9 <sup>b</sup>	2.75*	.33
Exterior deck material (deck boards, stair treads hand rails, etc.)	13.5	16.3 <sup>a</sup>	14.7 <sup>a</sup>	13.4 <sup>a</sup>	8.7 <sup>a</sup>	1.77	.27
Wood flooring	10.1	11.6 <sup>a</sup>	9.9 <sup>a</sup>	10.7 <sup>a</sup>	7.6 <sup>a</sup>	0.41	.24
Cabinetry	9.7	10.3 <sup>a</sup>	9.6 <sup>a</sup>	10.6 <sup>a</sup>	7.5 <sup>a</sup>	0.19	.26
Structural wood sheathing (plywood, oriented strand board)	9.6	16.1 <sup>a</sup>	7.3 <sup>ab</sup>	11.3 <sup>ab</sup>	4.2 <sup>b</sup>	2.32	.31
Wood I-joists	9.4	13.7 <sup>a</sup>	7.9 <sup>a</sup>	9.8 <sup>a</sup>	6.8 <sup>a</sup>	1.02	.20
Architectural millwork (trim, interior paneling, etc.)	9.3	12.1 <sup>a</sup>	10 <sup>a</sup>	7.6 <sup>a</sup>	7.9 <sup>a</sup>	0.70	.28
Wood burning appliance (stove, furnace, fireplace)	9.3	11.8 <sup>a</sup>	10.7 <sup>a</sup>	8.4 <sup>a</sup>	5.5 <sup>a</sup>	1.56	.22
Fencing	9	13.4 <sup>a</sup>	10.9 <sup>ab</sup>	6.9 <sup>ab</sup>	4.7 <sup>b</sup>	3.12*	.36
Furniture	8.5	11.8 <sup>a</sup>	9.1 <sup>a</sup>	7.9 <sup>a</sup>	4.7 <sup>a</sup>	1.18	.25
Lumber lap siding	7.3	10.3 <sup>a</sup>	8.8 <sup>a</sup>	5.9 <sup>a</sup>	4.2 <sup>a</sup>	1.72	.23
Framing lumber (standard 2x4 and 2x6)	5.6	7.2 <sup>a</sup>	6.4 <sup>a</sup>	4.5 <sup>a</sup>	4.2 <sup>a</sup>	1.00	.25

<sup>1</sup>Variables for the scales were coded on a seven point scale from 1=not at all important to 7=extremely important.

<sup>2</sup>All cell entries are percents and means with different superscripts across the rows differ significantly at  $p < .05$ . Scheffe was used for the post hoc test.

<sup>3</sup> $\eta$  or "eta" is a measure of the strength of association or effect size. In Human Dimensions research  $\eta = .1$  represents a minimal relationship,  $\eta = .3$  represents a typical relationship and  $\eta = .5$  represents a substantial relationship (Vaske, in press).

\* $p < .05$ .