

LIBRARY

Michigan State University

PLACE IN RETURN BOX to remove this checkout from your record.
TO AVOID FINES return on or before date due.

DATE DUE	DATE DUE	DATE DUE
NOV 02 2004 226	OCT 19 2004	
MAY 03 1 2005 216	111804	

MSU is An Affirmative Action/Equal Opportunity Institution

c:\circ\datedue.pm3-p.1

**A DYNAMIC PRODUCT VIEW OF DIFFUSION:
INCORPORATING TIMING INTO THE ADOPTION PROCESS**

By

Ted Aron Haggbloom

A DISSERTATION

**Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of**

DOCTOR OF PHILOSOPHY

Department of Marketing and Supply Chain Management

1996

ABSTRACT

A DYNAMIC PRODUCT VIEW OF DIFFUSION INCORPORATING TIMING INTO THE ADOPTION PROCESS

By

Ted Aron Haggblom

New Products are often vital to the success of the firm and marketers must be concerned with the rate of diffusion, or marketplace acceptance, of a new product. Previous studies of diffusion have generally regarded the innovation as a single product diffusing unchanged throughout the population of potential adopters. Under this static product view, potential adopters were assumed to evaluate the product and make a single adopt/nonadopt decision. This research proposes a dynamic view of diffusion that allows consideration of successive generations of a new product. Conceptualizing the innovation in evolutionary terms means incorporating into the adoption process a timing decision that permits the potential adopter various postponement options.

An experiment was designed to simulate the decision facing a potential adopter confronted with successive generations of a new product. A sequential logit model was used to analyze the influence of new product characteristics on both the evaluation and timing stages of the decision process. The results indicate that product characteristics have differential impacts on the two stages and that a favorable attitude toward a new product does not preclude postponement of adoption. This model helps explain the frequently observed time lag between awareness and eventual adoption of an innovation.

The model was also used to test the hypothesis that positive disconfirmation of performance expectations has an inverted U-shaped moderating effect on the positive relationship between performance and both evaluation and timing. After manipulating next generation performance expectations in the experiment, the results confirmed this effect. The implication is that better than expected performance improvements may come as a pleasant surprise, adding to the positive influence of performance on evaluation and adoption timing. However, products that are perceived to be improving much more rapidly than anticipated may create a dissonance that inhibits the otherwise positive relationship between performance and the likelihood of a favorable attitude and subsequent adoption.

**Copyright by
Ted Aron Haggblom
1996**

This dissertation is dedicated to my mother, Irene Haggblom, whose unwavering love and support continues to sustain me; to the memory of my father, Lloyd Haggblom, who would have been extremely proud of this day; and to my sister, Julie Haggblom, a fellow scholar who understands the challenges and rewards of academic life.

ACKNOWLEDGMENTS

This is to gratefully acknowledge the assistance of my dissertation committee:

Dr. Roger Calantone, my mentor and dissertation committee co-chair, who guided the conceptual development of this dissertation; Dr. Thomas Page, dissertation committee co-chair, for his helpful suggestions throughout the experimental design and data collection; Dr. Dale Wilson who provided valuable insights into the experimentation process; and Dr. Bixby Cooper for providing reality checks and keeping the dissertation on an even keel. In addition to their helpful comments and ideas, the manner in which all committee members responded expeditiously and with good humor to short turnaround times is particularly appreciated.

TABLE OF CONTENTS

LIST OF TABLES	x
LIST OF FIGURES	xi
CHAPTER 1	
INTRODUCTION	1
1.1 Importance of Diffusion in Marketing	1
1.2 Motivation for the Research	3
1.3 Purpose of the Research	6
1.4 Expected Contributions of the Research	8
1.5 Summary	9
CHAPTER 2	
LITERATURE REVIEW AND THEORY CONSTRUCTION	11
2.1 Traditional Perspective of Diffusion: Static Product View	11
2.1.1 Static Product View of the Social System	12
2.1.2 Static Product View of the Adoption Process	15
2.1.3 Static Product View of the Innovation	18
2.1.4 Static Product View of Marketer Actions	19
2.1.5 Static Product View of Competitive Actions	20
2.1.6 Static Product View of Potential Adopters	21
2.2 Need For a New Theoretical Framework	22
2.3 Product Evolution	28
2.4 Dynamic Product View	30
2.4.1 Dynamic Product View of the Social System	31
2.4.2 Dynamic Product View of the Adoption Process	33
2.4.3 Dynamic Product View of the Innovation	34
2.4.4 Dynamic Product View of Marketer Actions	35
2.4.5 Dynamic Product View of Competitive Actions	36
2.4.6 Dynamic Product View of Potential Adopters	37
CHAPTER 3	
MODEL DEVELOPMENT AND HYPOTHESES	39
3.1 Adoption Timing Decision Model	39
3.2 Construct and Hypotheses	44
3.2.1 Benefit Constructs	47

3.2.2 Uncertainty Constructs	49
3.2.3 Expectation Constructs	53
3.2.4 Interaction Effects	56
3.2.5 The Role of Subjective Disconfirmation	58
3.3 The Sequential Logit Model	62
 CHAPTER 4	
RESEARCH METHODOLOGY	67
4.1 Experimental Design	67
4.2 Procedure	73
4.3 Measure Development	80
4.4 Sampling Procedure	86
4.4.1 Subject Recruitment	87
4.4.2 Power Analysis and Sample Size	87
4.4.3 Subject Assignment	90
 CHAPTER 5	
RESEARCH RESULTS	91
5.1 Manipulation Checks	91
5.2 Measurement Testing Approach	94
5.2.1 Item-to-Total Correlations.....	95
5.2.2 Principal Components Factor Analysis.....	95
5.2.3 Reliability and Validity	97
5.3 Collinearity	102
5.4 Hypothesis Testing Approach	104
5.5 Model Estimation	107
 CHAPTER 6	
CONCLUSIONS	111
6.1 Research Findings	111
6.1.1 The Influence of Perceived Newness	111
6.1.2 The Influence of Perceived Performance	115
6.1.3 The Influence of Performance Uncertainty	116
6.1.4 The Influence of Risk of Obsolescence	118
6.1.5 The Influence of Ease of Use	119
6.1.6 The Influence of Next Generation Performance Expectation	120
6.1.7 The Influence of Next Generation Performance Uncertainty ...	122
6.1.8 The Role of Subjective Disconfirmation	123
6.2 Contributions of the Research.....	127
6.2.1 Theoretical Implications	128
6.2.2 Managerial Implications	132
6.3 Research Limitations	136
6.4 Future Research Directions	138
6.5 Summary	139

APPENDIX A - Descriptive Statistics	142
APPENDIX B - Initial Factor Analysis - Pattern Matrix	144
APPENDIX C - Consumer Electronics Report	145
APPENDIX D - High Expectations Treatment	146
APPENDIX E - Medium Expectations Treatment	147
APPENDIX F - Low Expectations Treatment	148
LIST OF REFERENCES	149

LIST OF TABLES

Table 1 - The Static Product View	13
Table 2 - Comparison of the Static and Dynamic Product Views	32
Table 3 - Hypothesized Main Effects	56
Table 4 - Hypothesized Interaction Effects	62
Table 5 - Layout of Experimental Design	72
Table 6 - ANOVA Manipulation Checks	93
Table 7 - Construct Reliabilities	99
Table 8 - Measurement Model Solution	100
Table 9 - Construct Correlations	101
Table 10 - Factor Analysis Loadings	103
Table 11 - Factor Analysis Correlation Matrix	104
Table 12 - Sequential Logit Model Estimation Results	109
Table 13 - Hypothesis Tests	112
Table 14 - Descriptive Statistics	142
Table 15 - Initial Factor Analysis - Pattern Matrix	144

LIST OF FIGURES

Figure 1 - New Product Family Hierarchy	24
Figure 2 - Types of Innovation	25
Figure 3 - Innovation-Decision Process	40
Figure 4 - Decision Tree for Adoption Timing Decision Model	41
Figure 5 - New Constructs as a Result of New Product Evolution	45
Figure 6 - Diagram of Hypothesized Direct Effects	46

Chapter 1

INTRODUCTION

1.1 Importance of Diffusion in Marketing

The diffusion of an innovation, or new product, refers to its spread among a given set of prospective adopters over time (Mahajan and Muller 1979; Mahajan, Muller and Bass 1990). New products are often vital to the success of the firm and one of the critical functions in marketing is forecasting their rate of market acceptance. Diffusion may be defined as the rate at which a new product penetrates the population of potential adopters. It has implications related to achieving economies of scale and reaching a critical mass of marketplace acceptance ahead of competitors. Rapid marketplace acceptance may also be instrumental for a product to be considered the industry standard or dominant design. For marketers interested in rapid diffusion of their innovations, the characteristics of the new product that influence its rate of acceptance assume considerable importance. Incorporating attributes into a new product that positively affect diffusion has obvious implications for new product development activities. Central to the pattern of diffusion is the timing of adoption. Getting a new product adopted, even when it has obvious advantages, is often very difficult for marketers. The difficulty may be compounded when marketers continue to improve the relative

advantage of the new product during its diffusion. When this is the case, new product characteristics may influence the rate of adoption in ways that are quite distinct from their influence on the communicability of the innovation. Certainly the rate at which information about the innovation is communicated influences the rate of diffusion, but adoption is not contingent solely on awareness. Additional importance is placed on the evolving nature of the product as competitive forces put pressure on marketers to continue to improve their new products during diffusion. This may be particularly true for products that were initially rushed to market in a rudimentary state of development. This research will place additional emphasis on the impact of changing product characteristics.

Why do potential adopters not adopt new products immediately upon becoming aware of them? The answer is that innovation adoption involves more than simply becoming aware of an innovation, it frequently involves a behavioral decision. For many products, there is often a time lag between the time of first learning about a new product and the point that the product is acquired and put into use. This is because consumers are heterogeneous with regard to the time span between attitude formation and first purchase. One source of this heterogeneity is the innovation itself. New product developers often believe that superior technologies will sell themselves, resulting in rapid diffusion. Unfortunately, this is often not the case. Understanding the determinants of the rate of marketplace acceptance therefore takes on great importance for marketers concerned with how to launch a new product more efficiently.

1.2 Motivation for the Research

This study takes the position that there are three assumptions implicit in the current research on diffusion. These assumptions are: 1) that potential adopters adopt as soon as they become aware of an innovation; 2) that the innovation does not change during its diffusion; and 3) that the adoption decision is a binary decision resulting in either adoption or rejection of the innovation. The motivation for this research is to investigate the implications of relaxing these assumptions.

Diffusion has been defined as “the process by which an innovation is communicated through channels, over time, among the members of a social system” (Rogers 1983). Marketing research on diffusion, or the rate of marketplace acceptance of new products, has taken both a macro- and a micro-perspective. The macro-perspective considers the social system as a whole and examines the spread of an innovation throughout the entire system. Here the unit of analysis is the population of potential adopters. Included in the macro-perspective are the various aggregate models of diffusion. Aggregate models may be contrasted with the micro-perspective. Viewing diffusion from the micro-perspective means disaggregating the diffusion process to the level of the individual consumer. Individual adoption decisions, when aggregated, form the overall pattern of the diffusion of the new product. Aggregate models of diffusion typically use only time as the dependent variable and estimate various model parameters from historical time-series data. While simple in concept, these models often lack theoretical justification and may make assumptions that are not in accordance with actual marketplace behavior. A

prominent example of this is the Bass (1969) model and its extensions. Often referred to as a communication model, the theoretical interpretation of the Bass model is analogous to the spread of an epidemic. Following an S-shaped curve, acceptance of a new product is initially slow but accelerates as increasing numbers of adopters spread the word to those who have not yet adopted. As more people “catch it”, the likelihood increases that those who have not yet adopted will “catch it” too. Finally, the pattern of diffusion levels off as saturation is approached. Among the underlying theoretical assumptions of the Bass model, and many of its variants, is the assumption that potential adopters will “catch”, or adopt, the innovation as soon as they are “exposed”, or become aware of, the innovation. The problem with this interpretation, and with these models, is that they do not allow for a time lag between awareness and adoption. Arising from the communication interpretation of diffusion, this problem begins to form the basis for this research.

Another assumption implicit in the diffusion modeling literature is that the nature of the innovation does not change over time. This is also a frequent assumption made in the micro-perspective literature of consumer behavior. Since much of the research in this field consists of cross-sectional studies, incorporation of a changing product is generally not feasible. However there is much in the literature to suggest that innovations or new products evolve into families of new products during their diffusion (Wheelwright and Clark 1992; Meyer and Utterback 1993). Technological change during diffusion has been shown to follow a pattern characterized by initial ferment over product design, followed by the emergence of a dominant design and subsequent

incremental changes eventually culminating in the emergence of a new innovation (Abernathy and Utterback 1982; Anderson and Tushman 1990). It would seem worthwhile to incorporate consideration of a dynamic product into studies of diffusion. The communication interpretation and the assumption of an unchanging product have done much to determine the direction of prior diffusion research. Relaxing the unchanging product assumption and moving beyond the communication interpretation of diffusion provides additional motivation for this research.

The final assumption that motivates this research is the assumption that the micro-perspective adoption decision is binary. Partly as an outgrowth of the assumption of an unchanging innovation, the potential adopter has traditionally been assumed to either adopt or reject the innovation. Research into the adoption process, or the micro-perspective, has occurred primarily in the field of consumer behavior. The focus on a single, unchanging product has characterized much of the consumer behavior research into adoption. This may be termed the static product view. The current study seeks to expand the static product view into a dynamic product view that incorporates the evolutionary nature of many product types. This necessitates a relaxation of the binary adoption decision. Incorporating the concept of an evolving new product, one in which the potential adopter may have multiple generations from which to choose, means that the adopt/reject decision may not be adequate to describe the nature of the decision and its impact on the ultimate pattern of diffusion. One implication of the idea that new products improve over time is that, at the micro-level, individual adopters are faced with a choice between the current version of the new product and an anticipated future

improvement. It then follows that the consumer decision changes from the simple binary adopt/reject decision to a decision that includes postponement of adoption. This relaxation of the binary adoption decision provides the final motivation for this research.

1.3 Purpose of the Research

The purpose of this research is to move beyond the narrow perspective imposed by the static product view by considering a dynamic product view of the determinants of the rate of marketplace acceptance. Moving beyond the communication interpretation means acknowledging the fact that potential adopters may not adopt a new product as soon as they become aware of it. There is often a time lag between the time of first awareness and the eventual point at which the innovation is adopted. The communication interpretation generally assumes that, as in the case of an epidemic, adoption takes place as soon as sufficient contact occurs. The dynamic product view offers an alternative explanation for this time lag. When potential adopters perceive that a new product is changing, postponement of adoption becomes a viable alternative. More importantly, the decision to postpone may be made in spite of the fact that the potential adopter has a favorable attitude toward the current version of the new product. Consequently, the first question to be addressed by this research is an investigation into the viability of adding a timing stage to the adoption process. Time has always been a fundamental and essential element of diffusion. Incorporating timing into adoption decision-making is necessitated by the relaxation of the traditional assumption of an unchanging new product. This promises to add “life” to the adoption process by

enhancing the traditional models of adoption, such as the various hierarchy of effects models, with the inclusion of a timing stage. Potential adopters may now go through the stages of awareness, persuasion, and timing prior to purchase.

The innovation is considered to be part of a family of products undergoing evolutionary improvement over time. What implications does this have for the influence of product characteristics on the adoption process? Are there additional factors that arise in conjunction with the dynamic product view that were not operable in the static product view? In the static product view of diffusion, innovation characteristics such as relative advantage, compatibility, complexity, trialability, and observability have been shown to influence the rate of diffusion. In the context of a dynamically evolving product, additional characteristics that reflect the changing nature of the product must be considered. Thus the second research question addressed in this study concerns those product characteristics that are implied by the dynamic product view. A third research question asks how these proposed dynamic product characteristics influence the evaluation of new products and, given a favorable evaluation, how they influence the timing of adoption.

The presence of successive generations of products in a product family means that consumers may form expectations about future levels of improvement. These expectations change the nature of the adoption decision. The choice is no longer simply adopt or reject. Postponement may be thought of as a purposeful decision to forgo current adoption in favor of the next generation. It now emerges as an additional

decision alternative. As a result, marketers must be concerned with the rate and degree of improvement within the product family. One implication may be that too rapid a pace of improvement might induce feelings of uncertainty in the consumer which may, in fact, inhibit the likelihood of current adoption in favor of a “wait and see” attitude. This should cause marketers, under a dynamic product framework, to be concerned about how their new product preannouncing behavior influences the creation of expectations about the next generation of the innovation. The final research question involves the investigation of the impact of preannouncements, and their resulting expectations, on the likelihood of adoption or postponement.

1.4 Expected Contributions of the Research

The incorporation of a dynamic product view into diffusion is expected to result in the following contributions to the theoretical literature:

1. Allow the development of an adoption model that incorporates timing as one stage in the adoption process.
2. Provide insight into the impact of dynamic product characteristics on the evaluation stage of the adoption process.
3. Provide insight into the influence of dynamic product characteristics on the timing stage of adoption, given that a favorable attitude is formed during the evaluation stage.
4. Investigate the possibility that evolutionary products can improve more

rapidly than potential adopters expect, resulting in moderation of the influence of performance on both evaluation and timing.

The incorporation of a dynamic product view into diffusion is expected to result in the following managerial contributions:

1. Insight for marketers on how the pace of technological change may influence postponement and the rate of diffusion.
2. Insight into the possible need to accurately educate potential adopters through new product preannouncements about the level of product improvements.
3. Insight into the possibility that there may be an optimal rate of product improvement, as distinguished from time to market, which is slower than technological capabilities permit.

1.5 Summary

A basic proposition set forth herein is that the direction of diffusion research in marketing has been determined largely by the interpretation of diffusion as a communication model. This is not an incorrect interpretation, but it has resulted in a focus on the spread of information as the primary mechanism for the rate of marketplace acceptance. To the extent that the role of the innovation itself has been considered, that role is viewed almost entirely in terms of the attributes of the innovation that facilitate communication. The relegation of the innovation to a secondary role has resulted in a fundamental weakness in the adoption/diffusion literature. By viewing the innovation

simply as the object of communication, it has been implicitly assumed to be a single, unchanging object. This static view of the innovation has been translated into an explicit assumption in much of the diffusion modeling literature. One consequence of this myopia about the role of the new product is that potential adopters, upon hearing about an innovation, are assumed to be confronted with a decision simply to accept or reject the innovation. This traditional perspective of diffusion is referred to as the static product view. In view of the fact that many new products evolve into evolutionary families of products, it is time to incorporate a dynamic product view into the processes of diffusion and adoption.

Chapter 2

LITERATURE REVIEW AND THEORY CONSTRUCTION

2.1 Traditional Perspective of Diffusion: Static Product View

Diffusion is often defined in terms of the essential elements of the diffusion process. One definition that separates diffusion into four elements holds that it is “the process by which (1) an innovation (2) is communicated through certain channels (3) over time (4) among members of a social system” (Rogers 1983). In an attempt to model the diffusion research paradigm, Gatignon and Robertson (1991) enhance Rogers’ definition by including consideration of the adoption process, competitive activity, and marketer actions. In the context of the present research, the diffusion process will be decomposed into six elements. These elements are: (1) the social system, (2) the adoption process, (3) the innovation, (4) marketer actions, (5) competitive actions, and (6) the potential adopters. Since diffusion is a macro-level process, the first element to be considered is the social system through which the innovation spreads. The pattern and timing of this process is simply an aggregate of the micro-level adoption decisions made by the individual adopters. It follows naturally that the second element is the adoption process itself. This process has been described in terms of various hierarchy of effects models. The third element is the innovation itself. This often-neglected component of diffusion

forms the centerpiece of this research. Since new products frequently must replace existing products and, if successful, will soon face other entrants; the competitive environment is the fourth element. In many marketing studies of diffusion, the actions of the marketer are thought to influence the rate of marketplace acceptance of the new product. Marketer actions are therefore included as the fifth element of this discussion. Finally, much research has been done on the personal characteristics of potential adopters and the personal influence process that impacts their decisions. This stream of research is classified under the sixth element -- potential adopters. In the following sections, the traditional perspectives that have guided research in these six elements of diffusion are discussed in more detail. This traditional perspective is referred to in this discussion as the static product view. In Table 1, the six elements of the diffusion paradigm are listed along with some of the dominant features of the static product view.

2.1.1 Static Product View of the Social System

One of diffusion's fundamental principles is the interaction between those who have already adopted and those who have yet to adopt. It is postulated that the probability of adopting a new product is a function of the number of individuals already using it. This has its roots in contagion models that trace the spread of epidemics. The larger the number of people that catch a disease, the more likely one is to catch it too. Diffusion is likewise modeled as a process of awareness and imitation. As more and more individuals adopt, probability of exposure for non-adopters increases and pressure builds for non-adopters to follow the adopter's lead.

Table 1
The Static Product View

Elements of the Diffusion Process:	The Static Product View:
1. The Social System	• Fixed number of adopters • Epidemic theory
2. The Adoption Process	• Single, binary decision • Hierarchy of effects model • Focus on awareness
3. The Innovation	• Single new product • Unchanging new product • Characteristics: - relative advantage - compatibility - complexity - trialability - observability - perceived risk
4. Marketer Actions	• Influence of Promotion • Neglects the role of product
5. Competitive Actions	• High product competition increases diffusion rate • High technology competition decreases diffusion rate
6. Potential Adopters	• Ranked adopter categories • Role of personal influence

Some of the earliest diffusion studies are found in anthropology, where the spread of modern Western ideas into more primitive societies is examined. This is where the tradition of diffusion through a social system originated, and early sociological studies provide the first suggestion that the adoption of new ideas follows an S-shaped pattern over time (Tarde 1903). Tarde also contributed the insight that one mechanism of diffusion is the imitation by individuals of the behavior of opinion leaders. It would seem likely that these early concepts influenced some of the first diffusion studies. In an early study, Mansfield (1961) defines diffusion as the rate at which others follow an innovator. This phenomenon has come to be referred to as the rate of imitation. The pressure to conform produces a “bandwagon “ effect in which non-adopters feel pressure to keep pace with ever-increasing numbers of adopters. This social interpretation is also echoed in an early definition that considers diffusion as the adoption of a product over time by customers who are linked to the social structure by channels of communication (Bernhardt and MacKenzie 1972). More recently, the communication field has investigated the effects of mass media and interpersonal communication channels on influencing personal behavior.

Within marketing, the development of models of diffusion has received considerable attention. One of the best known marketing diffusion models is that of Bass (1969). Drawing its underlying theory from Rogers (1962), the Bass model assumes that potential adopters are influenced by two means of communication -- mass media and word-of-mouth. The first to adopt, referred to as innovators, adopt independently of the social system and are mainly influenced externally by mass media communication.

The remainder of the individuals in the social system not considered innovators are described as imitators. Responding mainly to word-of-mouth communication from within the social system, the imitators are influenced to adopt by those who have already adopted. This linkage of diffusion mechanisms to the social system and its communication channels is responsible for explanations of diffusion that are divorced from the object of diffusion.

In marketing, the social system also represents the market for the new product. The Bass (1969) model and most of its extensions assume that the total market potential of the new product remains constant over time. However, some researchers have proposed linking the market potential to economic conditions or population growth (Mahajan and Peterson 1978; Sharif and Ramanathan 1981; Lackman 1978; Jain and Rao 1989; Jones and Ritz 1991; Chow 1967; Kamakura and Balasubramanian 1987).

2.1.2 Static Product View of the Adoption Process

Another consequence of the inextricable link between diffusion and the social system is the perspective of diffusion as an aggregate or macro-level process. The population of potential adopters is seen as relatively homogeneous. Diffusion models are concerned with the overall pattern of diffusion with respect to those who will eventually adopt. They are not concerned with the decision of “whether” to adopt; they are concerned only with the aggregate “when” of adoption. The question of whether to adopt has resided in the domain of consumer behavior. In that field, research into the disaggregate or

micro-level process of adoption has proceeded almost entirely apart from diffusion research. It is the timing of individual decisions to adopt that, when aggregated over the entire population of potential adopters, determines the pattern of diffusion. Only recently have attempts been made to incorporate this heterogeneity into diffusion models. Researchers have looked at incorporating perceived utility (Jensen 1982; Lattin and Roberts 1989), risk aversion (Oren and Schwartz 1988), and perceived product performance (Chatterjee and Eliashberg 1990) into models of diffusion. Despite these attempts, diffusion models in marketing still lack solid linkage with underlying theory.

The adoption decision is treated as one of adopt/reject in both the modeling stream of diffusion as well as consumer behavior research into adoption. Exceptions to this in the modeling literature include Kalish (1985); Mahajan, Muller and Kerin (1984); and Mahajan, Muller and Sharma (1984). Most of the modeling literature follows the assumption made by the Bass (1969) model that there is a single binary adoption decision (Mahajan, Muller and Bass 1990).

The adoption process comprises the stages that an individual goes through in making the decision to adopt a new product. This process is frequently represented by a hierarchy of effects model. Consumers engage in a number of processes when making an initial evaluation of an innovation, including attempts at categorization, judgment processing, formation of evaluative criteria, formation of expectations about the innovation, and comparisons with their present product or existing products. Much research on decision making is based on the assumption that attitudes influence

consumer behavior (Petty, Unnava and Strathman 1991). In the case of an innovation or new product, attitude formation may be a critical part of the adoption process. One influential model based on the expectancy-value approach is the theory of reasoned action (Fishbein and Ajzen 1975). The crux of this theory is that consumers are considered to be rational decision makers who consider the consequences of their actions when making a decision. Other decision models consider behavior that is habitual or impulsive but new product adoption is generally believed to involve more extensive problem solving behavior. Miniard and Cohen (1983) similarly combine beliefs about the consequences of a behavior, along with an evaluation of the consequences, into a single attitude construct. Their model differs in that they decompose beliefs into personal and normative components.

The theory of reasoned action posits that behavioral intention is a primary determinant of overt behavior and that intention is a function of a person's attitudes and subjective norms. Attitudes, as an antecedent to evaluation and adoption, are important to considerations about the postponement of adoption because, once formed, they are considered persistent and enduring and may be resistant to change. If an innovation, particularly a discontinuous innovation, requires consumers to change strongly held beliefs, then adoption may be postponed until marketers are able to overcome this resistance. However, innovations change in their degree of radicalness over time, so later adopters may not be faced with radical departures from existing practice. Fisher and Price (1992) extend the expectancy-value model of Miniard and Cohen (1983) to include the social context of adoption.

2.1.3 Static Product View of the Innovation

Rogers (1983) defines an innovation as “an idea, practice, or object that is perceived as new by an individual or other unit of adoption.” For the purpose of this research, the terms “innovation” and “new product” will be used interchangeably. What is the role of the innovation in diffusion? Under the traditional interpretation of diffusion as a communication process, the attributes of a new product that facilitate communication are thought to be among the determinants of the rate of adoption and diffusion. Rogers (1962, 1983) and Rogers and Shoemaker (1971) identify these product characteristics as relative advantage, compatibility, complexity, trialability, and observability. These five innovation characteristics have been widely cited in introductory textbooks (c.f. Kotler and Armstrong 1994). Relative advantage refers to the degree to which an innovation or new product is perceived by the consumer to be superior to substitute products.

Compatibility represents the extent to which the innovation corresponds to the value system, needs, or lifestyle of the potential adopter. Complexity is the level of difficulty or the sophistication of the technology embedded in the product or innovation that makes it hard to understand or use. Trialability (also referred to as divisibility) refers to the possibility that a potential adopter may try the new product on a limited basis, such as sampling or demonstrations. Finally, observability (also called communicability) implies that the features and attributes of the innovation are easily conveyed to others. This helps spread awareness among potential adopters. Whereas relative advantage, compatibility, and complexity are obviously tied to the features and attributes of the product, trialability and observability have less relationship to product design and more

relationship to the communication mechanisms of diffusion. In a meta-analysis of seventy-five articles concerned with innovation characteristics and their relationship to adoption; relative advantage and compatibility were found to be consistently positively related to adoption while an inverse relationship was found between complexity and adoption (Tornatzky and Klein 1982). In a study of the interaction between these product characteristics and purchase intention; compatibility and relative advantage were found to have a direct positive effect while communicability (observability) complexity and divisibility (trialability) were indirectly related to purchase intention (Holak and Lehmann 1990).

A sixth characteristic called perceived risk is included in many studies (Holak 1988; Holak and Lehmann 1990). One aspect of perceived risk is uncertainty. Reduction in uncertainty should increase the rate of adoption. There have been studies that consider uncertainty reduction as a function of the acquisition of additional information that promotes learning about the innovation (Kalish 1985; Horský 1990). These studies conform to the traditional communication interpretation. However, the impact of improvements in product performance on uncertainty has not been widely studied.

2.1.4 Static Product View of Marketer Actions

Under the communication interpretation of diffusion, one of the elements of marketing in which the marketer is thought to be able to influence the rate of diffusion is advertising. Another element of marketing widely researched for its impact on diffusion

is price. The impact of supply constraints has also been investigated. Probably the least incorporated element of marketing has been the product. The role of the new product has been overlooked in the vast majority of studies related to the Bass model. Only one study (Kalish and Lilien 1986) explicitly looks at the changing adopter perceptions of the new product over time. As a result, Mahajan, Muller and Bass (1990) call for future research into the impact of expectations on diffusion.

Several studies look at marketer actions when market potential is considered to be a function of price (Kalish and Sen 1986; Kalish 1983, 1985). Another investigation looks at how price influences the coefficients of internal and external influence (Jain and Rao 1989). Some studies have examined diffusion in the presence of supply restrictions (Simon and Sebastian 1987; Jain, Mahajan and Muller 1991) and market potential as a function of the growth of distribution systems (Jones and Ritz 1991). Other studies have looked at the impact of advertising on the parameters of the Bass (1969) model. Horsky and Simon (1983) found that advertising has an impact on the coefficient of innovation, while Simon and Sebastian (1987) found a more likely impact on the coefficient of imitation.

2.1.5 Static Product View of Competitive Actions

Very little empirical research has been conducted on the competitive factors that influence the rate of diffusion. In a cross-sectional examination of the adoption of technological innovations by organizations, Gatignon and Robertson (1989) considered

such competitive factors as industry concentration and competitive price intensity and found that diffusion is facilitated in concentrated industries with limited price intensity. Under the static product view, it has mainly been thought that the higher the competition within the product category, the faster the rate of diffusion. On the other hand, higher levels of competition from substitute product categories, or competing technologies, slow the rate of diffusion (Hirschman 1980; Olshavsky 1980).

2.1.6 Static Product View of Potential Adopters

Much of the research in diffusion centers around the personal characteristics of categories of potential adopters, with particular attention paid to innovators. This can be particularly important to marketers for the success of new products. However, innovators comprise a relatively small percentage of the potential adopter population. Of equal, or possibly even greater, significance for diffusion of an innovation over time is the imitator. In the context of diffusion, imitators have been described as all adopters other than innovators. They are the individuals who postpone adoption, but much less research has been conducted on the determinants of postponement. Assuming no limitations or restrictions on product availability (Simon and Sebastian 1987; Jain, Mahajan and Muller 1991), the time lag between awareness and adoption is considered here as postponement. This time lag should be distinguished from the communication time lag between product launch and initial awareness. This time lag is not the result of consumer cognitive processes and is therefore beyond the control of the consumer. It is important to note that, in this light, postponement is not the opposite of adoption, it is a

precursor to adoption (Ram 1987). Rogers (1983) concedes that much of the diffusion literature has a pro-innovation bias; it assumes that all innovations will be successful and immediately adopted as soon as consumers are made aware of them. Postponement acknowledges that this is frequently not what happens.

Rogers (1962, 1983) classifies individuals into five adopter categories ranging from the earliest adopters to those he terms laggards, those who are the last to adopt. Research into the characteristics of individuals that determine which category of adopter they become is beyond the scope of this investigation. However, one dimension of individual adopters is relevant to postponement. While it should be considered a characteristic of adopters rather than a product characteristic, psychological resistance to change (Sheth 1981) is one contributor to postponement.

2.2 Need for a New Theoretical Framework

Despite the obvious success of the communication interpretation of diffusion in the marketing literature, there are powerful reasons for believing that it diverts attention from important aspects of the diffusion process. One way in which this diversion occurs is the static view of diffusion that assumes that a given innovation diffuses unchanged. However, it can be argued that observed diffusion paths primarily reflect post-introduction changes in the innovation and adoption environment, rather than a process of learning within a static situation. Acceptance of a new product may be just as much a result of its improvement over time as it is a change in receptiveness of potential

adopters (Gold 1981). The most compelling justification for the need for a new framework is the existence of product families rather than isolated products. Recent thinking about new product management in light of the imperative for global competitiveness has marketers thinking in terms of focusing the core competencies of the firm on families of new products and how those families evolve (Wheelwright and Clark 1992; Meyer and Utterback 1993). Applying this view necessarily implies that the innovation evolves through multiple designs and that the characteristics of the innovation are being continually transformed during the diffusion process. New products may go through a “debugging” process and may actually be inferior in performance to an existing substitute product only to overtake it once its technical superiority is clearly established. A product innovation may be developed using alternative design or construction technologies that compete for preeminence during the early stages of the diffusion process. Variations of new products may be developed to serve different market niches. Lead-users may continue the improvement process by adapting new products to suit their particular needs. New products may be adapted to be more compatible with complementary or contingent products. All this is at variance with the common assumption that a new product arrives full-blown in the marketplace and diffuses independently and unhindered into a vacuum.

Functionally related products that are oriented toward a market segment comprise a product family, and products within this family may be mapped according to a hierarchy (Meyer and Utterback 1993). The hierarchy and terminology used in the context of this research is shown in Figure 1.

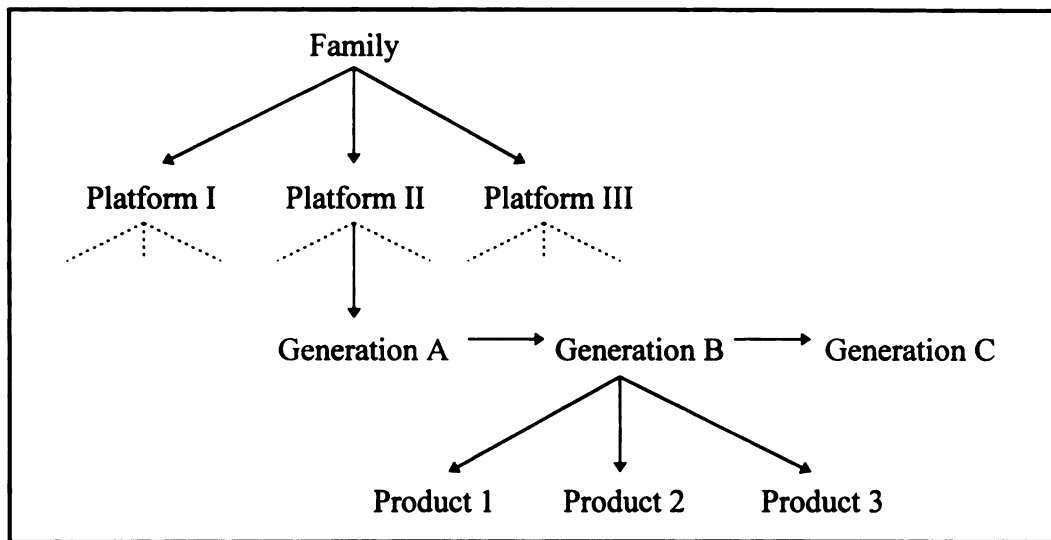


Figure 1
New Product Family Hierarchy

Closely related products within the product family that share common core design concepts are considered to be part of the same product platform. Whereas products within the entire family are related by virtue of their market orientation (they are targeted at the same segment), product platform products are related by virtue of their design orientation (they share common design and component technologies). If both the design and the component technologies are significantly altered, a radical innovation takes place and a new platform emerges. However, within the product platform, either the design technology or the component technologies may be individually refreshed from time to time resulting in a new generation of products within the existing platform. Since product generations typically succeed each other in time, product generations may be thought of as time-oriented. It is this time orientation of products that forms the basis of this research. Finally, within product generations, specific products exist that are

refined for particular niches within the market segment targeted by the product family. These specific products may be thought of as attribute-oriented. These individual products are the most specific level in the product family hierarchy. It can be seen from this that a continuum of change can take place within product families. Radical innovations produce new platforms, other changes in technology can produce successive generations, and incremental changes in attributes produce specific product variations. Innovation can occur in all levels of the family hierarchy. This offers a way of classifying types of innovation as shown in Figure 2.

		Core Concepts	
		Reinforced	Overturned
Linkages Between Core Concepts and Components	Unchanged	Incremental Innovation	Modular Innovation
	Changed	Architectural Innovation	Radical Innovation

Figure 2
Types of Innovation

Products, particularly high-technology products, have both an architecture and core design concepts (Henderson and Clark 1990). The core design concept (Clark 1985) represents the basic scientific and engineering knowledge underlying a component of a product, where the component is a distinct part of the product performing a well-defined

function. Innovation may occur in either the product architecture or component knowledge. The way in which the components of a product are linked together is termed the product architecture (Henderson and Clark 1990). When new component technologies are linked together in a new architecture, a radical innovation occurs. As mentioned earlier, a radical innovation produces a new product platform. If the change occurs due to the overturning or reinforcement of the component technology, while the architecture remains unchanged, it is termed a modular innovation (Henderson and Clark 1990). Conversely, a reconfiguration in the architectural linkages without changing underlying component technologies is called an architectural innovation (Henderson and Clark 1990). In either of these circumstances, new generations of the product are produced. Finally, merely refining or extending an established design is referred to as incremental innovation, and this takes place at the specific product level.

One segment of the literature that explicitly recognizes generational change in innovations is the technological substitution literature. In contrast to the characterization of diffusion as the isolated growth of a single innovation into a previously untapped market, substitution may be viewed as a sequential process in which a new technology or innovation better able to satisfy consumer needs is substituted for an existing product. Whereas diffusion is based on the rate of acceptance of a new product, substitution is based on the rate of interaction between the “challenger” and the “defender” (Fisher and Pry 1971). Diffusion models predict the percentage of potential adopters who adopt over time and substitution models predict the percentage of market share achieved by a new product over an existing product. Substitution models assume a preexisting market to be

substituted, while diffusion models make no such assumption (Norton and Bass 1987). Empirical evidence has shown that the process of substitution follows an S-shaped pattern of growth (Fisher and Pry 1971). The underlying hypothesis is that the rate of adoption of a new product is proportional to the fraction of the old one still in use. The most frequently used determinants of substitution are relative advantage and perceived risk.

There have been some attempts in the marketing diffusion literature to model multi-generational diffusion patterns. Norton and Bass (1987) model the diffusion of successive generations of computer chips. Substitution concepts are incorporated into the model to show that the newer technology may widen the market of the previous technology through new applications while at the same time abbreviating the diffusion of the previous technology through cannibalization and disadoption. Thus each generation obtains sales by (1) expanding applications, i.e. generating sales that would not have gone to earlier generations, and (2) capturing sales that would have gone to earlier generations, either by causing individuals to forego or to switch out of the earlier generation (Norton and Bass 1992). They state that closer inspection of the substitution process, particularly for a series of substitutions, shows the process to be evolutionary, not revolutionary.

Despite these areas of limited recognition of product change during diffusion, there still remains a need to reconceptualize the link between marketplace acceptance and evolutionary products. The next section considers the literature concerning product

evolution that forms the basis for what will be termed, in the context of the present research, the dynamic product view.

2.3 Product Evolution

There is considerable evidence to show that new product technologies do not emerge fully developed at the outset of their commercial lives (Burns and Stalker 1966; Mansfield 1977; Abernathy and Utterback 1982; Rosenberg 1976; Clark 1985; Sahal 1981). Initial periods of experimentation in both core design concepts and methods of linking components together eventually result in the emergence of a dominant design. This is followed by a period of refinement and extension until a new radical innovation comes on the scene.

It has been observed that the process of innovation follows a cyclical pattern punctuated by product breakthroughs referred to as discontinuities (Tushman and Anderson 1986). These discontinuous changes foster a period of technological ferment in which product variation may be substantial and alternative product forms may compete for dominance (Abernathy and Utterback 1982). The emphasis is on functional performance and frequent product changes are stimulated by input from the marketplace. Due to uncertainty over performance criteria in the ferment stage, lead users may play an important role in determining the ultimate form the new product will take (von Hippel 1988). Because the performance criteria of the new product may be vague and unclear, several variations may emerge from pioneering firms attempting to differentiate

themselves to gain competitive advantage. Competing technologies may emerge that comprise different product platforms. Initial designs may be crude, but rapidly improve (Abernathy 1978). Therefore, reticence to adopt may be attributed to perceived performance rather than slow communication. Whereas traditional diffusion treats delays in adoption on the part of some consumers as evidence of a lack of innovativeness, a more complex explanation needs to be examined. A new product goes through a sorting out process that is more than simply eliminating the “bugs”. Negative characteristics of the new product are reduced while positive ones are enhanced. Acceleration in adoption following early slowness should be examined in terms of the progress of improving performance as well as systematic modification of the innovation to accommodate the diverse range of needs of a heterogeneous user population (Rosenberg 1976). It is not always apparent early in the cycle how an invention will ultimately be used. This is because it is hard to conceptualize needs that have yet to be articulated. It is hard to visualize how radical new products may eventually be used, so they are initially thought of in terms of supplements to existing systems. In the final analysis, they may constitute entirely new systems of need satisfaction. This is in contrast to traditional diffusion interpretations in which a given innovation is targeted at a given set of known tastes and requires only the spread of information for users to immediately adopt. Rogers (1983) has acknowledged this innovation bias in traditional diffusion literature.

As the demand for the innovation accelerates, the innovation enters a transitional phase. Product variation to meet market niches occurs, but the product line stabilizes to

facilitate volume production. Competition between technologies persists until a dominant design emerges (Utterback and Abernathy 1975). A dominant design is a single architecture that establishes dominance in a product class (Abernathy 1978; Sahal 1981). A dominant design permits standardization and economies of scale along with economies of learning by doing (Arrow 1962; Rosenberg 1976). The emergence of a dominant design is directly linked to the diffusion of a new generation of technology (Anderson and Tushman 1990). Due to the uncertainty caused by the absence of an industry standard, diffusion will not peak until after the emergence of a dominant design.

Following the emergence of a dominant design, the evolution of the new product family focuses on elaborating the now widely accepted product design, which becomes a guidepost for further product change (Sahal 1981). Evolution of the product family is characterized by numerous incremental improvements (Marquis and Myers 1969; Dutton and Thomas 1985). Although minor in degree, the cumulative result of the incremental improvements in this final stage of the cycle may be substantial due to their greater number. Thus it only remains for a new discontinuity to substitute for the existing innovation (Calantone, di Benedetto and Meloche 1988).

2.4 Dynamic Product View

The basis for the dynamic product view is the future orientation on the part of the consumer as a result of acknowledging the evolutionary character of an innovation. This future orientation results in the development of expectations and uncertainties about the

future trends of product characteristics. This future orientation changes the static product view of diffusion into a dynamic product view of diffusion. A comparison of the static product view and the dynamic product view is given in Table 2.

2.4.1 Dynamic Product View of the Social System

In their review of diffusion models in marketing, Mahajan, Muller and Bass (1990) acknowledge that there is no theoretical rationale for an unchanging adopter population. In fact, there are many reasons to believe that the size of the potential adopter population will continuously change. When innovations are first introduced, they are often limited in the scope of their application. The wide range of specialized uses to which they will eventually be put may not yet be known. Many potential users may delay adoption until the process of modification and refinement produces products more suited to their specific needs. This may apply to products suited for different income groups as well as product features and attributes designed to appeal to different market niches. The research on product families illustrates the evolution of product extensions to serve a variety of market niches. Apart from influence of a dynamic product, other variables may influence the size of the market. Kalish (1985) found that as price or uncertainty about product performance decrease, the size of the potential market can be expected to increase. In contrast to the static product view that considers an unchanging innovation and a fixed number of potential adopters, the dynamic product view maintains that the evolutionary nature of the product will result in an ever enlarging population of potential adopters.

Table 2
Comparison of the Static and Dynamic Product Views

Elements of the Diffusion Process:	The Static Product View:	The Dynamic Product View:
1. The Social System	• Fixed number of adopters • Epidemic theory	◆ Expanding number of adopters ◆ Niche theory
2. The Adoption Process	• Single, binary decision • Hierarchy of effects model • Focus on awareness	◆ Multiple postponement alternatives ◆ Focus on product evolution
3. The Innovation	• Single new product • Unchanging new product • Characteristics: - relative advantage - compatibility - complexity - trialability - observability - perceived risk	◆ New product families ◆ Generational improvements ◆ Characteristics - perceived performance - perceived newness - performance expectations - performance uncertainty - risk of obsolescence - ease of use
4. Marketer Actions	• Influence of Promotion • Neglects the role of product	◆ Timing of improvements ◆ Preannouncing strategy
5. Competitive Actions	• High product competition increases diffusion rate • High technology competition decreases diffusion rate	◆ Emergence of a dominant design increases the diffusion rate
6. Potential adopters	• Ranked adopter categories • Role of personal influence	◆ Heterogeneity of postponement

2.4.2 Dynamic Product View of the Adoption Process

The primary impact of an evolutionary product on the adoption process is the creation of additional adoption timing alternatives. The static product view, which considered the adoption decision at a single point in time, virtually necessitated a binary decision of adopt or reject. The hierarchy of effects model considered the lag between new product introduction and individual adoption as simply the result of delays in the spread of information. Once consumers became aware, the hierarchy of effects model led to a decision to either adopt or reject. With the dynamic product view, an additional stage can be added to the hierarchy of effects model -- a timing stage. The timing stage introduces postponement alternatives that are the outgrowth of expectations about the trends within the new product family. In fact, the dynamic product view considers that potential adopters will continue to be presented with adoption decisions each time the new product changes. Therefore, rejection becomes a less definitive alternative. Some individuals may be able to state categorically that they will never adopt the innovation regardless of how much change or improvement it undergoes. For most potential adopters however, a decision not to adopt the current version of the new product does not preclude the possibility of adoption at a later time as the product changes to better meet their needs. For this reason, absolute rejection is not considered under the dynamic product view. Although some individuals may still adopt immediately, those who do not are assumed to be engaging in postponement rather than absolute rejection. Absolute rejection may then be viewed as an infinite number of postponements. The most that can be said is that at any point in time, consumers postpone. It cannot be said with certainty

that they will never adopt. Viewed from an evolutionary perspective, continued improvements in the product, along with new uses and learning on the part of consumers, will continue to present consumers with opportunities to adopt. The important point is that under the dynamic product view, the concept of postponement explicitly introduces into the adoption process a timing decision concerning “when” to adopt.

2.4.3 Dynamic Product View of the Innovation

The dynamic product view introduces the aspects of expectations and uncertainty into the characteristics of the product that impact the rate of diffusion. The situation may arise during diffusion, particularly with products containing a high technology component, where consumers reasonably expect an increase in performance after the new product has been introduced. Under these circumstances, it is logical to assume that widespread diffusion may be slowed due to the postponement option of waiting for future improvements prior to adoption. As soon as the evolutionary nature of new products is accepted, expectations of future improvements bring other factors to the fore. Potential adopters must now consider the risk of obsolescence resulting from adoption of the current generation in the face of technological improvement. Thus the paradoxical result may be that rapid rates of improvement slow diffusion while slow and relatively stable rates of improvement increase the rate of diffusion (Rosenberg 1976).

Uncertainty may be characterized in two ways in the dynamic product view. First there is the uncertainty which attends any adoption decision. This uncertainty relates to the unknown performance of the product prior to actual usage. Lack of information or an inability to perceive the outcome potential of new products contributes to uncertainty. This type of uncertainty relates to the possible unproved performance of the current product. Many consumers expect that early versions of an innovation may not yet have the bugs worked out. When a consumer also adopts a future orientation, another type of uncertainty enters the picture. This is the uncertainty over expected future improvements in the performance of the product, or uncertainty over which product will emerge as the industry standard. Whereas current generation uncertainty may delay current adoption, future generation uncertainty may accelerate current adoption. Potential adopters who are unsure of the extent and timing of future improvements will be more likely to adopt now.

2.4.4 Dynamic Product View of Marketer Actions

Whereas the static product view considered marketer actions that facilitated communication of new product information, the dynamic product view includes marketer actions that signal product improvements. These preannouncements will create expectations on the part of potential adopters about the promise of coming generations of the innovation. Next generation expectations and uncertainties will impact the rate of adoption and diffusion of the current generation. In addition to considerations about the timing of preannouncements, marketers will have to be concerned with the level of

expectations they create. Will the announcements create unrealistic expectations? What will be the consequences of disconfirmation -- both positive and negative?

In addition to preannouncing behavior, marketing models of diffusion under the dynamic product view will need to consider the design of product improvements. The degree of improvement can impact the rate of diffusion through the creation of expectations and uncertainties. The dynamic product view implies that there will be an optimal rate of improvement that supports continuous favorable perceptions of the product, thereby facilitating the rate of adoption, without creating heightened levels of uncertainty due to concerns about the rate of technical progress being too rapid.

2.4.5 Dynamic Product View of Competitive Actions

Under the static product view, competitive activity was concerned primarily with the number of competing products and technologies. However, evolutionary improvement means that one of the competing technologies may very well achieve the status of dominant design. This has implications for the rate of diffusion. Once a dominant design emerges, the rate of diffusion should be enhanced since there are no longer competing technologies prevailing in the marketplace. The risk of adopting a new product that eventually turns out to embrace the wrong standard is reduced. Consumer receptivity to an innovation will not reach its peak until a dominant design emerges. Other benefits of standardization, such as experience curve effects and price reductions, should also accelerate adoption and diffusion. On the other hand, the emergence of a

dominant design can reduce the competitive effort put into research and development directed at product improvement. This is due to the fact that the benefits of standardization are typically achieved at the cost of reducing product improvements to those of an incremental nature. As with the static view, increased competitive intensity should also lead to more rapid rates of diffusion under the dynamic product view.

2.4.6 Dynamic Product View of Potential Adopters

Much of the research in the adoption and diffusion literature is concerned with profiling the various adopter categories described by Rogers (1962, 1983), with particular attention paid to innovators and early adopters. In many cases, attempts are made to attach demographic and other characteristics to the consumer *post hoc* based on their observed time of adoption and without regard to the actual mechanisms by which they influence the adoption process. Personal characteristics of adopters that have been studied include willingness to change, attitude toward risk, desire for social differentiation or conversely for conformity, independence of decision (Midgley and Dowling 1978), acquisitiveness or materialism, domain knowledge or expertise, a state or action orientation (Kuhl 1982), susceptibility to interpersonal influence (Bearden, Netemeyer and Teel 1989), and a propensity to use information from the mass media.

Although it is beyond the context of the present research to examine individual adopter characteristics, it can be said that the dynamic product view will offer a richer explanation for why certain categories of adopters take longer to adopt. Whereas the

static product view considered that it must be psychological differences such as resistance to innovation (Sheth 1981; Ram 1987) among potential adopters, the dynamic product view now offers alternative explanations based on postponement due to product evolutionary changes.

Chapter 3

MODEL DEVELOPMENT AND HYPOTHESES

3.1 Adoption Timing Decision Model

In the context of diffusion, which is defined as the pattern of first purchase of a new product, the adoption process consists of a series of stages. The initial stage typically represents the point at which the potential adopter first learns about the innovation. This stage is often termed the awareness, or knowledge, stage. Some models consider the potential adopters state of mind prior to learning about the product. One example of a pre-awareness stage might be problem recognition. Although most adoption models end with the adoption stage, recent attention has been devoted to understanding post-adoption phenomena such as satisfaction and even disposal. In the context of the present research, only the stages from awareness to first purchase are considered. This is because diffusion of durable products is generally considered to be the pattern of first purchase of an innovation. Adoption models incorporating stages of the adoption process are typically referred to as hierarchy of effects models, since they assume that the process proceeds according to a prescribed sequence, or hierarchy, of events. One such hierarchy of effects model cited widely in diffusion research is Rogers' (1983) innovation-decision process.

Rogers' process consists of five stages beginning with the knowledge stage and proceeding through persuasion, decision, implementation, and confirmation. A diagram of this innovation-decision process is shown in figure 3.

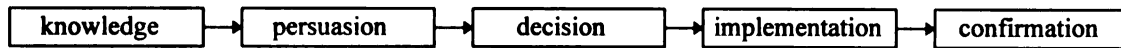


Figure 3
Innovation-Decision Process

The order of the stages is characteristic of the extensive problem solving considered to be more typical of the decision to adopt durable or high involvement products. For limited problem solving situations, such as for repeat purchase or low involvement products, it may be the case that a decision to purchase the product on a trial basis may precede the persuasion stage. This research only considers the extensive problem solving order of stages considered to be more applicable to new product adoption decisions. In the context of this research, the focus is on the stages in which the characteristics of the innovation impact the rate of new product acceptance. This is in contrast to the communication model of diffusion where the emphasis is on the spread of information about the innovation that leads to awareness. The unstated implication is that potential adopters purchase the new product immediately upon becoming aware of it. The difference in patterns of diffusion under the communication scenario is due to the time lag in the spread of information. In the context of the present research, the focus shifts from the time elapsed prior to awareness to the time elapsed between awareness

and first purchase. As a consequence, post-purchase stages, such as implementation and confirmation, are not considered in the current research. Writing from the perspective of the static view, Rogers states that the characteristics of the innovation, such as compatibility and relative advantage, mainly influence the persuasion stage. When the dynamic view is considered in the context of the present research, the persuasion and decision stages of the model need to be revised to include the timing alternatives confronting the potential adopter. The decision is no longer adopt or reject. Now the potential adopter faces choices about which generation of the evolving new product to adopt. The range of decision now becomes a continuous range between adoption and rejection. This introduces various postponement alternatives for the consumer. To reflect the timing alternatives inherent in the dynamic view, a new model is proposed called the Adoption Timing Decision Model (ATDM). A tree diagram of the sequential nature of the model and the resulting outcomes is shown in Figure 4.

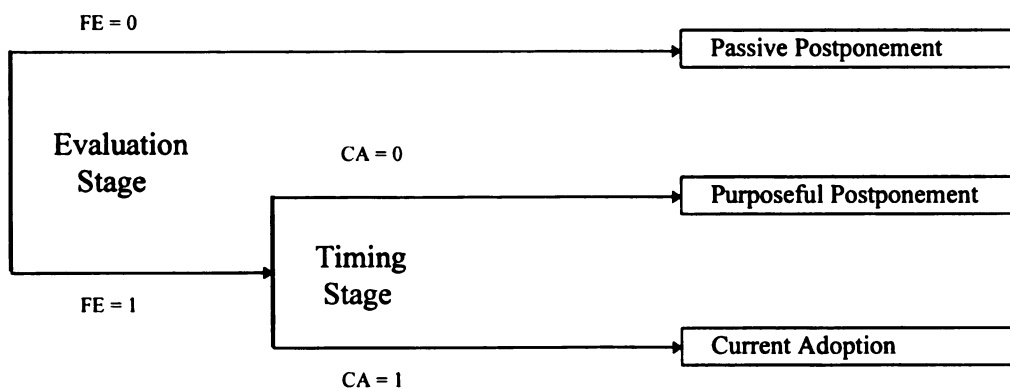


Figure 4
Decision Tree for Adoption Timing Decision Model

There are two stages in the Adoption Timing Decision Model, evaluation and timing. These stages produce three possible outcomes as a result of each adoption opportunity faced by the potential adopter. In the evaluation stage, attitude formation toward the new product takes place. The term FE refers to favorable evaluation. The circumstance where $FE = 1$ indicates that the potential adopter has formed a favorable attitude toward the new product. When $FE = 0$, the potential adopter fails to form a favorable attitude. Attitude formation must consider the dual nature of a product. In addition to satisfying functional needs, products may also be purchased for their symbolic value (Hirschman 1981; Solomon 1983). Therefore, potential adopters form attitudes based on the perceived performance of the product as well as its ability to satisfy socially derived desires (Miniard and Cohen 1983; Fisher and Price 1992). Consumers unable to form favorable attitudes about the innovation will perceive the new product as not relevant for further consideration. In this circumstance, consumers engage in passive postponement. Note that the term passive postponement is not synonymous with rejection since product evolution may result in a favorable attitude at a later time. Under the dynamic view, the adoption decision is not a one-time decision of adopt or reject. As the new product evolves, consumers will continue to be presented with opportunities to adopt improved versions of the product, versions which may have improved sufficiently to be relevant to their needs. Therefore, taking a dynamic view rather than a static view means that it is generally not possible to say that a consumer makes an irrevocable decision to reject the innovation. The term passive postponement simply implies that the new product is not relevant at a particular time in its current form. Those who do form a favorable

evaluation toward the product move to the next stage in the ATDM. In this regard, the model is sequential in nature and the sequence is determined by the assumed extensive problem solving nature of the hierarchy of effects model for the adoption of new products. Given a favorable evaluation, the potential adopter enters the timing stage.

In the representation of the model, the term CA refers to current adoption. In the case where $CA = 1$, the potential adopter decides to adopt the current version of the innovation. Conversely, when $CA = 0$ the potential adopter decides to wait for a future generation of the new product in spite of the fact that the potential adopter has a favorable attitude toward the innovation. The decision in the timing stage represents a tradeoff between the urgency to adopt now and the advantages of waiting for an anticipated next generation improvement. It has been noted in studies of behavior that there is a gap between behavioral intention and actual behavior. This gap may be a time lag or a failure to perform the intended behavior altogether. As with the previous stage, ultimate failure to perform generally cannot be concluded; therefore it is referred to as postponement. At this point in the hierarchy, the postponement is termed purposeful postponement, since it represents an intentional act on the part of the potential adopter to delay a behavior that appears likely. This decision to wait for a future generation product in anticipation of increased benefits has also been referred to as “leapfrogging” (Weiss and John 1989). The alternative outcome to purposeful postponement is current adoption. The urgency of need outweighs the possible advantages of waiting for future improvements in the innovation and the potential adopter adopts immediately.

In addition to the influence on adoption of the perceived benefits of a new product, research has shown that uncertainty about the new product also influences evaluation. The same may also be true of the timing of adoption. Just as an inability to overcome resource constraints forces postponement, in the same way an inability to overcome risk perceptions forces postponement. Improvements in the product over time may reduce perceived risk to the point where adoption is enabled.

The stages of the ATDM are inherently sequential in nature. Potential adopters must form a favorable evaluation prior to deciding on purchase timing. The binary dependent variables in the test of the ATDM are the discrete outcomes at each stage set equal to one. These are referred to hereinafter as favorable evaluation and current adoption.

3.2 Constructs and Hypotheses

In his innovation-decision process model, Rogers (1983) proposes that the innovation characteristics of relative advantage, compatibility, complexity, trialability, and observability have their primary impact on the persuasion stage. This is based on the static product view of market acceptance. In this research, new constructs are proposed as a result of the evolutionary nature of products under the dynamic product view. Three basic categories of constructs are proposed consisting of benefits, uncertainties, and expectations. Figure 5 offers a comparison of the influence these constructs with the influence of Rogers' constructs on the stages of adoption.

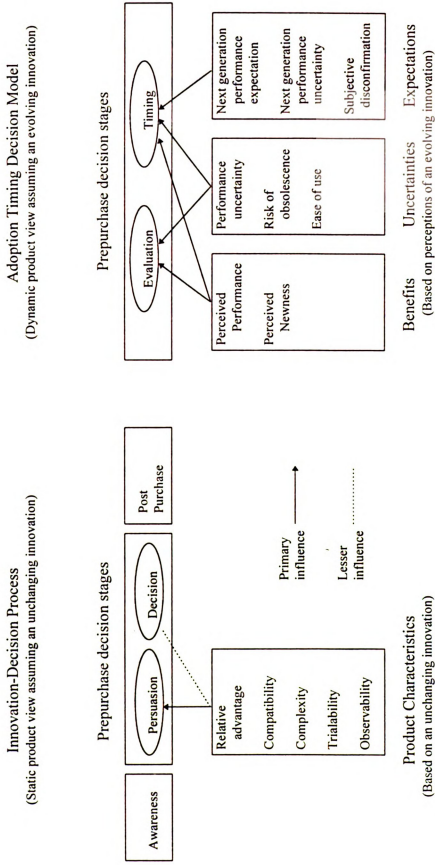


Figure 5
New Constructs as a Result of New Product Evolution

In addition to the benefit constructs that have a positive influence on the stages, anticipation of future generations can create uncertainty constructs and expectation constructs. How will these new product characteristics impact the stages of the Adoption Timing Decision Model under the dynamic product view? The hypotheses put forth in the remainder of this section are exploratory in nature and based on the dynamic product view along with findings from the literature concerning conceptual problems with the traditional innovation characteristics discussed by Rogers. In the following discussion, the constructs used in this study are defined and hypotheses are presented. A diagram of the direct effect hypotheses is shown in Figure 6.

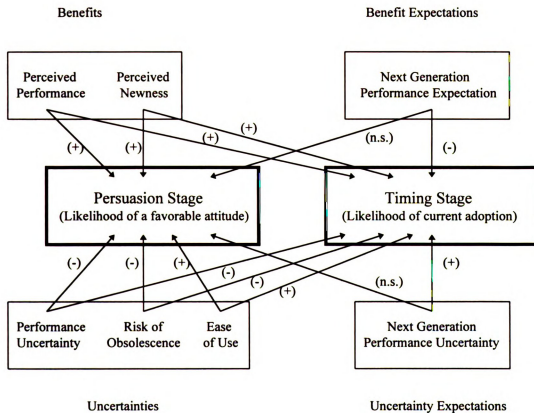


Figure 6
Diagram of hypothesized Direct Effects

3.2.1 Benefit Constructs

Perceived Performance. Rogers suggested, and many studies have supported, a positive relationship between relative advantage and rate of adoption. Relative advantage has been defined as “the degree to which an innovation is perceived as being better than the idea it supersedes” (Rogers 1983, p. 213). However, in a meta-analysis of seventy-five articles concerned with innovation characteristics and their relationship to adoption, Tornatzky and Klein (1982, p. 34) criticize the definition of relative advantage as “perhaps too broad and amorphous to be of much use.” They suggest that in place of the term relative advantage researchers should use the specific product dimensions thought to be superior. For example, if a product is felt to have superior speed, then perceptions of speed should be measured rather than the more general term, relative advantage. In addition, due to the dual nature of most products, i.e. they may be considered to possess both functional and symbolic value, it is desirable to decompose relative advantage into these components.

Perceived performance is defined as the functional capability of the product along specific product dimensions. Perceptions along these performance dimensions are formed after product trial. (This is in contrast to another construct used in this study, next generation performance expectations, which is measured along the same performance dimensions but prior to product trial.) According to the theory of reasoned action, beliefs about product attributes help determine attitude toward the product (Fishbein and Ajzen 1975). Although the theory of reasoned action specifies that attitude mediates the link

between beliefs and intention, other studies have found a direct link between beliefs and intention (Bagozzi 1982; Davis, Bagozzi and Warshaw 1989). Consistent with studies that have found a positive relationship between relative advantage and adoption (Holak 1988; Holak and Lehmann 1990), perceived performance is hypothesized to be positively related to product evaluation.

H_{1a} : In the evaluation stage, perceived performance has a positive influence on the likelihood of a favorable evaluation.

H_{1b} : For respondents with a favorable evaluation, perceived performance has a positive influence on the likelihood of current adoption in the timing stage.

Perceived Newness. To some extent, any innovation is new by definition. In fact, one definition of an innovation is an idea, practice, or material artifact perceived to be new by the relevant unit of adoption (Zaltman, Duncan and Holbeck 1973). In the context of the dual nature of products, and borrowing from the vernacular, newness is the “gee-whiz” component of a new product. It is the symbolic aspect of an innovation that carries with it the social approval of others and confers the status of opinion leader on innovators and early adopters. Whereas the terms radical and incremental have been used to describe the degree of embedded knowledge within an innovation (Dewar and Dutton 1986), newness in the context of this study refers to the level of sophistication perceived by potential adopters, as well as by referent others. Some studies have lumped newness in with compatibility. As one measure of compatibility, Fliegel and Kivlin (1966) asked subjects

to rate the innovation on how different it was from other ways of doing the job. For the purpose of this research, the degree of difference from existing items is considered one measure of perceived newness. In the dynamic product view, perceived newness will decline over time (Dewar and Dutton 1986). Since there is a window within which products confer symbolic value on adopters due to their newness, newness is hypothesized to positively impact the urgency to adopt now. This will be true to a greater extent for individuals high on domain specific innovativeness.

H_{2a} : In the evaluation stage, perceived newness has a positive influence on the likelihood of a favorable evaluation.

H_{2b} : For respondents with a favorable evaluation, perceived newness has a positive influence on the likelihood of current adoption in the timing stage.

3.2.2 Uncertainty Constructs

Performance Uncertainty. One of the factors influencing marketplace acceptance is perceived risk (Bauer 1960; Sheth 1981). Marketing researchers have found direct negative effects of perceived risk on purchase intention (Ostlund 1973; Holak and Lehmann 1990). Perceived risk can pertain to either side of the dual nature of products. Products may be perceived as having risk associated with product performance or social approval (Ostlund 1973). Marketer communications may be effective at mitigating social risk, but functional risk is best attacked by modification of the product (Ram 1989).

Another aspect of the interaction between the innovation and the potential adopter is a lack of clarity regarding the rewards from adoption and the consequences of possible failure. This dimension of perceived risk will be captured by performance uncertainty and next generation performance uncertainty. The performance uncertainty construct represents uncertainty about potential rewards and consequences of failure of the new product currently available for adoption. It attempts to capture uncertainty about whether the technology has been proven or whether the bugs have been worked out. It addresses whether the claims made by the marketer believable and relevant (Ostlund 1973). Uncertainty concerning the rewards or performance of the innovation, coupled with the expectation that improvement will take place over time, implies that marketplace acceptance of current generations could be slowed until potential adopter uncertainty is reduced.

H_{3a} : In the evaluation stage, performance uncertainty has a negative influence on the likelihood of favorable evaluation.

Individuals faced with uncertainty, which is often characterized as a lack of information, may postpone adoption until additional information can be gathered to reduce uncertainty. This information may come from the experience of earlier adopters as it is relayed to potential adopters through word-of-mouth. Potential adopters may have the increasingly frequent opportunities to observe the product in use as diffusion proceeds and market acceptance increases. In spite of the fact that they form a favorable attitude about a new product, individuals may also feel that early versions of an innovation are not

as technically advanced and that later versions will provide higher quality. It is therefore hypothesized that uncertainty about performance will not only reduce the likelihood of a favorable evaluation, it will also increase the likelihood of purposeful postponement.

H_{3b} : For respondents with a favorable evaluation, performance uncertainty has a negative influence on the likelihood of current adoption in the timing stage.

Risk of Obsolescence. Perceived risk can also mean the risk of financial loss. In the dynamic view, this possibility will be captured by perceived risk of obsolescence. Obsolescence may be defined in economic terms as the relative loss in value due to quality improvements in subsequent versions of the product (Levinthal and Purohit 1989). Expectations of obsolescence may cause potential adopters to postpone their purchase of the current generation (Rosenberg 1976). Obsolescence is not based on any decrease in perceived performance of the current version of the product due to such conditions as wear and tear or old age. It is based, instead, on the expectation that the current model of the new product soon be superseded by a superior version in the next generation of the new product (Levinthal and Purohit 1989).

H_{4a} : In the evaluation stage, risk of obsolescence has a negative influence on the likelihood of favorable evaluation.

H_{4b} : For respondents with a favorable evaluation, risk of obsolescence has a negative influence on the likelihood of current adoption in the timing stage.

Ease of Use. Examining the causal relationships between Rogers' five innovation characteristics and purchase intent, Holak and Lehmann (1990) found that perceived risk mediated the influence of complexity. In order to test the dynamic product view, the concept of perceived risk due to complexity is considered to be too general. This study will look at one risk dimension of complexity which is ease of use. Another dimension of complexity, technological sophistication or newness has been found to have a positive influence on purchase intent (Holak and Lehmann 1990). This dimension of complexity has been captured in this study by the perceived newness construct.

Ease of use may be defined as the degree to which a consumer believes that using or learning to use a new product is relatively uncomplicated and free of effort (Davis, Bagozzi and Warshaw 1989; Segars and Grover 1993). The easier a product is to use, the greater the sense that the desired outcome is achievable and under the control of the consumer (Bandura 1982). Ease of use has been found to have a significant effect on attitudes (Davis, Bagozzi and Warshaw 1989). Ease of use is likely to be positively influenced over time by learning and increased familiarity with the product. Therefore, products with low ease of use are likely to inhibit current adoption in the same way that complexity inhibits adoption (Rogers 1983, Holak and Lehmann 1990).

H_{5a} : In the evaluation stage, ease of use has a positive influence on the likelihood of a favorable evaluation.

H_{5b} : For respondents with a favorable evaluation, ease of use has a positive influence on the likelihood of current adoption in the timing stage.

3.2.3 Expectation Constructs

Next Generation Performance Expectation. When the dynamic product view is applied to marketplace acceptance, one of the major factors to emerge is expectations (Rosenberg 1976; Doyle and Saunders 1985). Expectations may be defined as the subjective evaluation of the value of a product attribute at a future point in time (Winer 1985; Oliver and Winer 1987). Customers form expectations based on direct experience with the product, historical patterns of similar products, and inferences drawn from external information (Howard and Sheth 1969; Holak, Lehmann and Sultan 1987; Bridges, Yim and Briesch 1995). Various theoretical foundations exist for the formation of expectations. Adaptation-level theory (Helson 1959) posits that background experience undergoes a weighted adjustment due to recent perceptions. Rational expectations theory (Muth 1961) asserts that expectations are formed in a manner that essentially conforms to economic theory. Customers implicitly consider which current economic conditions will be operative in the future with regard to the product of interest. Prospect theory (Tversky and Kahneman 1974) holds that expectations are formed on the basis of heuristics that include the use of knowledge of similar events, availability of information, and an anchor and adjust process where previous judgments are updated by new information. This anticipation of future events can influence current behavior.

Once the dynamic product view is accepted, the timing of adoption is necessarily influenced by anticipated future product improvements (Rosenberg 1976; Balcer and Lippman 1984; Weiss and John 1989). This construct differs from perceived performance in regard to the product generation to which it applies. For example, using product generation two as a reference point, perceived performance represents the subject's perception of generation two's performance. After trial of product generation two, the next generation performance expectation construct represents the subject's perception of generation three's performance prior to generation three trial. When consumers expect next generation performance to be considerably improved over the current generation, the leapfrogging effect implies that the timing of adoption will be delayed (Weiss and John 1989). Anticipated performance in the next generation is not considered to have an appreciable effect on the evaluation of the current version of the innovation.

H_{6a} : In the evaluation stage, next generation performance expectation has a non-significant influence on the likelihood of a favorable evaluation.

H_{6b} : For respondents with a favorable evaluation, next generation performance expectation has a negative influence on the likelihood of current adoption in the timing stage.

Next Generation Performance Uncertainty. This represents uncertainty formed about the next generation product during the time the current generation new product is on the

market. The next generation new product may be on the market but it has not yet been tried by the potential adopter. In this sense it is the same construct as performance uncertainty, however it refers to the next generation innovation. Potential adopters faced with an adoption decision about a current generation new product are likely to postpone adoption if the anticipated future advantages of waiting for the next generation's improvements outweigh the benefits of having the item at one's immediate disposal. This expectation construct is not considered to have an influence on the evaluation of the currently available product.

H_{7a} : In the evaluation stage, next generation performance uncertainty has a non-significant influence on the likelihood of a favorable evaluation.

H_{7b} : For respondents with a favorable evaluation, next generation performance uncertainty has a positive influence on the likelihood of current adoption in the timing stage.

A summary of the hypothesized main effects of each of the independent variables on the stages of the Adoption Timing Decision Model are shown in Table 3. The columns represent each of the stages of the ATDM. In each stage, direction of the hypothesized influence is determined by the outcome that equals one, i.e. favorable evaluation or current adoption. Those cases where statistically significant coefficients are hypothesized are shown in the tables by a coefficient not equal to zero. Coefficients hypothesized to be non-significant and indicated by "n.s.".

Table 3
Hypothesized Main Effects

Independent Variables	Evaluation Stage	Timing Stage
Perceived Newness	$\beta > 0$	$\beta > 0$
Perceived Performance	$\beta > 0$	$\beta > 0$
Performance Uncertainty	$\beta < 0$	$\beta < 0$
Risk of Obsolescence	$\beta < 0$	$\beta < 0$
Ease of Use	$\beta > 0$	$\beta > 0$
Next Generation Performance Expectation	n.s.	$\beta < 0$
Next Generation Performance Uncertainty	n.s.	$\beta > 0$

3.2.4 Interaction Effects

Innovativeness. Innovativeness is an adopter characteristic rather than a product characteristic but it is included as a potential confound on the hypothesized effects of the new product characteristics on the stages of the Adoption Timing Decision Model. There is a large volume of research on how to discriminate between innovators and imitators. A complete discussion of this body of literature is beyond the scope of the present research. However, innovativeness has been found to have a positive relationship with rate of adoption. While there is not complete consensus on what constitutes innovativeness, evidence has been found that innovativeness within a particular individual may vary according to the product category (Gatignon and Robertson 1985). Therefore, the innovativeness construct considered in this study is termed domain specific innovativeness and is measured by a six item scale developed by Goldsmith and Hofacker (1991).

H_{8a}: In the evaluation stage, perceived newness has a positive influence on the likelihood of a favorable evaluation when innovativeness is high and has a less positive (or even negative) influence on the likelihood of a favorable evaluation when innovativeness is low.

H_{8b}: For respondents with a favorable evaluation, perceived newness has a positive influence on the likelihood of current adoption in the timing stage when innovativeness is high and has a lesser (or even negative) influence on the likelihood of current adoption in the timing stage when innovativeness is low.

While higher levels of perceived performance are expected to have a positive influence on both stages of the Adoption Timing Decision Model, its influence on the timing stage is hypothesized to be moderated by expectations of increases in next generation performance (Weiss and John 1989). Higher levels of perceived performance of the next generation should weaken the influence of the current generation's positive performance on the timing stage.

H₉: For respondents with a favorable evaluation, the positive influence of perceived performance on the likelihood of current adoption in the timing stage is weakened by increases in next generation performance expectation.

Whereas high levels of next generation performance are hypothesized to reduce the likelihood of current adoption due to purposeful postponement, if uncertainty about this

performance is also high, it should weaken this relationship. Potential adopters may not want to trade-off current benefits for highly uncertain future benefits, even if those potential benefits are expected to be high.

H₁₀ : For respondents with a favorable evaluation, the negative influence of next generation performance expectation on likelihood of current adoption in the timing stage is weakened by increases in next generation performance uncertainty.

3.2.5 The Role of Subjective Disconfirmation

One of the research questions addressed by this study concerned the use of the Adoption Timing Decision Model and the new product characteristics that influence its stages to add explanation or insight into marketing theory. The marketing problem chosen to answer this question concerns the role of subjective disconfirmation in new product diffusion. Disconfirmation has not been widely studied in the context of the new product literature. Its primary application to date has been its role in the satisfaction literature. However, a study done by Bridges, Yim and Briesch (1995) considered the incorporation of expectations in a market share model. While they did not directly measure expectations or disconfirmation, they found evidence that gains in technology beyond that expected by consumers had a non-linear effect on market share. Specifically, lower levels of technology gain increased market share while higher levels of technology gain reduced market share. They speculated about, but did not test, the following

explanation. Technology improvements were positively received by consumers up to a certain threshold beyond which consumers started to feel that technology might be advancing too rapidly. Consumers begin to fear that the technology might not be proven or that it would be quickly outdone by even greater advances. They suggested that a fruitful area of research confirm this effect through an experimental design that directly measured expectations and disconfirmation.

Subjective Disconfirmation. Disconfirmation represents the perceived discrepancy, or gap, between next generation performance expectation and realized perceived performance. Since it is based on perceptions, rather than objective performance, it is termed subjective disconfirmation. Disconfirmation may be either positive or negative. Negative disconfirmation occurs when realized performance falls short of expectations. The impact of negative disconfirmation on slowing the rate of marketplace acceptance is intuitively apparent. Potential adopters are disappointed and the rate of adoption slows. Similarly, perceived performance that is very close to expectations is assimilated by the potential adopter with little adverse effect on the adoption rate. Not so obvious, however, is the impact of positive disconfirmation. Initially, it would seem that performance which is higher than expected would have a positive influence on adoption. Within a certain threshold, positively disconfirmed expectations are still assimilated by the consumer (Herr, Sherman and Fazio 1983). However, it has been hypothesized that expectations too far above a certain threshold will have a negative influence due to the contrast effect. Bridges, Yim, and Briesch (1995) found evidence of this effect on market share in a product choice model. Although they did not incorporate these variables in their model,

they theorize that this effect may be due to a contrast effect where high positive disconfirmation produces anxiety about whether the innovation may be unproved or too difficult to use. Therefore, it is hypothesized that the moderating effect of subjective disconfirmation will be non-linear. For a positive relationship between perceived performance and evaluation, neutral to moderate levels of subjective disconfirmation should strengthen the effect. This means that the coefficient of the linear interaction term will have a positive sign. As subjective disconfirmation continues to increase from moderate to high levels, the moderating effect will be to weaken the positive relationship between performance and evaluation. This means that the negative effect of the quadratic interaction term will exceed the positive effect of the linear interaction term. The sign of the coefficient for the quadratic interaction will be negative, signifying an inverted U-shape. For all situations in which the relationship is strengthened, the sign of the interaction term coefficient will be the same as the sign of the relationship being moderated. For all situations in which the relationship is weakened, the sign of the interaction term coefficient will be opposite the sign of the relationship being moderated.

H_{11a} : The positive influence of perceived performance on both the likelihood of a favorable evaluation and, given a favorable evaluation, the likelihood of current adoption will at first be strengthened by increases in disconfirmation and then begin to weaken with further increases in subjective disconfirmation.

Hypothesis 11a represents the inverted U-shaped non-linear moderating effect of subjective disconfirmation on influence of perceived performance on the evaluation and

timing stages. The following hypotheses attempt to explore a possible explanation for this effect using some of the other independent variables in the model. If the effect is due to increases in uncertainty about product performance, a linear strengthening of the relationship between performance uncertainty and the stages of the model should be observed. The same would be true if the influence of risk of obsolescence increases along with subjective disconfirmation. To help explain the effect, the positive influence of ease of use should be weakened in a linear fashion with increases in subjective disconfirmation.

H_{11b} : The negative influence of performance uncertainty on both the likelihood of a favorable evaluation and, given a favorable evaluation, the likelihood of current adoption will at first be weakened by increases in disconfirmation and then begin to strengthen with further increases in subjective disconfirmation.

H_{11c} : The positive influence of ease of use on both the likelihood of a favorable evaluation and, given a favorable evaluation, the likelihood of current adoption will be weakened by increases in subjective disconfirmation.

H_{11d} : The negative influence of risk of obsolescence on both the likelihood of a favorable evaluation and, given a favorable evaluation, the likelihood of current adoption will be strengthened by increases in subjective disconfirmation.

A summary of the hypothesized interaction effects along with the hypotheses involving subjective disconfirmation are shown in Table 4. The columns represent each of the stages of the ATDM.

Table 4
Hypothesized Interaction Effects

Moderating Effects	Persuasion Stage	Timing Stage
Perceived Newness x Innovativeness	$\beta < 0$	$\beta < 0$
Perceived Performance x NG Perf. Expectation	n.s.	$\beta < 0$
NG Perf. Expectation x NG Perf. Uncertainty	n.s.	$\beta > 0$
Perceived Performance x Subj. Disconfirmation	$\beta > 0$	$\beta > 0$
Perceived Performance x (Subj. Disconfirmation) ²	$\beta < 0$	$\beta < 0$
Performance Uncertainty x Subj. Disconfirmation	$\beta < 0$	$\beta < 0$
Risk of Obsolescence x Subj. Disconfirmation	$\beta < 0$	$\beta < 0$
Ease of Use x Subj. Disconfirmation	$\beta < 0$	$\beta < 0$

3.3 The Sequential Logit Model

As defined according to the discussion of hierarchy of effects models, the evaluation decision and the timing decision are inherently sequential. The decision about “when” to adopt is made in light of the decision “whether” to adopt. The dependent variable in each decision is discrete and dichotomous, indicating the use of a logit model to assess the impact of the independent variables (Greene 1990). Maximum likelihood estimation logistic regression is particularly appropriate when the dependent variable is dichotomous and the underlying assumptions of multivariate normality cannot be met. The fact that the timing decision is made in light of the evaluation outcome dictates the use of a

sequential logit model (Maddala 1983). In the sequential logit, the impact of the independent variables on the second stage of the model are estimated while holding the decision in the first stage constant. In this way, the estimated coefficients in stage two are not confounded with the estimates in stage one.

The Adoption Timing Decision Model has three possible outcomes:

- Outcome 1: $FE_i = 0$, where FE_i denotes whether the i th individual forms a favorable evaluation of the new product. Under this outcome, $FE_i = 0$, the consumer does not form a favorable evaluation and passive postponement occurs. With passive postponement, the subsequent stage of the adoption timing decision process is not relevant.
- Outcome 2: $FE_i = 1$ and $CA_i = 0$, where CA_i denotes whether the i th individual perceives that the benefits of current adoption outweigh the benefits of waiting for the next generation. Under this outcome, $FE_i = 1$ and $CA_i = 0$, the benefits of waiting exceed the urgency of adopting the current generation and the consumer engages in purposeful postponement.
- Outcome 3: $FA_i = 1$ and $CA_i = 1$. The urgency of adoption exceeds the benefits of waiting for the next generation and under this outcome, current adoption occurs.

Before developing the sequential logit model, consider a single-stage logit model with only two possible outcomes, A and B, where the probability of outcome A has the form:

$$\text{Prob}[A = 1] = L(\beta_0 + \mathbf{X}_i' \beta) \quad (1)$$

and the probability of outcome B has the form:

$$\text{Prob}[A = 0] = 1 - L(\beta_0 + \mathbf{X}_i' \beta) \quad (2)$$

Extending this to the multi-stage sequential logit (Maddala 1983) with three possible outcomes, the probability for each outcome can be stated as:

$$\begin{aligned} \text{Prob}[\text{Outcome 1}] &= \text{Prob}[FE_i = 0] = \\ &1 - L(\beta_{0\text{EVAL}} + \mathbf{X}_{\text{EVAL}i}' \beta_{\text{EVAL}}) \end{aligned} \quad (3)$$

$$\begin{aligned} \text{Prob}[\text{Outcome 2}] &= \text{Prob}[FE_i = 1] \text{Prob}[CA_i = 0] = \\ &[L(\beta_{0\text{EVAL}} + \mathbf{X}_{\text{EVAL}i}' \beta_{\text{EVAL}})] [1 - L(\beta_{0\text{TIM}} + \mathbf{X}_{\text{TIM}i}' \beta_{\text{TIM}})] \end{aligned} \quad (4)$$

$$\begin{aligned} \text{Prob}[\text{Outcome 3}] &= \text{Prob}[FE_i = 1] \text{Prob}[CA_i = 1] = \\ &[L(\beta_{0\text{EVAL}} + \mathbf{X}_{\text{EVAL}i}' \beta_{\text{EVAL}})] [L(\beta_{0\text{TIM}} + \mathbf{X}_{\text{TIM}i}' \beta_{\text{TIM}})] \end{aligned} \quad (5)$$

where $\mathbf{X}_{\text{EVAL}i}$ and $\mathbf{X}_{\text{TIM}i}$ are vectors of independent variables which are hypothesized to evaluation and timing, respectively; $\beta_{0\text{EVAL}}$ and $\beta_{0\text{TIM}}$ denote the intercept terms in the evaluation and timing outcomes, respectively; and β_{EVAL} and β_{TIM} are vectors denoting the impact of the independent variables $\mathbf{X}_{\text{EVAL}i}$ and $\mathbf{X}_{\text{TIM}i}$ on the evaluation and timing outcomes, respectively.

For the three outcomes above, the log-likelihood for the sequential logit model will have the following form:

$$\begin{aligned} L^* = \sum_i \{ & (1 - \text{FE}_i) \ln[\text{Probability of outcome 1}] \\ & + \text{FE}_i (1 - \text{CA}_i) \ln[\text{Probability of outcome 2}] \\ & + \text{FE}_i \text{CA}_i \ln[\text{Probability of outcome 3}] \} \end{aligned} \quad (6)$$

Substituting outcome likelihoods, equations 2 through 5, into equation 6 above, the sequential decision process log-likelihood function can be expressed as the sum of two terms as follows:

$$\begin{aligned} L^* = \sum_i \{ & \text{FE}_i \ln[L(\beta_{0\text{EVAL}} + \mathbf{X}_{\text{EVAL}i}'\beta_{\text{EVAL}})] \\ & + (1 - \text{FE}_i) \ln[1 - L(\beta_{0\text{EVAL}} + \mathbf{X}_{\text{EVAL}i}'\beta_{\text{EVAL}})] \\ & + \sum_{i|\text{FE}_i=1} \{ \text{CA}_i \ln[L(\beta_{0\text{TIM}} + \mathbf{X}_{\text{TIM}i}'\beta_{\text{TIM}})] \\ & + (1 - \text{CA}_i) \ln[1 - L(\beta_{0\text{TIM}} + \mathbf{X}_{\text{TIM}i}'\beta_{\text{TIM}})] \} \end{aligned} \quad (7)$$

Each of these two summation terms resembles a single-stage log-likelihood function.

The first summation term considers the evaluation of the new product by all respondents

($\sum_i$). The second summation term considers the purchase timing of those respondents

who have a favorable evaluation of the new product ($\sum_{i | FE_i = 1}$).

Chapter 4

RESEARCH METHOD

4.1 Experimental Design

The purpose of this research is to investigate how the new product characteristics derived from the dynamic product view influence the two stages of the Adoption Timing Decision Model. The Adoption Timing Decision Model provides a framework for viewing the timing of adoption from the perspective of the individual adopter. The two stages of the model produce two dichotomous dependent variables called evaluation and timing. More specifically, an evaluation may be either favorable or unfavorable. Given that a favorable evaluation is formed, an individual proceeds to a timing decision. Here the choice is to adopt the current version of the product or postpone adoption until a newer version is introduced. The stages of the model are therefore sequential, with the timing decision made only after a favorable evaluation in stage one. Under the dynamic product view, the innovation is assumed to be changing rather than static. This means that product characteristics that influence each of the decision stages may be different from those previously studied in the literature. A dynamic product is theorized to generate perceptions of newness, improving performance, risk of obsolescence,

performance uncertainty, ease of use, as well as expectations and uncertainties about the next generation. In addition, expectations developed previously may be either confirmed or disconfirmed. It is the objective of this experiment to investigate the influence of these independent variables on the two dependent variables -- the stages of the Adoption Timing Decision Model.

A fundamental prerequisite of this model is that a potential adopter is confronted with a choice between the current generation and the anticipated next generation. It was therefore necessary to create expectations about the technological trajectory of the product category. An attempt was made to simulate this trajectory within an experimental setting. This was done in four steps.

Step 1 - Subjects were shown a written description of product A.

Step 2 - Product A was demonstrated for the subjects.

Step 3 - Subjects were shown a written description of the next generation product B.

Step 4 - The next generation product B was demonstrated for the subjects.

The subjects for this experiment consisted of a convenience sample of university students. The product category was personal electronic entertainment products, specifically portable, personal-use television sets. Product A was a battery-powered portable television utilizing an LCD screen. The use of the LCD screen, similar in technology to those used in hand-held calculators, is a relatively new application to miniature television. Previous hand-held TV's made use of small scale versions of the

conventional television tube. The LCD screen television used was made by Tandy and sold by Radio Shack and similar models include the Watchman by Sony. Although commercially available, LCD versions of miniature televisions had been widely distributed for only a limited time prior to the conduct of the experiment. Product B was a virtual reality style headset version of the portable television. This product also used the LCD screen technology, however in this product the architectural configuration of the technology allowed the projection of the picture onto headset screens. This product is made by a company called Virtual i/o and, at the time of the experiment, was available only from the manufacturer through direct order. It is similar in design-concept to the popular headset versions of stereo players, such as the Sony Walkman. It was anticipated that the majority of subjects would not have purchased either product.

Student subjects were judged to be a logical target segment for either product. In fact, of the 310 usable responses, only 20 subjects, or 6.6%, indicated having ever purchased a battery-operated portable television. On the other hand, 161 out of 301 subjects, or 54%, reported having purchased a “boom-box” stereo; and 226 subjects, or 75%, indicated previous purchase of a walkman-style portable stereo. This suggests that students are familiar with the product category but have had little experience with the actual type of products involved in the experiment. Although the price might have been out of the reach of many students (the Radio Shack television sold for approximately \$200 and the Virtual i/o headset for around \$400), subjects were told that the price of both products was under \$200 and asked to assume that price was within their financial reach. Student subjects were also deemed appropriate due to their general familiarity

with the category of personal entertainment products. A large percentage of students own portable stereos with headsets and both of the products used in the experiment performed similar functions of personalized portable entertainment.

In addition to the appropriateness of the product category for use with student subjects, the products chosen for the experiment offered the advantage of being commercially available. This provided the opportunity for actual product demonstrations rather than relying on a less realistic presentation in the form of concept statements. This was felt to be particularly important for manipulation of disconfirmation. After being shown a new product preannouncement, subjects were able to view the actual product later in the experiment and develop subjective judgments about the extent to which the actual product lived up to or exceeded the claims made in the preannouncement. The fact that performance could be evaluated along the specific dimension of picture quality was an additional advantage to the use of television as a demonstration product. The products could also be demonstrated in a laboratory setting in a manner similar to a demonstration at the point of purchase. This simplified the respondent's task of assessing the performance dimension.

Since the products were relatively sophisticated in their use of technology, they had the advantage of generating varying expectations of performance uncertainty. Since actual products were be demonstrated, disconfirmation was manipulated through expectations rather than attempting to manipulate actual performance. In other words, since all subjects would see the same performance demonstration, performance was not

manipulated. In order to create variance in disconfirmation, it was the expectations of performance that were manipulated.

In addition to the direct influence of the product characteristics on the stages of the Adoption Timing Decision Model, there was a hypothesized moderating effect due to subjective disconfirmation. In order to test this relationship, it was necessary to manipulate the level of subjective disconfirmation between subjects. Therefore, subjects were randomly assigned to one of three groups - two treatment groups designed to experience positive disconfirmation and a control group designed to experience neutral disconfirmation (confirmation) of expectations. A layout of the experiment is shown in Table 5. The manipulation occurred in step three of the experiment. Steps one, two, and four were identical for all subjects. Steps one and two, which involved a description of product A followed by a demonstration of product A, were used to establish a common product experience base for all subjects. From this common product experience, subjects' expectations for the next generation product B were manipulated. This took place in step three of the experiment. In this step, the neutral treatment group was shown a product B description which corresponded as closely as possible to the actual performance of the product. It was anticipated that their expectations would be in line with what they saw during the subsequent product demonstration in step four. Their expectations would thus be confirmed. The moderate disconfirmation treatment group was shown a product B description that moderately understated the performance of the product. It was anticipated that their expectations would be moderately and positively

Table 5
Layout of Experimental Design

	Phase One - Current Generation		Phase Two - Next Generation	
	Step One	Step Two	Step Three	Step Four
Neutral Disconfirmation Treatment Group	PROCEDURE - Product description for product A. MEASURES: Innovativeness Demographics	PROCEDURE - Demonstrate product A. MEASURES: Perceived Performance Perceived Newness Performance Uncertainty Ease of Use Risk of Obsolescence Evaluation Timing	PROCEDURE - Product description for product B. - Description conforms to actual performance MEASURES: Next Generation Performance Expectation Next Generation Performance Uncertainty	PROCEDURE Demonstrate product B. MEASURES: Perceived Performance Perceived Newness Performance Uncertainty Ease of Use Risk of Obsolescence Subjective Disconfirmation Next Generation Performance Expectation Next Generation Performance Uncertainty Evaluation Timing
Moderate Disconfirmation Treatment Group	Same as above	Same as above	PROCEDURE - Description of product B. - Performance moderately understated. - Same measures as above	Same as above
High Disconfirmation Treatment Group	Same as above	Same as above	PROCEDURE - Description of product B. - Performance substantially understated. - Same measures as above	Same as above

disconfirmed. The high disconfirmation treatment group was shown a product B description that substantially understated the performance of the product. For this group, it was anticipated that their expectations would be highly positively disconfirmed as a result of seeing the actual product demonstrated in the next step of the experiment.

The test of the hypothesized influences of dynamic product characteristics on the decision stages was be carried out using only the measurement data obtained in step four (along with demographics and innovativeness data from step one). The measurement process in step two was expected to familiarize subjects with the questions to be asked in step four. This data may also be used in future research but is not part of the immediate study. In the next section, each of the steps in the experiment will be explained in greater detail.

4.2 Procedure

STEP ONE

Subjects were welcomed to the study, asked to read a brief description of the study and sign a form consenting to participate in the study. Subjects were told that “we are interested in your personal reactions to technology advances in the field of personal entertainment products”. As an example, they were given a product description for one of these products -- a miniature television with an LCD screen. The description was in the form of a consumer electronics report and stated that miniature televisions have

recently been introduced that use a Liquid Crystal Display or LCD screen rather than the cathode ray tubes used on larger televisions. The description informed subjects about a recent advance in LCD screen technology called ‘active matrix’.” The product described was a hand-held miniature television with a two and one-half inch color LCD screen using active matrix. This product A description, which was the same for all subjects, served as an introduction to the experiment and helped to identify the product category. This product description appears in Appendix C.

Subjects were given a four-part questionnaire, one part for each step in the experiment. After reading the product A description, they were asked to complete only the first part of the questionnaire consisting of 10 items. The first four items were demographic in nature (occupation, gender, age, and product experience) and the other six items were designed to measure product specific innovativeness. It has been shown that innovativeness may be domain specific rather than a general characteristic of individuals applicable to all types of products. In order to control for personal differences in innovativeness as a possible confound, subjects were asked a battery of six innovativeness questions developed by Goldsmith and Hofacker (1991).

STEP TWO

After completing the initial portion of the questionnaire, subjects were shown the actual product A described in the product description. The purpose of this demonstration was to provide all subjects with a common product experience upon which to base future

product performance expectations. The product, a battery-operated portable television, was demonstrated by plugging it into a VCR and all subjects were shown the same neutral programming. The program content contained a travelogue of the United States and was chosen for its lack of emotional appeal to control for program content as a possible confound. The intent was that subjects should not project their impression of the program content onto their impression of the product's performance. Subjects were allowed only a brief time (approximately one minute) to view product A. They were told to individually examine the product as if it were on display in a retail outlet. They were requested not to discuss the product among themselves. After viewing the product, they were asked to complete part two of the questionnaire.

The measures in part two pertained to the following product characteristic constructs: perceived performance, perceived newness, performance uncertainty, risk of obsolescence, and ease of use. Each of these constructs is measured by four items. In addition, the two dependent variables (evaluation and timing) were measured by two dichotomous discrete choice questions. There were also three items for each dependent variable which were not part of the immediate study. Part two of the questionnaire therefore contained twenty-eight items. As mentioned previously, the purpose of step two of the experiment was to familiarize subjects with the product category, the items used to evaluate the product, and provide a common actual product experience as a basis for the rest of the experiment. Research has shown that prior experience combined with current perceptions are sources of information used to form expectations. Since it was likely that prior experience varied from individual to individual, step two was an attempt

to control expectations by providing all subjects the same current product experience using an actual product. An attempt was then made in the next step of the experiment to further manipulate individual subject's expectations about the next generation product. The measures obtained in step two were not analyzed in the present study, but may be included in future research and analysis. A secondary advantage of obtaining these measures for the immediate study was to maintain the appearance of the stated purpose of the study, which was to obtain the subject's reactions to certain new products.

STEP THREE

At the beginning of the experiment, subjects were randomly assigned to one of three groups. Whereas step one was an introduction to the product category and step two was intended to provide a common product experience as a control, step three was intended to manipulate expectations about the next generation product. In step three, a between-subjects treatment was administered. One third of the subjects were shown a product description (in the form of a new product press release) for product B which essentially conforms to the actual performance of product B. This treatment is shown in Appendix D. The purpose of this treatment was to create generally realistic expectations of product B performance. This group can be considered a control group. Since one source of expectations is past experience with the product category or related products, it is not realistic to assume that a control group does not possess any expectations. An alternative was to have a confirmed-expectation group that received "accurate" (as opposed to understated or overstated) product information (Olson and Dover 1979). Another third

of the subjects were shown a similarly formatted product description that moderately understated the performance of product B. This treatment appears in Appendix E. The purpose was to create generally lower performance expectations that would be exceeded when product B was demonstrated. The final third of the subjects were shown a similarly formatted product description that considerably understated the performance of product B. This treatment is shown in Appendix F. Its purpose was to create substantially lower performance expectations and to have these expectations surprisingly exceeded during the product demonstration.

Since it was anticipated that the sample would be pooled for analysis, the general purpose of all treatments was to create variance in the level of subjective disconfirmation of expectations between subjects when they eventually saw the actual demonstration of product B. This was in fact the case when the data was analyzed. The manipulation had the intended effect of creating variance in the disconfirmation variable without undue unintended influence on the other independent variables. The purpose of this manipulation was to test the hypotheses relating to the supposition that high positive disconfirmation may reduce the rate of adoption. The alternative, and more intuitive, hypothesis would be that a much-improved product should increase the rate of adoption. After reading the product descriptions, subjects were asked complete the third part of the questionnaire.

Part three of the questionnaire measures two constructs: next generation performance expectation and next generation performance uncertainty. Each of these constructs is

measured with four items, making a total of eight measurement items for this part of the questionnaire. It should be noted that the manipulation in this step of the experiment was for the purpose of testing a subset of the research hypotheses - the impact of disconfirmation on model relationships. As such, it was an attempt to use the model to lend support to one or the other of two competing explanations of the impact of rapid product improvement on the rate of adoption. Failure of this manipulation to produce significant interactions would not have invalidated the model. It would instead provide support an alternative hypothesis about the effect of subjective disconfirmation. In either case, it would help validate the usefulness of the model for resolving questions arising from the dynamic product view.

STEP FOUR

The final step in the experiment consisted of a demonstration of product B. This represented a within-subjects manipulation of product improvement. Product B was judged to represent an advance in picture quality and it was expected that it would produce increased perceptions of perceived performance over product A. Product B represented an architectural improvement over product A in that it was not simply an incremental improvement in technology. It was a change in the design of the product utilizing the technology. As was the case with the product A demonstration, product B will be demonstrated by plugging it into a VCR and showing all subjects the same neutral programming for a short demonstration time of approximately one minute. Subjects were again asked to view the product individually as they would if it was on

store display and not to discuss the product among each other. The purpose of step four was to validate the model and investigate the hypothesized influence of the dynamic product characteristics on the model's decision stages. Respondents were then asked to complete part four, the final portion of the questionnaire. Subjects were then thanked for their participation and asked not to discuss the experiment with other students for the duration of the experiment. Although a hypothesis guessing question was not included in the questionnaire, approximately fifty subjects were randomly questioned following the experiment about their perception of the purpose of the experiment. Almost all subjects thought the experiment involved their reactions to new products. Many subjects asked specific questions about the products and where they could be purchased. This was an additional indication of their acceptance of the stated purpose of the experiment. None of the subjects questioned were aware of the expectations manipulation or were able to correctly deduce the purpose of the experiment. Hypothesis guessing was therefore judged not to be a biasing factor.

Part four of the questionnaire contained measures of the two benefit constructs (perceived performance and perceived newness), the three uncertainty constructs (performance uncertainty, risk of obsolescence, and ease of use), and the two dependent variables (evaluation and timing). Measurement of these constructs consisted of the same items as those contained in part two of the questionnaire. In addition, subjects were asked about their expectations and uncertainties concerning the next generation product. This next generation product, which may be thought of as a yet to be introduced product C, existed totally in the mind of the subject based on his/her prior

experiences and current experiences with products A and B. The intent of this construct was to capture the real-life circumstance in which potential adopters must make a decision to adopt the latest version of the product or wait for some, as yet undisclosed, next generation product. This next generation product could reasonable be expected, on the basis of past and current experience, to be an improvement over the current version. Uncertainty over the extent of the improvement also exists due to the lack of concrete information about the exact nature of an as yet unannounced next generation. The constructs of next generation performance expectation and next generation performance uncertainty were each measured with four items in the same way they were measured in part three of the questionnaire. Finally, subjective disconfirmation of product performance was measured using eight items. In total, part four of the questionnaire contained forty-four items for use in final data analysis and hypothesis testing.

4.3 Measure Development

Innovativeness. Since innovativeness has been shown to be specific to particular product categories (Gatignon and Robertson 1985), it was measured with a battery of six items suggested by Goldsmith and Hofacker (1991). The product category was inserted into each item. For the purpose of this study, the product category was described as personal electronic entertainment products. The six items are as follows:

- 1) In general, I am among the first (last) in my circle of friends to buy a new _____ when it appears.

- 2) If I heard that a new _____ was available in the store, I would (not) be interested enough to buy it.
- 3) Compared to my friends, I own a few of (a lot of) _____.
- 4) In general, I am the last (first) in my circle of friends to know the brands of the latest _____.
- 5) I will not buy a new _____ if I haven't tried it yet. (I will buy . . .)
- 6) I (do not) like to buy _____ before other people do.

Items 1, 2, and 4 were reverse-coded as negatively worded items in the questionnaire for this study. Whereas the Goldsmith and Hofacker studies used 5-point disagree-agree formats, in order to maintain consistency throughout the questionnaire, all six domain-specific innovativeness items in this study were measured on a seven-point scale anchored by strongly disagree to strongly agree.

Perceived Performance. Perceived performance may be conceptually distinguished from objective performance. In theory, there should be only one level of objective performance, the actual level of product performance, and it should be constant across respondents. Of interest in this study is subjective performance, or perceived performance. This construct should vary across respondents according to their expectations. Whereas traditional studies of diffusion used a construct called “relative advantage”, this has been criticized as too broad. As a replacement for relative advantage, Tornatzky and Klein (1982) suggested using specific dimensions of product performance. In the present research, an attempt was made to pick a product category that has a single major dimension along which the product could be rated. Television

was judged to have picture quality as a single primary dimension of performance. Measures in this study were developed to tap respondent's perceptions of this dimension. Measurement of this construct consisted of four items that asked respondents to rate the product they had just seen on the following characteristics: "picture sharpness", "apparent picture size", "picture color", and a global measure called "overall viewing experience". The scale format was a seven-point scale anchored by poor and excellent. Similar dimensions were used by Spreng and Olshavsky (1993) in an experiment involving cameras.

Perceived Newness. Since previous measures of product newness could not be found in the literature, these measures were developed specifically for this study. The intention was to capture the symbolic value of a product based on the approval of others. Intuitively, newness is a construct whose strength will decrease over time and is therefore an evolutionary construct associated with the dynamic product view. Newness was measured using a seven-point semantic differential format with endpoints consisting of "very new / not new at all", "dull / exciting", "a status symbol / not a status symbol", and "ordinary / unique".

Performance Uncertainty. Uncertainty is prevalent in product categories characterized by a rapid rate of technological change. Performance uncertainty was measured by four items using a seven-point semantic differential scale. The endpoints used were "reliable / unreliable", "unproven / proven", "may have 'bugs' / 'bugs' worked out", and "trustworthy / untrustworthy". These measures were adapted from a

factor analysis of product characteristics done by Holak and Lehmann (1990). One factor which may be antecedent to uncertainty is believability of manufacturer or retailer claims (Ostlund 1973). However, these measures do not attempt to capture this dimension directly, with the possible exception of the “trustworthy / untrustworthy” item.

Risk of Obsolescence. Four items were developed specifically for this study to measure risk of obsolescence. Subjects were asked, on a seven-point scale, how much they disagreed or agreed with the following statements concerning the product they had just seen:

- 1) It is likely that an improved product will soon be on the market.
- 2) This product may be discontinued soon.
- 3) I will not be able to keep this product long enough to get my money’s worth.
- 4) This product will be obsolete soon.

Some studies have used durability or useful life as a proxy for obsolescence. In the context of this study however, obsolescence is not the result of a lack of usefulness or productivity. It is the result of a product being superseded by a superior product (Levinthal and Purohit 1989).

Ease of Use. Traditional diffusion studies have hypothesized that complexity is negatively related to the rate of new product adoption and diffusion. However, Holak and Lehmann (1990) found that complexity may be interpreted by respondents in

different ways. For some high technology products, complexity may be interpreted as signaling a higher level of sophistication, thus rendering the product more desirable. As an element of uncertainty, complexity is conceptualized as one aspect of ease of use. Ease of use was assessed using subjects' perceptions of four items on a seven-point semantic differential format. The items were "simple / complex", "easy to operate / hard to operate", "hard to learn / easy to learn", and "high tech / low tech". These scales were adapted, in part, from scales tested by Segars and Grover (1993). In a confirmatory factor analysis of the dimensions of ease of use versus usefulness, they found "easy to use" and "easy to learn" related to ease of use.

Subjective Disconfirmation. Disconfirmation refers to realized performance that differs from expectations. Adaptation level theory (Helson 1959) provides support for the idea that one perceives stimuli in relation to an adapted standard and this standard serves as a guide for subsequent evaluations. Although disconfirmation may be defined as the gap between expectation and performance, prior research has found the use of difference scores to be problematic. Therefore, disconfirmation was operationalized as a subjective assessment. In a method similar to Spreng, MacKenzie and Olshavsky (1996), disconfirmation was measured using the same descriptors as were used to measure perceived performance. Subjects were asked to rate these characteristics according to how they compare to subject's expectations. This was measured on seven-point scales anchored by "exactly as I expected" and "extremely different from what I expected". Subjects were then asked, for the same four characteristics, whether this difference was good or bad. This weighting was measured on a seven-point (-3 to +3)

scale anchored by “very bad” and “very good”. The difference responses were multiplied by the expectation responses within characteristics and summed across characteristics to obtain a subjective disconfirmation score.

Next Generation Performance Expectation. Expectations reflect respondent’s predictions about the performance of the product. In addition to past experience, expectations can be induced by manufacturer’s or retailer’s announcements, test reports, or other unspecified sources of information (LaTour and Peat 1979). It was important to measure expectations before the consumption experience rather than in retrospect (Oliver 1981). In this study, performance expectations were measured on the same four characteristics as performance (picture sharpness, apparent picture size, picture color, and overall viewing experience). Subjects were asked how the next generation rated on these characteristics. A seven-point scale was used for each characteristic and was anchored by “poor expected performance” and “excellent expected performance”.

Next Generation Performance Uncertainty. This construct assessed the respondent’s expectation or prediction about how the next generation product rated on the performance uncertainty characteristics. These characteristics were described as “reliability”, “proven technology”, “all the ‘bugs’ worked out”, and “trustworthiness”. Subjects were asked how they expected the next generation product would rate on these characteristics using a seven-point scale anchored by “poor expected performance” and “excellent expected performance”.

Evaluation. This is the first stage dependent variable. After viewing a demonstration of each product, respondents were asked a discrete choice question concerning whether “all things considered, your evaluation of this product is generally favorable or generally unfavorable?” They were given the choice of responding “favorable, would probably buy a product like this” or “unfavorable, would probably not buy a product like this”.

Timing. The second stage dependent variable is timing. The measure stated “If you answered ‘favorable’ in the last question, would you be likely to buy the current version of the product or wait for a newer model?” The choice categories were “purchase current model” or “wait for newer model”.

4.4 Sampling Procedure

Subjects were recruited as a convenience sample from both undergraduate and graduate students at a large Midwestern university. The use of student subjects was considered appropriate for the types of products used in the study. It was a product category with which they were familiar and could be considered a target segment. The study investigated the decision processes of individuals who were presented with a new product. It was felt that student subjects go through the same adoption stages as non-students when considering products they might conceivably purchase.

4.4.1 Subject Recruitment

An announcement was made in classes where the instructor agreed to offer students extra credit as an incentive for participation in the study. As an extra incentive, a prize drawing among those who participated was held at the end of the study. First prize was a JVC video cassette recorder with remote control (with an approximate retail value of \$200). Second, third, fourth and fifth place prizes were cash awards of \$100, \$75, \$50, and \$25 respectively. As subjects turned in their completed questionnaires, each was given a separate drawing entry form on which to write their name and phone number. Immediately after the completion of all experimental sessions, a random drawing was held with the first name drawn receiving the first prize and subsequent names drawn receiving the additional prizes in order.

4.4.2 Power Analysis and Sample Size

In order to determine the appropriate sample size, a power analysis was conducted. The method of analysis was a logit model using maximum likelihood estimation. Power analysis is typically conducted for techniques utilizing ordinary least squares estimation, such as multiple regression. However since OLS and maximum likelihood estimation converge as samples get larger, power analysis techniques for OLS regression was used as a surrogate to determine sample size for this logit study. Using the power analysis technique described by Cohen and Cohen (1983), determination of sample size requires the specification of:

- a) the level of significance, α
- b) the desired power for the test, P
- c) the effect size, ES

Cohen and Cohen suggest that a widely accepted convention is a .05 significance level. This significance level was used to estimate the sample size for this study. Another widely used convention suggested by Cohen and Cohen is a power of .80. This is the probability of rejecting the null in the F test in regression. The significance level and the power are used, along with the number of independent variables, k, to derive a table value of the constant, L, to be used in sample size calculation. In this study, nine independent variable main effects were anticipated along with eight hypothesized interaction effects, resulting in k equal to 17. This produced a table value for the constant L equal to 19.7 (Cohen and Cohen 1983, p 527).

The final, and most difficult, value to be determined was effect size. There are three methods for determining effect size (Cohen and Cohen 1983). The first is to use an R^2 approximating that found in similar previous work. This was not feasible for this study since no previous studies could be found which closely approximated the nature of this study. The second alternative was to specify a minimum value for R^2 that would be of theoretical or practical significance; and the final alternative was to use some accepted conventional value. Conventional values for the behavioral and social sciences are

offered by Cohen (1977) as “small” = .01, “medium” = .09, and “large” = .25. Adopting a medium R^2 value of .09 for this study, the effect size was calculated as:

$$\text{Effect Size (ES)} = R^2 / (1 - R^2) = .09 / (1 - .09) = .0989$$

With the calculation of effect size, all the values were specified for the calculation of sample size according to the formula given in Cohen and Cohen (1983):

$$\text{Sample Size (n*)} = (L / \text{ES}) + k + 1 = (19.7 / .0989) + 17 + 1 = 218$$

For the purposes of this study, 218 completed questionnaires was considered the minimum response size. However, to safeguard against the possibility that the three treatment groups could not be pooled and might require separate analysis, a minimum sample size of 300 was used. This was also deemed advisable since further analysis of the data requiring a sample size of around 300 was anticipated. This also offered an additional margin of sample size in case additional interaction variables were added to the analysis. As an example, what if the number of independent variables in the analysis is doubled so that $k = 28$. This results in $L = 23.89$ (Cohen and Cohen 1983, p 527) and:

$$\text{Sample Size (n*)} = (L / \text{ES}) + k + 1 = (23.89 / .0989) + 28 + 1 = 270$$

maintaining the same significance level of .05 and power of .80. Therefore a response size of 300 was considered a desirable and conservative target. In the experiment, 313

questionnaires were received of which 12 were considered unusable due to inappropriate responses or missing values, resulting in a final usable sample of 301.

4.4.3 Subject Assignment

Due to the fact that product demonstrations were involved and only one of each product was purchased for the study, the experiment was conducted in a number of small sessions. Typical sessions consisted of between five and ten subjects. These sessions were scheduled every hour over a five day period (or until the target response size was reached). In fact, the sessions had to be extended for two additional days to reach the target of 300+ respondents. Students were recruited in class and asked to sign up for a single session that was convenient to their schedule. Each session was randomly assigned to one of the three treatment groups (two treatment levels and a control group). In this way, all subjects in any particular session received the identical materials. The treatments were distributed among the sessions to achieve as close to an equal number of subjects in each treatment group as possible. Of the 301 questionnaires used in the final study, 102 received the neutral disconfirmation treatment, 100 received moderate disconfirmation treatment, and 99 received the high disconfirmation treatment.

Chapter 5

RESEARCH RESULTS

5.1 Manipulation Checks

In this experiment, since the performance of the product was not manipulated, variance in disconfirmation was created through manipulation of expectations. This treatment took place in step three of the experiment. Subjects were randomly assigned to one of three treatment groups designed to create low, medium or high expectations. It was anticipated that the low expectation group would have their expectations highly disconfirmed, the medium expectation group would have their expectations moderately disconfirmed, and the high expectation group would have their expectations approximately met. The first check of the success of the manipulations was to ask respondents in step three of the experiment to rate their expectations for the next generation product (what would turn out to be the television eyeglasses) based on the preliminary product announcement just shown to them. Four items were used to measure expectations and these items were summed. The mean for the high expectation group was 21.24; the mean for the medium expectation group was 16.98; and the mean for the low expectation group was 12.84. An ANOVA was performed with performance expectations as the dependent variable and the three levels of expectation manipulation

as the factor. This manipulation check revealed a statistically significant difference between the three treatment groups with an F value of 67.41 ($p < .001$). The magnitude of the three means was in the intended direction indicating that the manipulation was successful in creating different levels of expectation.

The subjective disconfirmation construct, as measured in step four of the experiment, was the primary target of the manipulation of expectations. The subjective disconfirmation construct serves as a measure of each respondent's level of disconfirmation and may also be used as a check of the success of the manipulation. An ANOVA was performed using subjective disconfirmation as the dependent variable and the three levels of expectation manipulation as the factor. The results of these ANOVA manipulation checks are shown in Table 6. The value of the dependent variable is the sum of the four items used to measure subjective disconfirmation. The mean for neutral disconfirmation was 22.82, the mean for moderate positive disconfirmation was 33.21, and the mean for high positive disconfirmation was 45.93. The neutral disconfirmation group is the same group as the high expectation group as intended. Similarly, the moderate disconfirmation group comes from the moderate expectation manipulation, and the high disconfirmation is based on the low expectation manipulation. Based on the ANOVA, the difference between subjective disconfirmation means is statistically significant ($F=19.2$, $p<.001$) and in the proper direction. This demonstrates that the manipulations are related to the latent variable they were designed to alter and is another check of the success of the manipulations (Cook and Campbell 1979; Perdue and Summers 1986).

In addition to testing the convergence of the manipulation and intended measures, it is advisable to test for a divergence of manipulations and measures of related but different constructs.

Table 6
ANOVA Manipulation Checks

<u>Model Variables</u>	<u>Manipulation Cell Means</u>			<u>ANOVA Results</u>	
	<u>Neutral Disconfirmation</u>	<u>Moderate Disconfirmation</u>	<u>High Disconfirmation</u>	<u>F</u>	<u>Signif.</u>
Discon	22.82	33.21	45.93	19.2	.001***
New	23.48	23.89	24.09	1.0	.368
Perf	22.03	22.08	22.02	.1	.994
Uncer	15.89	15.75	15.15	.8	.449
Obsol	14.79	14.71	13.37	3.1	.046**
EOU	17.48	17.19	18.08	1.8	.172
NGPerf	23.69	22.70	24.04	3.2	.043**
NGUnc	11.01	11.74	11.47	.6	.543
Innov	23.66	23.53	22.45	.9	.405
New x Innov	559.12	558.18	544.22	.2	.814
Perf x NGPerf	524.96	507.72	537.91	1.0	.371
NGPerf x NGUnc	250.69	257.59	263.81	.5	.628
Perf x Discon	588.09	780.54	1088.43	13.7	.001***
Perf x (Disc) ²	33923.22	40450.94	67332.56	10.9	.001***
Uncer x Discon	308.81	512.38	651.28	16.8	.001***
Obsol x Discon	287.24	442.78	558.11	13.5	.001***
EOU x Discon	385.88	578.60	837.11	19.9	.001***

*** indicates $p < .01$

** indicates $p < .05$

* indicates $p < .10$

As Table 6 indicates, the manipulations were successful and in the desired direction. Disconfirmation, and the interaction terms in which disconfirmation is included, all had means which were significantly different (at the $p < .01$ level) with trends in the desired direction. Of the eleven remaining variables proposed for use in later model analysis, two variables, risk of obsolescence and next generation performance expectation,

showed evidence of unintended manipulation (at the $p < .05$ level). However, the means of these variables did not exhibit a distinct trend between treatments. Although the manipulations may have induced some additional variation, they did not appear to be systematic. The remaining variables showed very little evidence of unintended impact from experimental manipulation. Based on these results, the manipulation was deemed successful and the subjects were pooled across treatment groups in subsequent analyses.

5.2 Measurement Testing Approach

Thirty-eight items were developed to measure the nine constructs used in this study. With the exception of the innovation construct, these items represented new operationalizations of constructs for which previously tested measures were not available from the literature. Due to the limited amount of prior operationalization of the constructs used in this research, a series of steps was taken to purify the items used to measure each construct and eliminate items that impeded construct reliability and validity consistent with accepted techniques (cf. Bearden, Netemeyer, and Teel 1989). Measurement scale items were first checked for low item-to-total correlations. A principal components factor analysis was performed to further examine the remaining items for simple structure. Items were then subjected to confirmatory factor analysis using LISREL to further assess validity and unidimensionality. Remaining items were checked for internal consistency using Cronbach's alpha and rechecked for simple structure through principal component factor analysis. Following measure purification, remaining items were used for hypothesis testing in a sequential logit model.

5.2.1 Item-to-Total Correlations

To examine the correlation of each item with its intended construct, item-to-total correlations were computed for each of the thirty-eight items used in this study. A list of all thirty eight items and their respective means, standard deviations, and item-to-total correlations is shown in Table 14, Appendix A. As suggested by Nunnally (1978), items that do not have an item-to-total correlation of at least .30 should be eliminated. Four items failed to meet the .30 minimum criterion. One of the risk of obsolescence measures, a disagree/agree item that read “it is likely that an improved product will soon be on the market”, had a corrected item-to-total correlation of .2925 and was eliminated. Two semantic differential measures of the ease of use construct, “complex/simple” and “high tech/low tech”, were eliminated with correlations of .2466 and -.0907, respectively. Also eliminated with an item-to-total correlation of .2333 was a disagree/agree item from the battery of innovativeness measures that read, “I will buy a new electronic entertainment product even if I haven’t tried it yet.”

5.2.2 Principal Components Factor Analysis

To further examine the remaining set of items, a principal components factor analysis specifying a nine factor solution and an “oblimin” rotation was performed using SPSS. An oblique rotation was used because the constructs were expected to be distinct but not orthogonally independent (Churchill 1979). A complete table of the results of this factor analysis is shown in Table 15, Appendix B.

The pattern matrix was first examined for loadings below .50 on the intended factor. The factor corresponding to perceived newness had an item, “dull/exciting”, that loaded on the intended factor at .37 and had cross-loadings as high as .41. This item was eliminated from further analysis. All items in the performance uncertainty construct had loadings above .50, ranging from .58 to .80, with all cross-loadings below .20. These items were retained. Similarly, risk of obsolescence had measure loadings ranging from .62 to .84 with cross-loadings below .15; ease of use had item loadings of .87 and .88 with all cross-loadings below .10; and next generation performance uncertainty items loaded well (from .80 to .86) with cross-loadings below .20. All items in these constructs were retained. The innovativeness measure loadings ranged from .68 to .84 with cross-loadings under .20 and these items were retained.

The major problems preventing achievement of a simple structure came from perceived performance, next generation performance expectation, and subjective disconfirmation. These three constructs all made use of common measurement terminology. To be consistent therefore, an item deleted from one should similarly be deleted from the others. For example, if picture sharpness is used as one measure of perceived performance, it should also be part of the measurement of next generation performance expectation. The worst offenders among these measures occurred in the next generation performance expectation factor where “overall viewing experience” and “apparent picture size” did not load above .50 on any factor and had high cross-loadings. Similarly, “overall viewing experience” did not load above .50 on the perceived

performance factor. To be consistent, these two items were eliminated from all three constructs.

5.2.3 Reliability and Validity

The remaining twenty-six item measurement model was assessed for convergent and discriminant validity using LISREL. A nine construct LISREL confirmatory factor analysis model was specified with each measurement item constrained to load only on its hypothesized construct. The model was estimated using maximum likelihood estimation of the covariance matrix. This confirmatory factor analysis model failed to yield acceptable fit statistics. Fit can be assessed through a non-significant chi-square goodness-of-fit, a high goodness-of-fit index (GFI), and a low root mean square residual (Joreskog and Sorbom 1988). Acceptable fit of the measurement model, along with significant t-values and low standardized residuals, provides evidence of the degree of convergent validity. Poor fit was indicated by a chi-square of 470.18 with 263 degrees of freedom. This statistic was significant at the $p < .01$ level and this would normally be evidence of unacceptable fit. The chi-square statistic in this case however, with a sample size of 301, should not be taken as definitive evidence of poor fit. The goodness-of-fit index was .89, marginally below the .90 generally considered to be the minimum level for acceptable measurement model fit. Additionally, the root mean square residual, an indication of the amount of residual variances and covariances, was .175 and there were 11 standardized residuals below -3 and 6 standardized residuals above +3, the smallest and largest of which were -4.124 and 5.771 respectively. Taken altogether, the fit of the

confirmatory factor analysis model was considered unacceptable. Examination of the modification indices revealed that two items in particular were potentially confounded with constructs other than their hypothesized constructs. The modification indices show the improvement in chi-square obtained if additional parameters are free to be estimated. A major offender was a measure of risk of obsolescence, "I will not be able to keep this product long enough to get my money's worth." Another was "reliability", a measure of next generation performance uncertainty. This item corresponds to a semantic differential measure of uncertainty called "reliability/unreliability." To be consistent, these three measures were eliminated from the measurement model and the model was rerun using LISREL. With these further purifications of the measurement model, the LISREL confirmatory factor analysis achieved an acceptable fit. Again, the chi-square statistic was significant at 308.04 with 194 degrees of freedom. However, the goodness-of-fit index was .916, above the minimum .90, and the root mean square residual was .041. Only one standardized residual was below -3, and two standardized residuals above +3.

Next the reliability (internal consistency) of the scales was assessed using Cronbach's coefficient alpha. One construct, perceived newness, had a coefficient alpha of .5393 that was below the .70 suggested by Nunnally (1978) as acceptable for early stages of research. Based on the results of the reliability computations, perceived newness was reduced to a single item measure. The remaining item with the largest item-to-total correlation was also the item that represented the intent of the perceived newness construct. This item, "ordinary/unique", was retained as the measure of the construct.

The reliability for the remainder of the constructs provided evidence of internal consistency with coefficient alphas ranging from .70 to .90 as shown in Table 7.

Table 7
Construct Reliabilities

<u>Construct</u>	<u>Number of items</u>	<u>Coefficient Alpha</u>
Perceived Newness	2	.54
Perceived Performance	2	.85
Performance Uncertainty	3	.75
Risk of Obsolescence	2	.70
Ease of Use	2	.73
Next Generation Performance Expectation	2	.88
Next Generation Performance Uncertainty	3	.88
Disconfirmation	2	.90
Innovativeness	5	.82

A final LISREL confirmatory factor analysis model was estimated using the remaining eight multi-item constructs to assess convergent validity. The model achieved acceptable fit with a chi-square of 280.40 (161 degrees of freedom, $p < .01$), goodness-of-fit index of .917, root mean square residual of .041, and low standardized residuals. The t-values and standardized solution paths are shown in Table 8. To assign units of measurement to the constructs, one measure for each construct has its path set equal to one. The items with parameters set equal to one are shown with a dashed line in the t value column. Since the path has a fixed value and is not estimated, a t value is not available. The path estimates are all statistically different from zero with high t values. All except four of the t values are above 10.0.

Table 8.
Measurement Model Solution

<u>Items</u>	<u>t-Values</u>	<u>Standardized Solution</u>
INNOV		
...last to buy...	-- *	.789
...not interested	11.235	.695
...I own a lot...	10.980	.678
...last to know...	10.997	.679
...buy before...	9.874	.610
UNCER		
proven	-- *	.806
"bugs" out	10.760	.762
trustworthy	8.762	.567
EOU		
easy to operate	-- *	.739
easy to learn	4.142	.776
PERF		
picture sharpness	-- *	.925
picture color	14.467	.806
OBSOL		
...discontinued...	-- *	.799
...obsolete soon...	6.391	.676
NGPERF		
picture sharpness	-- *	.878
picture color	14.846	.898
NGUNC		
proven	-- *	.752
"bugs" out	15.377	.873
trustworthy	15.781	.911
DISCON		
picture sharpness	-- *	.932
picture color	14.876	.870

* There is no t-value. Parameter fixed equal to 1.0.

LISREL Model Fit: $\chi^2 = 280$, d.f. = 161, $p < .01$
 Goodness of Fit Index (GFI) = .917
 Root Mean Square Residual = .041

One method of examining discriminant validity is through analysis of correlations among constructs. Evidence of discriminant validity is obtained when the correlation between each pair of constructs is less than 1.0 by an amount equal to twice its respective standard error (Bagozzi and Warshaw 1990). The results from the LISREL confirmatory factor analysis are shown in Table 9. The top numbers in the matrix are the correlations between constructs and the lower numbers in parentheses are the standard errors.

Table 9
Construct Correlations

	<u>Perf</u>	<u>Uncer</u>	<u>Obsol</u>	<u>EOU</u>	<u>NGPerf</u>	<u>NGUnc</u>	<u>Discon</u>
Uncer	-.347 (.058)						
Obsol	-.323 (.059)	.202 (.052)					
Eou	.084 (.051)	-.075 (.047)	-.095 (.049)				
NGPerf	.305 (.057)	-.040 (.049)	-.148 (.052)	.167 (.053)			
NGUnc	-.188 (.047)	.224 (.046)	.202 (.047)	-.136 (.045)	-.365 (.053)		
Discon	.526 (.065)	-.219 (.054)	-.252 (.057)	.088 (.051)	.226 (.055)	-.164 (.047)	
Innov	.090 (.050)	-.036 (.046)	-.019 (.047)	.040 (.044)	.105 (.048)	-.049 (.040)	.028 (.049)

For all pairwise correlations between constructs, the correlations are less than 1.0 by an amount substantially greater than twice their respective standard errors. For example, the least discrimination is between perceived performance and subjective disconfirmation.

This might be expected since they use similar underlying measures. In this case, the correlation is $(1.000 - .526)$ or .474 less than 1.000 which is much larger than twice the corresponding standard error of $(2 \times .065)$ or .130. Therefore, strong evidence exists for discriminant validity.

To further assess discriminant validity, the principal components factor analysis was rerun to check for simple structure. The results, shown in Table 10, demonstrate high loadings on the intended factors and low cross loadings on unintended factors. For all factors, loadings range from a low of .66 to a high of .94. There are only five cross loadings above .20 with the largest being .26. This simple structure provides additional evidence of discriminant validity.

5.3 Collinearity

To assess the potential for multicollinearity among the constructs, the factor correlation matrix was examined. Correlations above .50 between independent variables signal the possible presence of multicollinearity. This matrix is presented in Table 11. The largest correlation among factors is .342, so multicollinearity does not appear to be a problem among the primary constructs. However, there were a number of hypotheses that necessitated the inclusion of interaction terms in the model. Because multiplicative terms might be highly correlated with their constituents, multicollinearity could be a potential problem for the estimation of the coefficients (Cohen and Cohen 1983).

Table 10
Factor Analysis Loadings

Final Model Factor Analysis - Pattern Matrix

<u>Items</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>Factors</u> <u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>
INNOV									
...last to buy...	-.09	.84	.01	.06	.03	-.06	-.11	.00	.04
...not interested	.15	.77	-.09	.14	.04	.01	-.07	-.10	.09
...I own a lot...	-.06	.75	.09	-.15	-.11	-.01	.03	.05	-.09
...last to know...	-.06	.76	.01	-.09	.15	-.05	.06	-.11	-.06
...buy before...	.12	.66	-.04	.04	-.11	.18	.12	.26	-.04
NEW									
unique	.03	-.03	-.04	.01	.09	-.10	-.04	.94	.06
UNCER									
proven	-.20	.05	.09	.80	.01	-.06	-.04	.01	-.03
"bugs" out	-.21	-.05	.19	.72	.01	-.00	-.04	.05	-.24
trustworthy	.21	-.04	-.08	.78	-.07	.11	.16	-.05	.14
EOU									
easy to operate	.07	.03	-.02	-.00	.89	.00	-.04	.00	.06
easy to learn	-.02	-.01	-.00	-.01	.87	.04	.08	.06	-.07
PERF									
picture sharpness	.69	-.00	.10	-.15	.00	-.12	-.21	.10	-.19
picture color	.79	.01	.04	-.07	.07	-.09	-.15	.02	-.12
OBSOL									
...discontinued...	-.14	-.01	.14	.03	.07	.85	-.10	-.00	-.02
...obsolete soon...	.05	-.01	-.06	-.03	-.04	.86	.07	-.09	.02
NGPERF									
picture sharpness	.08	.02	-.10	.01	-.00	-.03	.02	-.03	-.89
picture color	.10	.02	-.14	.07	.04	.04	-.02	-.00	-.85
NGUNC									
proven	.11	.07	.74	.13	-.04	-.05	.03	-.07	.17
"bugs" out	-.02	-.04	.93	-.01	-.00	.02	.02	.02	-.01
trustworthy	.05	-.02	.86	-.00	-.01	.12	.05	-.02	.09
DISCON									
picture sharpness	.08	.03	-.05	.00	-.03	.01	-.92	.01	.05
picture color	.04	-.02	-.04	-.03	-.01	.03	-.92	.02	-.03

Mean centering has been shown to reduce such multicollinearity (Yi 1989). Therefore, the data was mean centered by subtracting the mean of each variable from its individual values. This was done prior to estimating the sequential logit model.

Table 11
Factor Analysis Correlation Matrix

	<u>Innov</u>	<u>New</u>	<u>Uncer</u>	<u>EOU</u>	<u>Perf</u>	<u>Obsol</u>	<u>NGPerf</u>	<u>NGUnc</u>	<u>Discon</u>
Innov	1.000								
New	.090	1.000							
Uncer	-.180	-.050	1.000						
EOU	-.203	-.038	.237	1.000					
Perf	-.009	.025	-.149	-.091	1.000				
Obsol	-.131	.008	.149	.188	-.144	1.000			
NGPerf	-.292	.002	.120	.186	-.131	.279	1.000		
NGUnc	.122	.087	-.038	-.063	.069	-.178	-.151	1.000	
Discon	-.097	-.093	.342	.037	-.169	.124	.217	-.205	1.000

5.4 Hypothesis Testing Approach

The hypotheses described in chapter three were tested by estimating a sequential logit model (Maddala 1983). This model was deemed appropriate due to the binary choice nature of the dependent variables. The sequential nature of the decision framework measured by the dependent variables provided the rationale for a sequential logit procedure. Using sequential logit, the influence of the independent variables on each stage of the decision could be assessed unconfounded with their influence on the other stages of the decision. Specifically, the influence of each independent variable on evaluation was estimated for all respondents. Of those who had a favorable evaluation, the influence of each independent variable on the timing of adoption was then estimated while holding evaluation constant.

The first step was to estimate the model. In this step, observations on the discrete variable $EVAl_i$ take the value 1 if the i th individual has a favorable evaluation of the current product and 0 if the i th individual's evaluation is unfavorable. The independent variables which represent hypothesized main effects are:

PERF = Perceived performance

NEW = Perceived newness

UNC = Performance uncertainty

OBS = Risk of obsolescence

EOU = Ease of use

NGPERF = Next generation performance expectation

NGUNC = Next generation performance uncertainty

Maximizing the likelihood function for this portion of the sequential logit model provided estimates for the intercept, β_{0EVAl} , and the independent variable coefficients, β_{EVAl} . Interpretation of the estimates is similar to the standard logit regression. For the evaluation stage, a statistically significant coefficient implies that the independent variable is associated with the likelihood of favorable evaluation. Significance can be assessed through the asymptotic t-test of the null hypothesis that the particular coefficient is equal to zero. The sign of the coefficient indicates the direction of the relationship between the independent variable and evaluation. A positive sign implies

that an increase in the independent variable is associated with an increase in the likelihood of favorable evaluation.

In the second portion of the sequential logit model, estimation was accomplished for only those respondents for whom $EVAL_i = 1$. These were individuals who indicated a favorable evaluation of the product and were then faced with a timing decision of whether to adopt now, $TIM_i = 1$, or postpone adoption until the next generation, $TIM_i = 0$. In the same manner as stage one estimation, estimates for the intercept, β_{0TIM} , and independent variable coefficients, β_{TIM} , were obtained through maximum likelihood estimation techniques. Hypotheses were tested using the sign of the coefficients and the statistical significance based on the asymptotic t-test.

The significance of the overall model was assessed through the use of the likelihood ratio test. Analogous to the F test in multiple regression, the likelihood ratio tests the null hypothesis that all independent variable coefficients are jointly equal to zero. The underlying framework of the likelihood ratio test is the comparison of an unrestricted model with a restricted, or nested, version. The test statistic is then $-2(L_{restricted} - L_{unrestricted})$ and is distributed as χ^2 with $(k_{unrestricted} - k_{restricted})$ degrees of freedom, where k refers to the number of estimated coefficients in each model (Ben-Akiva and Lerman 1985). An additional test of model fit was provided by the goodness-of-fit test where a large significance value indicates that the model does not differ significantly from a “perfect” model.

5.5 Model Estimation

Prior to estimating the coefficients of the model, evidence for the existence of two stages, an evaluation followed by a timing stage, was examined. The dependent variable for the evaluation stage asked respondents to indicate, assuming price was within their reach, whether their attitude toward the product was generally “favorable, would probably buy a product like this,” or “unfavorable, would probably not buy a product like this.” Of the 301 respondents, 213 (70.8%) indicated a favorable attitude and they would probably buy a product like this. Considering this stage in isolation, a 70% favorable attitude would suggest a high rate of new product acceptance. This is the interpretation that might have been placed on this result if the new product were a single product considered in isolation. However, the 213 respondents that indicated a favorable attitude were then asked if they would be likely to buy the current version of the product or wait for a newer model. This measures the timing stage of adoption with the implicit assumption that the product is part of an evolving family of products. Of the 213 respondents with a favorable attitude, 100 indicated they would “purchase current model” and 113 indicated they would “wait for newer model.” In other words, 53.1% of the 213 respondents with a favorable attitude opted to purposefully postpone their purchase. This result supports the inclusion of a timing stage in hierarchical models of the adoption process. In this case, using only the attitude construct as a surrogate or determinant of eventual behavior would have considerably overstated potential adopters’ intention to adopt. Inclusion of a timing stage when potential adopters face the possibility that successive generations of the innovation will be introduced provides a

more accurate indication of the rate of adoption. Based on this result, the sequential logit model is appropriate for examining the two stages of the Adoption Timing Decision Model.

The advantage of the sequential logit model is that it allows estimation of both stages of the model simultaneously. Estimation of the second stage is accomplished while controlling for the effects of the first stage. The model was estimated utilizing the Logistic Regression Procedure in SPSS. The coefficient estimates for both stages, along with their corresponding standard errors, are shown in Table 12.

Stage one estimation considered data from all 301 participants in the survey. One measure of model fit is the likelihood ratio statistic that compares -2LL (-2 times the log likelihood) for the full model with -2LL for a model with the constant only. The difference is chi-square distributed. This tests the null hypothesis that all coefficients in the model, with the exception of the constant, are zero. Additionally, the goodness-of-fit statistic compares the observed probabilities to those predicted by the model. This statistic also has a chi-square distribution. The likelihood ratio statistic for stage one indicated a good fit to the model (chi-square = 105.28, 17 degrees of freedom, $p < .001$) and the goodness-of-fit test was non-significant indicating acceptable fit (chi-square = 294.50, 283 degrees of freedom, $p = .3067$). Additionally, the overall “hit” ratio was 79.73% indicating that stage one of the model correctly classifies almost 80% of the evaluation decisions.

Table 12
Sequential Logit Model Estimation Results

VARIABLES & INTERACTIONS	EVALUATION STAGE		TIMING STAGE	
	<u>Coefficient</u>	<u>Std. Err.</u>	<u>Coefficient</u>	<u>Std. Err.</u>
Perceived Newness	.612 ***	.232	.222	.288
Perceived Performance	.203 ***	.095	.494 ***	.127
Performance Uncertainty	-.117 **	.055	-.054	.059
Risk of Obsolescence	-.239 ***	.067	-.125 *	.073
Ease of Use	.167 **	.079	-.021	.087
Next Generation Perf. Expectation	.087	.095	-.061	.123
Next Generation Perf. Uncertainty	.003	.054	.014	.058
Innovativeness	.105 ***	.028	.079 ***	.028
Subjective Disconfirmation	-.013	.028	-.059	.036
Perceived Newness x Innovativeness	-.019	.040	-.029	.049
Perceived Performance x NG Perf. Expectation	-.008	.031	-.001	.047
NG Perf. Expectation x NG Perf. Uncertainty	-.006	.019	-.001	.023
Perceived Performance x Subj. Disconfirmation	.037 ***	.014	.031 *	.016
Perceived Performance x (Subj. Disconfirmation) ²	-.002 *	.001	-.002 *	.001
Performance Uncertainty x Subj. Disconfirmation	.014	.007	-.006	.007
Risk of Obsolescence x Subj. Disconfirmation	.005	.010	.007	.010
Ease of Use x Subjective Disconfirmation	.021	.011	.024	.010
Constant	1.423 ***	.208	-.460 **	.204

*** indicates $p < .01$ and in the hypothesized direction.

** indicates $p < .05$ and in the hypothesized direction.

* indicated $p < .10$ and in the hypothesized direction.

Model Fit: Evaluation Stage Likelihood Ratio $\chi^2 = 105$, d.f. = 17, $p < .001$
Evaluation Stage "Goodness of Fit" $\chi^2 = 294$, d.f. = 283, $p = .30$

Timing Stage Likelihood Ratio $\chi^2 = 58$, d.f. = 17, $p < .001$
Timing Stage "Goodness of Fit" $\chi^2 = 207$, d.f. = 195, $p = .26$

Stage two estimation considered only the 213 participants in the experiment who indicated a favorable evaluation of the new product. Again, the likelihood ratio indicated acceptable model fit (chi-square = 58.16, 17 degrees of freedom, $p < .001$) as did the goodness-of-fit test (chi-square = 207.11, 195 degrees of freedom, $p = .2629$). The overall correct classification for stage two was 70.42%. The acceptable fit of the stage two model provides additional evidence for the inclusion of the timing stage in the adoption process.

To investigate the contribution of the interaction terms, a nested model containing only direct effects was estimated. The incremental chi-square with 8 degrees of freedom was 13.714 in stage one ($p < .10$) and 14.559 in stage two ($p < .10$). The interaction terms do appear to make a significant contribution to the explanatory power of the model.

Chapter 6

CONCLUSIONS

6.1 Research Findings

This chapter discusses the results and implications of the tests of the hypotheses contained in this study. A complete listing of the results of each hypothesis test is presented in Table 13. Influences that were hypothesized to be statistically significant have a plus or minus sign indicating whether the influence was hypothesized to be positive or negative. Cases where the independent variable was hypothesized not to influence the dependent variable are shown as n.s. indicating not statistically significant.

6.1.1 The influence of Perceived Newness

Perceived newness, or the uniqueness of the product, was hypothesized to have a positive influence on the likelihood of a favorable evaluation of the new product. This hypothesis was supported by a statistically significant coefficient ($p < .01$) with a positive sign. This lends support to the concept that products have both functional and symbolic value. The uniqueness of a product appears to contribute to a favorable

Table 13
Hypothesis Tests

VARIABLES & INTERACTIONS	EVALUATION STAGE		TIMING STAGE	
	<u>Hypothesis</u>	<u>Results</u>	<u>Hypothesis</u>	<u>Results</u>
Perceived Newness (New)	+	Supported	+	Not Supported
Perceived Performance (Perf)	+	Supported	+	Supported
Performance Uncertainty (Uncer)	-	Supported	-	Not Supported
Risk of Obsolescence (Obsol)	-	Supported	-	Supported
Ease of Use (EOU)	+	Supported	+	Not Supported
Next Generation Perf. Expectation (NGPerf)	n.s.	Supported	-	Not Supported
Next Generation Perf. Uncertainty (NGUnc)	n.s.	Supported	+	Not Supported
Perceived Newness x Innovativeness	-	Not Supported	-	Not Supported
Perceived Perf. x NG Perf. Expectation	n.s.	Supported	-	Not Supported
NG Perf. Expectation x NG Perf. Uncertainty	n.s.	Supported	+	Not Supported
Perceived Perf. x Subj. Disconfirmation	+	Supported	+	Supported
Perceived Perf. x (Subj. Disconfirmation) ²	-	Supported	-	Supported
Perf. Uncertainty x Subj. Disconfirmation	-	Not Supported	-	Not Supported
Risk of Obsolescence x Subj. Disconfirmation	-	Not Supported	-	Not Supported
Ease of Use x Subj. Disconfirmation	-	Not Supported	-	Not Supported

evaluation, conferring some benefit to the user other than that afforded by the functional utility of the product. It was further hypothesized that this influence would be stronger for innovators, those persons who by nature place greater emphasis on the symbolic rewards conferred by a new product. Innovativeness was therefore included as a control variable. Innovativeness was hypothesized to have a positive moderating effect on the relationship between newness and the likelihood of a favorable evaluation of the new product. This interaction was not found to be present in this experiment. While innovativeness itself had a significant positive relationship with the likelihood of a favorable evaluation ($p < .01$), it was not found to increase the positive relationship between perceived newness and the likelihood of a favorable new product evaluation.

The significant positive direct influence of innovativeness as a personal characteristic of potential adopters supports the idea that those individuals typically referred to as innovators are more likely to positively evaluate new products. The positive influence of innovativeness was not hypothesized since the intent of the present study was to focus on product characteristics. As an adopter characteristic, innovativeness was included to examine its possible effect as a moderator. The fact that innovativeness does not act as a moderator of the perceived newness relationship with evaluation means that newness has an equivalent effect for both innovators and imitators. Imitators appear to value newness in the same way as innovators. This lends support to the notion that innovativeness is a personal characteristic independent of the newness characteristic of the innovation, at least in the case of the product used in the current study. A possible implication is that product characteristics and adopter characteristics have independent direct influences on

product evaluation and do not interact. Further research is called for to investigate whether this is true for a greater range of personal and product characteristics.

Perceived newness was also hypothesized to have a positive influence on the likelihood of current adoption of a new product. Since the uniqueness of a new product is subject to erosion over time as copycat products enter the market, it was felt that in order to derive these symbolic benefits, potential adopters would be motivated to adopt the current generation. This relationship was not found to be statistically significant. It may be that consumers do not assume that highly unique products will lose this attribute quickly. On a 1 to 7 scale, participants in this study gave the product a mean rating of 6.4. With a uniqueness rating this high, respondents may have felt less sense of urgency to adopt the product while it was still unique. They may feel that the window of opportunity to capture the newness benefits will remain open longer or that the next generation of the product will be equally unique. This implies that there may be a halo effect of current generation newness on perceptions of next generation newness. Further study may provide additional insight into expectations about how long products retain symbolic value. It should be noted that the differential effect of perceived newness on the evaluation and timing stages provides evidence that these aspects of the adoption decision should be considered separately.

Innovativeness was also hypothesized to positively impact the relationship between perceived newness and likelihood of current adoption. Similar to the evaluation stage, this moderating effect was not found in the timing stage. The explanation for this may be

similar to the evaluation stage. Rather than interacting, personal characteristics and product characteristics appear to influence the decision process independently. Although not part of the hypotheses to be tested, innovativeness as an independent variable had a positive significant relationship to the likelihood of current adoption. The direct effect of innovativeness implies that higher levels of innovativeness on the part of the individual reduces the likelihood of either passive postponement or purposeful postponement of adoption.

6.1.2 The Influence of Perceived Performance

Perceived performance represents the functional value of the product. This aspect of new products is one dimension of what is frequently referred to in the adoption literature as relative advantage. In this study, relative advantage is decomposed into functional advantage, which manifests itself as perceived performance of the product, and symbolic advantage, which has been discussed in terms of perceived newness. Perceived performance was hypothesized to positively influence the likelihood of favorable evaluation of the new product. For the television products used in the present study, perceived performance has been operationalized using actual product attributes such as picture sharpness and picture color. Two measures of performance were eliminated during measure purification - overall viewing experience and apparent picture size. It is possible that these measures were too global or too general to capture specific perceptions of performance. Based on the experimental results, perceived performance

was found to be positively related to the likelihood of favorable evaluation ($p < .05$).

The hypothesized relationship is thus supported.

Perceived performance was also hypothesized to have a positive relationship with the likelihood of current adoption, and evidence was found for this relationship ($p < .01$). It appears that the higher the perceived performance of the current generation of new product, the lower the motivation to purposefully postpone adoption in favor of the next generation. This suggests that decomposing the traditional construct of relative advantage into both functional and symbolic constructs is useful. Whereas perceived performance was significantly related to both evaluation and timing, the perceived newness dimension of relative advantage was significant only in the evaluation stage.

6.1.3 The Influence of Performance Uncertainty

In contrast to the positive influences of new product benefits such as newness and performance, potential adopters may form perceptions that have a negative influence on evaluation and timing. One of these constructs is performance uncertainty. Performance uncertainty refers to the possibility of anticipated dissatisfaction with the product due to eventual poor performance. Doubts about whether the new product or its underlying technology has been adequately tested or proved may weaken evaluative ratings. Performance uncertainty was therefore hypothesized to have a negative impact on the likelihood of a favorable evaluation. This hypothesis was found to be statistically significant ($p < .05$) with the correct sign and the hypothesis was supported. It appears

that doubts about the efficacy of rewards from adoption increase the possibility of passive postponement. It was also hypothesized that performance uncertainty would have a negative influence on the likelihood of current adoption. This purposeful postponement could be the result of a need to search for additional information to reduce uncertainty, or simply a decision to wait until the product has been proven in the field. However, this hypothesis of a negative influence in the timing stage was not supported in the current experiment.

A differential effect was again observed between the evaluation and timing stages. It is theorized that the artificial nature of the experimental setting may have created the feeling among respondents they were faced with a one-time decision. The experiment was conducted in a single session and subjects may have felt that searching for additional information to reduce uncertainty was not an available alternative. Of the two categories of the dependent variable however, one category was the option to wait for the next generation product. This alternative to current adoption should have encompassed the possible need to postpone while acquiring additional information. It is not clear why respondents who may have had high feelings of uncertainty about the performance of the product did not choose the course of purposeful postponement. The most likely explanation seems to be that they felt the unconscious need to make an adopt or reject decision, the type of binary decision that characterizes much adoption research. Further research is warranted in which the experimental setting makes clear in the mind of respondents the alternative of postponement of adoption.

6.1.4 The Influence of Risk of Obsolescence

Implicit in successive generations of products is the understanding that improved products may make existing products obsolete. Risk of obsolescence was hypothesized to have a negative relationship with the likelihood of favorable evaluation. Expectation that the product will soon be obsolete or soon be discontinued was hypothesized to result in a lower present value for the existing product. Evidence from the experiment supported this hypothesis ($p < .01$) in the evaluation stage. Similarly, if expectations are high that an improved product will soon be released, the tendency to leapfrog to the next generation should increase. Thus it was hypothesized that higher perceptions of risk of obsolescence are associated with a reduced likelihood of current adoption. This hypothesis was weakly supported ($p < .10$).

It therefore appears that risk of obsolescence increases the probability of purposeful postponement. By definition, obsolescence is a construct that depends on the evolutionary nature of products. It was felt that when the dynamic nature of products was incorporated into the adoption decision process, a timing decision would necessarily arise. The fact that risk of obsolescence has a negative influence on both the evaluation and timing decisions provides additional evidence for the inclusion of a timing stage in models of the adoption process. Risk of obsolescence is also confirmed as a determinant of the rate of adoption when evolutionary products are considered.

6.1.5 The influence of Ease of Use

It was hypothesized that products which appear difficult to use or learn to use will induce passive postponement. Ease of use should therefore be positively associated with the likelihood of a favorable evaluation of the new product. The coefficient in the evaluation stage was both statistically significant ($p < .05$) and in the correct direction. Products that appear difficult to use will receive a less favorable evaluation than products that appear easy to learn about or easy to use. It was also hypothesized that ease of use would be positively related to the likelihood of current adoption in the timing stage. In contrast to the evaluation stage, ease of use was not statistically significant in its influence on the timing stage.

Once again, a differential effect between the evaluation and timing stages was observed. One possible explanation for the lack of significance in the timing stage is proposed. The product that was the subject of this experiment received relatively high scores for ease of use. On a 1 to 7 scale, the mean the “easy to operate” measure was 5.7 and the mean for the “easy to learn” measure was 5.9. It is possible that respondents felt that future generations of the product would not improve much over the current product’s high ratings. Looking at this from another perspective, respondents may have felt that once a level of ease of use is established, it will not decline in future generations. Their experience with this category of products has led to the belief that products only become easier to use over time, not more difficult. This illustrates a conceivable asymmetric impact of scores on the extreme end of this scale. Very high perceptions of

ease of use may have a negative impact on the likelihood of current adoption. In fact, the coefficient in this model had a negative, although not statistically significant, sign. It may be that ease of use has a positive influence on evaluation but a neutral or negative influence on timing, and this may be a topic for future research. One alternative that should be pursued in future research is to incorporate multiple products into the experiment to reduce possible product-specific effects.

Another implication of the results of this study comes from examination of the items used to measure ease of use. One measure of ease of use that was eliminated during measure purification was “high tech/low tech”. It has been theorized in the literature that high tech is synonymous with complexity and difficulty of use. This product was rated as both high tech (mean of 1.9 where 1 is high tech) and easy to use. Perceptions of high technology are apparently distinct from perceptions of ease of use.

6.1.6 The Influence of Next Generation Performance Expectation

If potential adopters anticipate a next generation product, their perceptions of the extent of improvement in the anticipated product were hypothesized to influence the timing of adoption. These perceptions of the rate of improvement were not theorized to influence subject’s evaluations of the current offering. Therefore, next generation performance expectation was hypothesized to have a non-significant influence on the likelihood of favorable evaluation and a negative influence on the likelihood of current adoption. The non-significant influence hypothesis in the evaluation stage was

supported. It is only the performance of the current model that influences that model's evaluation in the eyes of the potential adopter. The fact that the next generation might conceivably be better does not take away from a potential consumer's attitude about the currently available product. It was theorized that the scenario in the timing stage would be different. High expectations about next generation performance were thought to reduce the likelihood that potential adopters would adopt the current generation. It was hypothesized that they would be more likely to engage in purposeful postponement. In fact, the results from the experiment did not produce a statistically significant coefficient for this construct in the timing stage. The means of the measurement items for this construct were all above 5.8 on a 7 point scale, indicating that respondents expected high performance from the next generation product. Although the sign of the coefficient was in the hypothesized negative direction, it is unclear why this variable did not have a significant influence on adoption timing. It was also hypothesized that next generation performance expectation would negatively moderate the positive influence of perceived performance on adoption timing. In other words, feelings that the next generation would exhibit improved performance would mitigate the influence of the current generation's performance on the likelihood of current adoption. This interaction was also not statistically significant. Rather than contradicting the theory behind the hypotheses, it seems more likely that respondents were simply unable to generate sufficiently realistic feelings about the longitudinal nature of product evolution in the single session provided in the experiment. Before expectations can operate to influence the timing decision, consumers must be convinced that the product is actually evolving and that there is a real benefit to waiting for the next generation.

Another explanation for the lack of significant influence in the expectation construct is the use of student subjects for this study. While it was felt prior to the commencement of the study that students were among the target audience for this type of product, it may be that student subjects have not had sufficient length of experience to easily form expectations about product evolution. In addition to product category experience, student subjects may not have the financial capacity for this product, although it was described as under \$200. This may also contribute to a lack of decision making experience because they are accustomed to simply asking their parents to make the decision concerning products beyond their financial reach.

6.1.7 The Influence of Next Generation Performance Uncertainty

Next generation performance uncertainty is similar to the uncertainty construct but differs in that it represents perceptions about the anticipated next generation product. It was hypothesized not to influence the likelihood of favorable evaluation and this hypothesis was supported by a non-significant coefficient in the evaluation stage. The stage at which next generation performance uncertainty was hypothesized to have its effect was the timing stage. Higher levels of next generation performance uncertainty were hypothesized to be associated with an increased likelihood of current adoption. Uncertainty over future product generations should motivate potential adopters to opt for the existing product. However, evidence for this relationship was not found in the data from this experiment. In addition, uncertainty about the next generations performance was hypothesized to moderate the negative influence of next generation performance

expectation on the likelihood of current adoption. This interaction effect was likewise not present in the data. As with the non-significant effects for next generation performance expectation, the lack of significant influence is judged to be more a result of the lack of experimental realism, along with the use of student subjects, than a refutation of the underlying theory.

6.1.8 The Role of Subjective Disconfirmation

One of the tests of the usefulness of the Adoption Timing Decision Model was to see if it would help explain marketing problems pertaining to acceptance of new products. Subjective disconfirmation is a construct used to test the model's ability to examine a particular theoretical implication of the adoption of successive generations of new products. Disconfirmation refers to the extent to which consumer's expectation are not met. The most investigated aspect of disconfirmation is the case in which realized performance does not live up to expectations of performance. This is referred to as negative disconfirmation. A less extensively researched side of disconfirmation is the case where realized performance exceeds expectations. Common sense would indicate that adopters should be pleased with this circumstance. But what happens if potential adopters expect a certain level of performance from the next generation of new product and, when the product is introduced, their expectations are greatly exceeded? One study found evidence that low to moderate levels of disconfirmation have a linear positive moderating effect on the relationship between performance and evaluation (Bridges, Yim and Briesch 1995). However, this same study found evidence that upon reaching higher

levels of positive disconfirmation, the interaction becomes negative quadratic. The high disconfirmation, even though positive, may induce feelings of dissonance, possibly due to uncertainty over performance or concerns that the product is advancing too fast and may soon become obsolete.

The Adoption Timing Decision Model being investigated in this study seemed appropriate to test this theory. It was hypothesized that neutral or moderate levels of positive disconfirmation would have a positive linear influence on the positive relationship between perceived performance and the likelihood of a favorable evaluation. This was represented by a linear interaction term as an independent variable in the model. This term was hypothesized to have a positively signed coefficient and this hypothesis was supported in the experiment ($p < .01$). The additional hypothesis that higher levels of positive disconfirmation would impact the relationship negatively was investigated through the inclusion of a quadratic interaction term. This term was hypothesized to have a negatively signed coefficient and this coefficient was also statistically significant ($p < .10$).

The conclusion can be drawn that positive disconfirmation of performance does enhance the performance/evaluation relationship up to moderate levels. But when disconfirmation becomes too marked, feelings of discomfort retard the performance/evaluation relationship. What are these feelings of discomfort? This model contains three possible explanatory variables - performance uncertainty, risk of obsolescence, and ease of use. To investigate these variables as possible influences, it

was hypothesized that disconfirmation would have a linear negative moderating influence on the relationship between performance uncertainty and the likelihood of favorable evaluation, a linear negative moderating relationship between the negative relationship between risk of obsolescence and the likelihood of favorable evaluation, and a linear negative relationship between the positive relationship between ease of use and the likelihood of a favorable new product evaluation.

The performance uncertainty/disconfirmation interaction was statistically significant ($p < .05$), however the sign of the coefficient was positive rather than negative. The hypothesis was not supported. This evidence implies that as positive disconfirmation increases, perceptions of uncertainty about product performance have less impact on a favorable evaluation. This would appear logical for lower levels of uncertainty. Respondents are pleasantly surprised at the realized performance of the new product and their feelings of uncertainty seem less important. But what about high levels of positive disconfirmation? Might there also be a quadratic moderating influence of disconfirmation and performance uncertainty? The model was rerun with this interaction term added and it was not statistically significant.

The risk of obsolescence/disconfirmation interaction was not statistically significant in the evaluation stage of the model. It would seem that while risk of obsolescence has a direct negative influence on the evaluation stage, this influence is not enhanced by feelings of dissonance over disconfirmation of performance expectations. This suggests

that perceptions about obsolescence are independent of whether or not the product lived up to expectations formed prior to its introduction.

A similar circumstance to that which occurred with the performance uncertainty variable also occurred with the ease of use variable. Higher levels of positive disconfirmation had a statistically significant ($p < .10$) moderating effect on the positive ease of use association with the likelihood of favorable evaluation. In this situation as well, the sign of the interaction term was in the opposite direction from that hypothesized, resulting in lack of support for the hypothesis. The implication in this case is that as realized performance exceeds expectations to a greater and greater extent, ease of use has a larger positive impact on favorable product evaluation. A possible explanation is that if product performance is much more advanced, ease of use takes on more importance. Therefore, if ease of use achieves high ratings, this construct has a greater influence on the likelihood of a favorable evaluation.

Similar hypotheses were proposed for the timing stage. It was thought that neutral to moderate levels of disconfirmation would interact in a linear manner to enhance the positive influence of performance on the likelihood of current adoption. However, higher levels of positive disconfirmation were hypothesized to negatively interact with the performance/current adoption relationship. Respondents who felt that the new product they were faced with was much better than they expected should begin to feel some unease. This unease was thought to influence the effect of high performance on the decision to adopt now or engage in purposeful postponement. Both of these

hypotheses received some support from the data ($p < .10$). Again, the mechanism for this effect was hypothesized to be the interactions between disconfirmation and performance uncertainty, disconfirmation and risk of obsolescence, and disconfirmation and ease of use. In the timing stage of the model, only the interaction between disconfirmation and ease of use was significant ($p < .05$). As in the evaluation stage, the sign for this interaction was the opposite of the hypothesized sign. Instead of reducing the positive impact of ease of use on current adoption, positive disconfirmation had an enhancing effect on the positive relationship between ease of use and the likelihood of current adoption. This implies that when a new product comes to market with performance much better than expected, high ease of use ratings have even more influence on the motivation to buy the current product rather than leapfrog to the next generation. High positive disconfirmation does not appear to induce fear that the new product will be difficult to operate. Although the quadratic relationship between positive disconfirmation and performance influence is supported, the mechanism by which this occurs requires closer examination.

6.2 Contributions of the Research

The purpose of this research was to incorporate timing into the adoption process. This motivation was based on the fact that many product types evolve during their diffusion and potential adopters are faced with the option of postponing current adoption in favor of anticipated future generations. In this sense, adoption timing becomes a choice between adoption of the current version of the new product or improved later generations

of the new product. The addition of a timing stage allowed investigation into the new product characteristics that were thought to influence both evaluation and timing. Finally, the model was used to empirically test a theory relating to disconfirmation and its moderating effect on various influences hypothesized in the model. The theoretical and managerial implications of the results of this study will be discussed in the following sections.

6.2.1 Theoretical Implications

Support for the inclusion of a timing stage in the adoption process is provided by this research. Inclusion of a timing stage in the decision process is particularly useful when potential adopters are able to anticipate future product improvements. The theoretical contribution of the inclusion of a timing stage is to help explain the lag between initial awareness of a new product and its eventual adoption. As demonstrated by this research, one explanation for the lag between awareness and adoption is the decision to postpone current adoption in favor of additional expected benefits anticipated from future performance improvements. This postponement is purposeful in the sense that it takes place in spite of a favorable attitude toward the new product. Hierarchy of effects models that are based on the theory that attitude leads to behavior may be enhanced by the inclusion of a timing stage. While not contradicting the link between attitude and behavioral intent, postponement due to the recognition of an evolutionary product offers an additional explanation for the lapse of time between attitude formation and purchase.

This explanation is tied to the dynamic product view and the resulting evolutionary characteristics of present and future versions of the product.

Also demonstrated by this research is the fact that the timing stage is part of an inherently sequential process. In this study, timing was modeled as a separate decision that occurs subsequent to attitude formation. Placing the timing stage after the evaluation stage assumes that potential adopters engage in a more elaborate form of decision-making that is characteristic of high-tech durables rather than low involvement, repeat purchase products. For low involvement products, the timing stage may well occur prior to the evaluation stage, however this alternative sequence is not considered in the context of this research. Inclusion of a timing stage along with an evaluation stage allows the examination of the impact of product characteristics on each stage, with the impacts on timing unconfounded with the impacts on evaluation. Inclusion of a timing stage also facilitates a change from a binary adopt or reject outcome to outcomes that include various forms of postponement as alternatives to current adoption.

With the explicit specification of a timing stage, this study looked at the factors that influence both evaluation and timing. Research results suggest that product benefits positively influence the evaluation stage of the adoption process. Higher levels of perceived performance and perceived newness appear to lead to an increased likelihood of a favorable evaluation. The evaluation stage is negatively impacted by uncertainty factors such as doubts about product performance, fears of product obsolescence, and concern over ease of use. A further contribution to the literature is provided by the

ability to map the effects of these variables on the timing stage. Along with a positive impact on evaluation, perceived performance also increases the likelihood of adoption of the current generation of the innovation. Perceived newness, on the other hand, appears to have its influence only on the evaluation stage. Higher levels of newness do not increase the likelihood of adopting the current generation. This is the case regardless of the potential adopter's level of innovativeness.

The theoretical implication is that when potential adopters are introduced to a new product, they do not explicitly foresee the possibility that the product could become commonplace over time. This is in contrast to theories that the radicalness of an innovation declines over time. The difference could be due to the dynamic product view. Potential adopters feel that newness is important when they evaluate a new product, but they may assume that future generations of the product will embody a corresponding amount of newness when eventually introduced. Therefore, the impact of newness on timing is mitigated. Differential effects were also found for the uncertainty factors. While all three uncertainty variables influenced new product evaluation, only risk of obsolescence influenced the timing stage. This suggests that uncertainties about the innovation are more likely to induce passive postponement rather than purposeful postponement.

Another theoretical contribution of this research relates to its examination of the innovation characteristics proposed by Rogers. The results of this study strongly support the multidimensionality of at least two of these characteristics, relative advantage and

complexity; and suggest the need for further clarification and definition of these characteristics. This is particularly true under the dynamic product view. As this study demonstrated, complexity involves more than one dimension. Ease of use was found to be a significant construct in its own right and analysis of the measures of ease of use indicate that it is distinct from concepts such as high-tech. Previous definitions of complexity incorporated the idea that high technology and technical sophistication contributed to perceptions of complexity in the same manner as difficulty of use. This is not the case. High technology may go hand in hand with perceptions of ease of use. This study demonstrated that a similar decomposition of relative advantage is required. There are many dimensions to product advantage, not the least of which are its functional and symbolic components. Once this decomposition is made, it should be possible to develop more specific measures of the dimensions of relative advantage. This takes on even more importance in the case of evolutionary products where relative advantage is really relative to past and even future generations of the innovation.

Finally, in a test of the usefulness of the model, this research provides support for the idea that there may be a threshold beyond which positive disconfirmation can have an adverse moderating effect on the influence of perceived performance. In situations in which generations of new products demonstrate rapid advances in performance, potential adopters form expectations about the next generation. Product preannouncements from the marketer may produce or reinforce these expectations, as was the case in this study. Theory suggests that expectations that are negatively disconfirmed will adversely influence product evaluations. Similarly, theory suggests that positively disconfirmed

expectations provide potential adopters with a pleasant surprise, thereby enhancing new product evaluations. This research lends support to these propositions and extends the theory to show that positive disconfirmation also influences the likelihood of current adoption in the timing stage. Current theory is amplified by finding support for the hypothesis that increasing levels of positive disconfirmation begin to erode the positive influence wrought by improved performance. It appears that when performance exceeds expectations by a wide enough margin, the positive influence of performance is not sufficient to overcome the dissonance caused by disconfirmation of expectations. This phenomenon was observed in both the evaluation stage and the timing stage.

6.2.2 Managerial Implications

A sequential introduction of new products with varying levels of performance has been shown to be better than a simultaneous introduction when cannibalization is a problem (Moorthy and Png 1992). When the products will coexist on the market, the preferred order is to introduce the high performing product first. This allows price skimming for the more demanding market segment prior to introducing a less expensive, low end product. In the situation where the lower performance product is introduced first, even more discriminating buyers, if they are impatient for the product, will purchase immediately, thereby cannibalizing sales from the potentially more profitable high performance product. This assumes that the technology for the higher performance product is available simultaneously with the lower performance technology. A more common case is one in which the improved technology is not immediately available

(Norton and Bass 1987; Levinthal and Purohit 1989). In situations involving generations of product improvement, marketers frequently engage in preannouncing behavior to educate opinion leaders whose eventual word-of-mouth impact is thought to accelerate the diffusion of the new product. A preannouncement was defined by Eliashberg and Robertson (1988) as “a formal, deliberate communication before a firm actually undertakes a particular marketing action.” Preannouncing forces the marketer to precommit to the design of the subsequent product. Even when a marketer cannot precommit, potential adopters will rationally look ahead and take these expectations into account when making an adoption decision. The objectives of preannouncing are to gain pioneering advantages and to possibly deter competitive entry. Prior to the emergence of a dominant design, preannouncing may even facilitate the adoption of the marketers technology as the product category standard (Katz and Shapiro 1986). In the case where a competitor already has a product on the market, the advantage of preannouncing, from a diffusion standpoint, is to prevent the “bandwagon effect” of diffusion from starting for your competitor (Farrell and Saloner 1986).

There are also risks associated with preannouncing a new product. Among the potential dangers are the possibility of cueing competitors who may be able to introduce a new product more quickly, and the possibility of cannibalizing the current product if the new product is a substitute. The delay in introducing a higher performance product may provide an opportunity for competitors to preempt that market segment by introducing first. Preannouncing may also induce postponement of the existing product. If postponement due to expectation of obsolescence occurs on a large enough scale, it

can act as an incentive for marketers to reduce the development of more sophisticated models (Rosenberg 1982). The objective should be to convince potential adopters of product stability while still pursuing product improvement.

Recognition of the timing stage as part of the adoption process, and its attendant implications for the rate of diffusion of evolutionary products, provides a number of insights for marketers. It may no longer be sufficient to focus exclusively on the communication interpretation of diffusion. Certainly, facilitating the spread of awareness concerning a new product remains a worthwhile objective. As this study shows, attention must also be paid to the content of the communications. This is important because a product preannouncement can induce postponement as well as adoption. What are the implications for marketers?

One implication involves the level of performance predicted by marketers in new product announcements. Among the possible scenarios for introduction of a new generation of an innovation, one possibility involves introduction of a new generation in response to a competitors preannouncement. Marketers may attempt to induce postponement of adoption of competitors products. One way of accomplishing this is in the evaluation phase. By announcing a product with superior performance, marketers may attempt to create a perception of risk of obsolescence for the competitors product. This study has shown that risk of obsolescence has a negative influence on evaluation and contributes to passive postponement. This study has also demonstrated that risk of obsolescence can contribute to purposeful postponement by negatively influencing the

timing decision. Marketers faced with a competitor that is attempting a first strike announcement in hopes of achieving first mover advantages have the option of counter-attacking by inducing potential adopter postponement of adoption of the competitive new product.

An alternative scenario involves a circumstance in which the marketer is substituting for its own existing new product with a new generation. In this instance, early preannouncing activities may not be in the best interest of the marketer due to the risk of premature cannibalization of the existing product line. This research indicates that it may be more advantageous to delay preannouncing in order to reduce the likelihood of either passive or purposeful postponement of adoption of the existing product. This might be contrary to the natural inclination to preannounce to preempt a competitor or create interest in the next generation. If marketers do decide to preannounce, other implications of this study may be pertinent. It has been suggested in the literature that overly optimistic predictions that are later disconfirmed may result in postponement. On the other hand, this study demonstrates that overblown statements about product performance may result in levels of disconfirmation high enough to induce postponement. Under the competitive scenario, it may be desirable to attempt to highly positively disconfirm a competitors new product announcement resulting in both passive and purposeful postponement.

Implications also exist for the new product design processes. Marketers must remain cognizant of the fact that for evolutionary products, the rate of performance

improvement influences not only the evaluation of the product, but also the timing of adoption. A rapid pace of technological change may lead to postponement as opposed to current adoption, retarding the rate of diffusion. This may be exacerbated by product preannouncements that do not accurately reflect the future performance of the next product generation. Marketers interested in the rate of diffusion of a new product generation should be wary of creating the perception among consumers that performance is advancing by leaps and bounds. In addition, care should be taken to accurately educate potential adopters about the level of improvement they can expect. Overly optimistic announcements can lead to negative disconfirmation. Less obvious is the fact that significantly understating future performance may lead to levels of positive disconfirmation high enough to cause dissonance, resulting in an erosion of product evaluation and a tendency to postpone adoption. As with negative disconfirmation, the rate of diffusion is retarded. Carrying this logic forward produces the implication that there is an optimal degree of improvement that should be incorporated into the design of new products. Marketers should include the timing variable into new product concept tests to capture feelings of uncertainty resulting from rapid technological change.

6.3 Research Limitations

Some limitations to this study should be noted. First, only new product characteristics were included as factors influencing the two adoption stages. One adopter characteristic, innovativeness, was included as a control and possible moderator variable. Exclusion of other adopter characteristics could lead to bias resulting from misspecification of the

model. Product characteristics were considered to be the most relevant variables from the perspective of product evolution. In addition to the product characteristics used in this study, future studies should also include price. Consumers form expectations about future price levels as well as future performance levels. Although an attempt was made in this study to hold price constant, actually measuring the influence of price would lead to a better understanding of evolutionary effects.

Another limitation concerns the use of a single evolutionary product. In this case, the second generation product represented an architectural innovation. An architectural innovation is one in which the technology does not change, but the way in which the technology is used is changed. In this case, the technology was the LCD matrix screen technology and the architectural innovation was the incorporation of this technology in virtual reality glasses. A more comprehensive study would encompass more than one product family and include examples of radical, modular, and incremental innovation along with architectural innovation. The use of a single product family representing a single type of innovation may have resulted in effects, or a lack of effects, that were specific to this particular product.

Attempt to simulate a longitudinal process in a single experimental session represents another limitation of this research. Although respondents were introduced to each generation of products in a series of steps designed to create the feeling of evolutionary change, it is not clear whether respondents viewed the process as longitudinal. The fact

that the expectations variables did not have a significant influence on the stages of the model may be a result of this experimental design limitation.

6.4 Future Research Directions

Before additional research into the influence of product characteristics on adoption is undertaken, the marketing field would benefit from a study to clearly define the nature of these constructs and to develop reliable and valid measurement scales.

One logical extension of this research would be the inclusion of adopter characteristics as possible factors influencing the stages of the Adoption Timing Decision Model. For example, how does a potential adopter's tolerance for lower levels of performance influence adoption timing. If potential adopters are less discriminating in their demand for performance, will they adopt the current generation because it is "good enough". Conversely, will potential adopters who demand superior performance forgo immediate use of the product and postpone adoption until future generations meet or exceed their performance criterion. Another personal characteristic that should influence the timing of adoption is the urgency of need for the product. Intuitively, those who are impatient for the product should adopt earlier. The influence of other personal characteristics, such as product category involvement, could also be included in the model.

One area of potential for future research concerns the mechanism that causes high positive disconfirmation to adversely moderate the relationship between performance

and the stages of the model. One interesting direction would be to develop a study to determine whether marketers can manipulate expectations through preannouncing behavior and consequently manipulate the timing of adoption.

Future efforts to investigate the adoption stages of evolutionary products should be undertaken in a true longitudinal setting. An experimental setting was used for this study in order to manipulate certain variables. While experimental designs have the advantage of control over some variables, their artificial nature often induces a lack of realism and inability to generalize to a larger population. Replicating this study in a more realistic longitudinal context may result in creation of actual expectations and perceptions about product characteristics that are grounded in an evolutionary context. This may mean introducing generations of products separated in time by a number of months. This introduces other complications relating to the ability to maintain contact with the respondents over time that could not be accommodated in the present study.

6.5 Summary

New Products are often vital to the success of the firm and marketers must be concerned with the rate of diffusion, or marketplace acceptance, of a new product. Previous studies of diffusion have generally regarded the innovation as a single product diffusing unchanged throughout the population of potential adopters. Under this static product view, potential adopters were assumed to evaluate the product and make a single adopt/nonadopt decision. This research proposes a dynamic view of diffusion that

allows consideration of successive generations of a new product. Conceptualizing the innovation in evolutionary terms means incorporating into the adoption process a timing decision that permits the potential adopter various postponement options.

An experiment was designed to simulate the decision facing a potential adopter confronted with successive generations of a new product. A sequential logit model was used to analyze the influence of new product characteristics on both the evaluation and timing stages of the decision process. The results indicate that product characteristics have differential impacts on the two stages and that a favorable attitude toward a new product does not preclude postponement of adoption. This model helps explain the frequently observed time lag between awareness and eventual adoption of an innovation.

The model was also used to test the hypothesis that positive disconfirmation of performance expectations has an inverted U-shaped moderating effect on the positive relationship between performance and both evaluation and timing. After manipulating next generation performance expectations in the experiment, the results confirmed this effect. The implication is that better than expected performance improvements may come as a pleasant surprise, adding to the positive influence of performance on evaluation and adoption timing. However, products that are perceived to be improving much more rapidly than anticipated may create a dissonance that inhibits the otherwise positive relationship between performance and the likelihood of a favorable attitude and subsequent adoption.

The exploratory results of this study indicate that the development of a model of adoption timing may be possible. Determining all the factors relating to adoption timing would be a first step in the construction of this model. This study examined only one group of factors - evolutionary product characteristics. Future research could productively examine all of the factors included in the diffusion paradigm. This would encompass potential adopter characteristics, social system factors, the adoption process, marketing mix elements, and the competitive environment. The objective would be to develop a more general model of dynamic product adoption timing to help explain the likelihood of postponement in the adoption decision. In the case of innovation characteristics, and new product performance in particular, this research suggests a strategy of step-wise growth for marketers that does not exceed customer expectations, either inferred from experience or based on new product preannouncements, about the trajectory of technological improvements.

APPENDICES

APPENDIX A

Table 14
Descriptive Statistics

<u>Construct & Measurement Items</u>	<u>Mean</u>	<u>Standard Deviation</u>	<u>Item-to-Total Correlation</u>
<i>Perceived Newness (New)</i>			
not new at all/very new (reversed)	6.336	1.051	.3975
dull/exciting	6.213	.906	.3513
not a status symbol/status symbol (reversed)	4.877	1.787	.3323
ordinary/unique (7-point semantic differential)	6.392	.702	.5253
<i>Perceived Performance (Perf)</i>			
overall viewing experience	5.711	1.211	.7294
picture sharpness	5.372	1.268	.7404
apparent picture size	5.522	1.430	.6037
picture color (7-point poor/excellent)	5.439	1.203	.7032
<i>Performance Uncertainty (Uncer)</i>			
reliable/unreliable	3.505	1.272	.5316
proven/unproven (reversed)	3.827	1.597	.6521
“bugs” worked out/may have “bugs” (reversed)	4.548	1.508	.5892
trustworthy/untrustworthy (7-point semantic differential)	3.721	1.250	.5708
<i>Risk of Obsolescence (Obsol)</i>			
It is likely that an improved product will soon be on the market.	5.007	1.629	.2925
This product may be discontinued soon.	2.957	1.479	.5160
I will not be able to keep this product long enough to get my money’s worth.	3.259	1.536	.5456
This product will be obsolete soon. (7-point strongly disagree/strongly agree)	3.076	1.618	.6034
<i>Ease of Use (EOU)</i>			
complex/simple (reversed)	4.040	2.034	.2466
hard to operate/easy to operate (reversed)	5.684	1.245	.4359
hard to learn/easy to learn	5.920	1.137	.3329
high tech/low tech (7-point semantic differential)	1.937	1.149	-.0907

APPENDIX A

Table 14 (cont'd).

Next Generation Performance Expectation (NGPerf)

overall viewing experience	5.844	1.110	.7572
picture sharpness	5.900	1.041	.8343
apparent picture size	5.811	1.236	.7141
picture color	5.920	1.120	.7587
(7-point poor/excellent expected performance)			

Next Generation Performance Uncertainty (NGUnc)

reliability (reverse coded)	2.751	1.273	.7845
proven technology (reverse coded)	2.588	1.353	.7392
all the "bugs" worked out	3.183	1.502	.7890
trustworthiness	1.536	.280	.8428
(7-point poor/excellent expected performance)			

Innovativeness (Innov)

In general, I am among the last in my circle of friends to buy a new electronic entertainment product when it appears. (reverse coded)	4.239	1.799	.6558
If I heard that a new electronic entertainment product was available in the store, I would not be interested enough to buy it. (reverse coded)	4.259	1.577	.5939
Compared to my friends, I own a lot of electronic entertainment products.	4.176	1.772	.6005
In general, I am the last in my circle of friends to know the brands of the latest electronic entertainment products.	4.814	1.645	.5629
I will buy a new electronic entertainment product even if I haven't tried it yet.	2.412	1.537	.2333
I like to buy electronic entertainment products before other people do.	3.319	1.595	.5943
(7-point strongly disagree/strongly agree)			

Subjective Disconfirmation (Discon)

overall viewing experience	9.708	7.934	.7527
picture sharpness	7.658	7.569	.7415
apparent picture size	8.668	9.766	.6427
picture color	7.841	7.728	.7620
(7-point exactly as expected/extremely different from what I expected times 7-point -3 to +3 very bad/very good)			

APPENDIX B

Table 15
Initial Factor Analysis - Pattern Matrix

<u>Items</u>	<u>Factors</u>								
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>
INNOV									
...last to buy...	-.09	.00	.84	.07	-.08	.05	.08	-.03	-.08
...not interested	.03	.03	.76	.01	.13	-.01	.05	-.03	.05
...I own a lot...	.04	.02	.76	-.04	-.03	-.06	.02	-.02	-.12
...last to know...	-.08	-.02	.74	-.05	.02	.16	-.05	-.03	-.01
...buy before...	.09	-.02	.68	.02	-.06	-.14	-.14	.14	.20
NEW									
new	.04	.07	-.04	.02	-.75	.05	-.01	-.11	-.19
exciting	.17	.08	-.05	-.20	-.37	.04	-.13	-.21	.41
status	-.13	-.12	.04	-.03	-.73	-.13	.16	.21	.05
unique	.07	.04	.03	.05	-.67	.08	-.06	-.19	.17
UNCER									
reliable	-.07	.06	-.02	.58	.12	-.13	.05	.02	-.19
proven	-.05	.15	.06	.79	-.01	.01	-.01	-.08	-.05
"bugs" out	.04	.13	-.04	.76	-.12	.04	-.00	.05	.00
trustworthy	.00	.09	-.03	.61	.12	-.19	-.06	.10	.08
EOU									
easy to operate	-.04	.05	.02	-.08	.04	.87	.06	.02	.02
easy to learn	-.04	.01	.00	-.03	-.01	.88	-.01	.04	-.05
PERF									
overall viewing	.35	.08	.06	-.29	-.08	.01	.02	-.20	.41
picture sharpness	.63	.13	.02	-.32	-.04	-.08	.30	-.12	.05
picture size	.07	.02	.08	-.16	-.00	-.00	.06	-.08	.76
picture color	.62	.13	.04	-.33	.02	-.04	.30	-.08	.01
OBSOL									
...discontinued...	.03	.13	.01	.05	-.01	.13	.02	.84	.04
...not keep long...	-.14	.07	-.11	.07	-.01	-.08	.00	.62	-.09
...obsolete soon...	.09	-.02	.02	-.11	.05	-.04	-.08	.84	-.02
NGPERF									
overall viewing	.37	-.48	-.00	.23	-.03	.18	-.09	-.12	.18
picture sharpness	.60	-.47	.03	.25	-.06	.09	.02	-.01	-.02
picture size	.32	-.42	.02	.17	.07	.22	-.11	.02	.40
picture color	.55	-.48	.05	.26	-.04	.12	.09	.05	.00
NGUNC									
reliability	-.05	.86	-.00	.06	.01	.01	.07	.07	.02
proven	.03	.80	.06	.19	.07	-.04	-.05	-.05	.05
"bugs" out	.10	.85	-.04	.15	-.06	.06	-.07	.06	-.00
trustworthy	.06	.85	-.02	.11	-.01	.01	-.07	.13	.01
DISCON									
overall viewing	-.12	-.04	-.07	.02	-.07	.06	.57	-.17	.42
picture sharpness	.12	-.02	.03	.00	-.06	.01	.88	-.03	-.00
picture size	-.21	.03	.00	.04	.03	.04	.42	-.07	.74
picture color	.14	-.07	-.02	.02	-.04	.05	.86	-.01	.04

APPENDIX C

Consumer Electronics Report

**Portable pocket-size color LCD TVs
put exciting television action in the palm of your hand.**

**Lightweight and compact (with screens less than 3"),
LCD pocket TVs enable you to keep up with
TV news, sports and favorite programs on the go.**

NEW

Announcing TFT Active-Matrix Screen Technology.

The TFT (thin film transistor) active-matrix LCD screen delivers crisp video and looks great from any viewing angle. Consumer Reports says active matrix provides by far the brighter picture, with better contrast and color.

Standard LCD Screen Technology

Mini-TVs use a liquid-crystal display screen, a technology that lends itself far better than cathode-ray picture tubes to portable design. But LCD screens have had their drawbacks. Older models using a passive-matrix technology had a limited viewing angle. Watching the TV from the side could make dark areas look silvery. When watching from a high or low angle, contrast seemed reduced or overemphasized. In addition, passive-matrix models tended to make fast-moving images seem smeary.

PORTAVISION 37 SPECIFICATIONS:

Screen size	2.5 inches diagonally
Display element	high resolution color LCD
Drive system	TFT active-matrix system
Channel coverage	Ch 2-13 VHF, Ch14-69 UHF
Audio	AM/FM with 2" speaker
Estimated retail price	less than \$200

APPENDIX D

High Expectations Treatment

NEW PRODUCT NEWS

NEW A west coast company has announced a personal TV that you put on like glasses. Featuring a lightweight headset with miniature LCD television screens, it provides your own personal home theatre without disturbing the person next to you.

Early reports on what is being called virtual reality eyeware provide some clues about how the final product will be introduced:

- * The LCD screens give the impression of a big screen that appears to come alive right in front of you
- * The LCD screens will feature full color capability
- * Features active-matrix LCD screen technology
- * High resolution picture with 180,000 pixels per LCD panel
- * Picture features projection-TV imagery that appears to float in front of you
- * Designed with the most demanding buyer in mind
- * Estimated retail price less than \$200

APPENDIX E

Medium Expectations Treatment

NEW PRODUCT NEWS

NEW

A west coast company has announced a personal TV that you put on like glasses. Featuring a lightweight headset with miniature LCD television screens, it provides your own personal home theatre without disturbing the person next to you.

Early reports on what is being called virtual reality eyeware provide some clues about how the final product will be introduced:

- * The 0.7 inch LCD screens look like a larger screen seen from a distance
- * First models of the product will probably have average color separation
- * Picture quality comparable to average portable LCD sets
- * Eyeware provides a 30 degree field of vision
- * Designed with the less demanding, more cost conscious buyer in mind
- * Estimated retail price less than \$200

APPENDIX F

Low Expectations Treatment

NEW PRODUCT NEWS

NEW A west coast company has announced a personal TV that you put on like glasses. Featuring a lightweight headset with miniature LCD television screens, it provides your own personal home theatre without disturbing the person next to you.

Early reports on what is being called virtual reality eyewear provide some clues about how the final product will be introduced:

- * The miniature LCD screens will be only 0.7 inches in size
- * First models of the product will probably feature a black-and-white picture
- * Uses older style passive-matrix LCD screen technology
- * LCD screens have, in the past, provided fair picture quality at best, compared with that of conventional sets
- * Picture must be viewed from a narrow viewing angle
- * Designed as a prototype model
- * Estimated retail price less than \$200

LIST OF REFERENCES

LIST OF REFERENCES

Abernathy, William (1978), *The Productivity Dilemma*, Baltimore, MD: Johns Hopkins University Press.

_____ and James M. Utterback (1982), "Patterns of Industrial Innovation," *Technology Review*, 80, (June-July), 40-47.

Amemiya, Takeshi (1985), *Advanced Econometrics*, Cambridge, MA: Harvard University Press.

Anderson, Philip and Michael L. Tushman (1990), "Technological Discontinuities and Dominant Designs: A Cyclical Model of Technological Change," *Administrative Science Quarterly*, 35 (December), 604-633.

Arrow, Kenneth (1962), "The Economic Implications of Learning by Doing," *Review of Economic Studies*, 29, 155-173.

Bagozzi, Richard P. (1982), "A Field Investigation of Causal Relations among Cognitions, Affect, Intentions and Behavior," *Journal of Marketing Research*, 19, 562-584.

_____ and Paul R. Warshaw (1990), "Trying to Consume," *Journal of Consumer Research*, 17 (September), 127-140.

Balcer, Yves and Steven A. Lippman (1984), "Technological Expectations and Adoption of Improved Technology," *Journal of Economic Theory*, 34, 292-318.

Bandura, A. (1982), "Self-Efficacy Mechanism in Human Agency," *American Psychologist*, 37, 122-147.

Bass, Frank M. (1969), "A New Product Growth Model for Consumer Durables," *Management Science*, 15:5 (January), 215-227.

Bauer, Raymond A. (1960), "Consumer Behavior as Risk Taking," in *Dynamic Marketing for a Changing World*, Roberd S. Hancock, ed., Chicago, IL: American Marketing Association.

Bearden, William O., Richard G. Netemeyer and Jesse E. Teel (1989), "Measurement of Consumer Susceptibility to Interpersonal Influence," *Journal of Consumer Research*, 15 (March), 473-481.

Bernhardt, Irwin and Kenneth D. MacKenzie (1972), "Some Problems in Using Diffusion Models for New Products," *Management Science*, 19 (October), 187-200.

_____, Chi Kin (Bennett) Yim and Richard A. Briesch (1995), "A High-Tech Product Market Share Model with Customer Expectations," *Marketing Science*, 14:1 (Winter), 61-81.

Burns, Tom and George Stalker (1966), *The Management of Innovation*, London: Tavistock.

Calantone, Roger J., C. Anthony di Benedetto and Martin S. Meloche (1988), "Strategies of Product and Process Innovation: A Loglinear Analysis," *R&D Management*, 18:1, 13-21.

Chatterjee, Rabikar and Jehoshua Eliashberg (1990), "The Innovation Diffusion Process in a Heterogeneous Population: A Micromodeling Approach," *Management Science*, 36:9 (September), 1057-1079.

Chow, Gregory C. (1967), "Technological Change and the Demand for Computers," *American Economics Review*, 57 (December), 1117-1130.

Churchill, Gilbert A., Jr. (1979), "A Paradigm for Developing Better Measures of Marketing Constructs," *Journal of Marketing Research*, 16 (February), 64-73.

Clark, Kim B. (1985), "The Interaction of Design Hierarchies and Market Concepts in Technological Evolution," *Research Policy*, 14, 235-251.

Cohen, Jacob (1977), *Statistical Power Analysis for the Behavioral Sciences*, Revised Edition, New York: Academic Press.

_____, and Patricia Cohen (1983), *Applied Multiple Regression/Correlation for the Behavioral Sciences*, Second Edition, Hillsdale, NJ: Lawrence Erlbaum Associates, Publishers.

Cook, Thomas D. and Donald T. Campbell (1979), *Quasi-Experimentation: Design and Analysis Issues for Field Settings*, Boston: Houghton Mifflin Company.

Davis, Fred D., Richard P. Bagozzi and Paul R. Warshaw (1989), "User Acceptance of Computer Technology: A Comparison of Two Theoretical Models," *Management Science*, 35:8 (August), 982-1003.

Dewar, Robert D. and Jane Dutton (1986), "The Adoption of Radical and Incremental Innovations: An Empirical Analysis," *Management Science*, 32:11 (November), 1422-1433.

Doyle, Peter and John Saunders (1985), "The Lead Effect of Marketing Decisions," *Journal of Marketing Research*, 22 (February), 54-65.

Dutton, John and Annie Thomas (1985), "Relating Technological Change and Learning by Doing," in *Research on Technological Innovation, Management, and Policy*, Richard D. Rosenbloom, ed., Greenwich, CT: JAI Press, 187-224.

Eliashberg, Jehoshua and Thomas S. Robertson (1988), "New Product Preannouncing Behavior: A Market Signaling Study," *Journal of Marketing Research*, 25 (August), 282-292.

Farrell, Joseph and Garth Saloner (1986), "Installed Base and Compatibility: Innovation, Product Preannouncements, and Predation," *The American Economic Review*, 76:5 (December), 940-955.

Fishbein, Martin and Icek Ajzen (1975), *Belief, Attitude, Intention and Behavior: An Introduction to Theory and Research*, Reading, MA: Addison-Wesley.

Fisher, Robert J. and Linda L. Price (1992), "An Investigation into the Social Context of Early Adoption Behavior," *Journal of Consumer Research*, 19 (December), 477-486.

Fisher, J.C. and R.H. Pry (1971), "A Simple Substitution Model of Technological Change," *Technological Forecasting and Social Change*, 3, 75-88.

Fliegel, Frederick C. and Joseph E. Kivlin (1966), "Attributes of Innovations as Factors in Diffusion," *American Journal of Sociology*, 72 (November), 235-248.

Gatignon, Hubert and Thomas Robertson (1985), "A Propositional Inventory for New Diffusion Research," *Journal of Consumer Research*, 11 (March), 849-867.

_____ and _____ (1989), "Technology Diffusion: An Empirical Test of Competitive Effects," *Journal of Marketing*, 53 (January), 35-49.

_____ and _____ (1991), "Innovative Decision Processes," in *Handbook of Consumer Behavior*, Thomas S. Robertson and Harold H. Kassarian, eds., Englewood Cliffs, NJ: Prentice Hall.

Gold, Bella (1981), "Technology Diffusion in Industry: Research Needs and Shortcomings," *Journal of Industrial Economics*, 29 (March), 247-269.

Goldsmith, Ronald E. and Charles Hofacker (1991), "Measuring Consumer Innovativeness," *Journal of the Academy of Marketing Science*, 19 (Summer), 209-221.

Greene, William H. (1990), *Econometric Analysis*, New York, NY: Macmillan.

Helson, Harry (1959), "Adaptation Level Theory," in *Psychology: A Study of a Science*, Sigmund Koch, ed., New York: McGraw-Hill, 565-621.

Henderson, Rebecca M. and Kim B. Clark (1990), "Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms," *Administrative Science Quarterly*, 35 (March), 9-30.

Herr, Paul M., Steven J. Sherman and Russell H. Fazio (1983), "On the Consequences of Priming: Assimilation and Contrast Effects," *Journal of Experimental Social Psychology*, 19, 323-340.

Hirschman, Elizabeth C. (1980), "Innovativeness, Novelty Seeking, and Consumer Creativity," *Journal of Consumer Research*, 7, 283-295.

_____ (1981), "Symbolism and Technology as Sources for the Generation of Innovations," in *Advances in Consumer Research*, A. Mitchell, ed., St. Louis, MO: Association for Consumer Research, 537-541.

Holak, Susan L. (1988), "Determinants of Innovative Durables Adoption: An Empirical Study with Implications for Early Product Screening," *Journal of Product Innovation Management*, 5, 50-69.

_____ and Donald R. Lehmann (1990), "Purchase Intentions and Dimensions of Innovation: An Exploratory Study," *Journal of Product Innovation Management*, 7, 59-73.

_____, _____ and Fareena Sultan (1987), "The Role of Expectations in the Adoption of Innovative Consumer Durables: Some Preliminary Evidence," *Journal of Retailing*, 63:3 (Fall), 243-259.

Horsky, Dan (1990), "A Diffusion Model Incorporating Product Benefits, Price, Income and Information," *Marketing Science*, 9:4, 342-365.

_____ and Leonard S. Simon (1983), "Advertising and the Diffusion of New Products," *Marketing Science*, 2:1 (Winter), 1-17.

Howard, John A. and Jagdish N. Sheth (1969), *The Theory of Buyer Behavior*, New York: John Wiley.

Jain, Dipak, Vijay Mahajan and Eitan Muller (1991), "Innovation Diffusion in the Presence of Supply Restrictions," *Marketing Science*, 10:1 (Winter), 83-90.

_____ and Ram C. Rao (1989), "Effect of Price on the Demand for Durables: Modeling, Estimation and Findings," *Journal of Business and Economic Statistics*

Jensen, Richard (1982), "Adoption and Diffusion of an Innovation of Uncertain Profitability," *Journal of Economic Theory*, 27, 182-193.

Jones, J. Morgan and Christopher J. Ritz (1991), "Incorporating Distribution into New Product Diffusion Models," *International Journal of Research in Marketing*, 8, 91-112.

Joreskog, Karl G. and Dag Sorbom (1988), *LISREL 7: A Guide to the Program and Applications*, Chicago: SPSS inc.

Kalish, Shlomo (1983), "Monopolist Pricing with Dynamic Demand and Production Costs," *Marketing Science*, 2:2 (Spring), 135-159.

_____ (1985), "A New Product Adoption Model with Price, Advertising and Uncertainty," *Management Science*, 31 (December), 1569-1585.

_____ and Gary L. Lilien (1986), "A Market Entry Timing Model for New Technologies," *Management Science*, 32 (February), 194-205.

_____ and S.K. Sen (1986), "Diffusion Models and the Marketing Mix for Single Products," in *Innovation Diffusion Models of New Product Acceptance*, Vijay Mahajan and Yoram Wind, eds., Cambridge, MA: Ballinger, 87-115.

Kamakura, W.A. and S.K. Balasubramanian (1987), "Long-Term Forecasting with Innovation Diffusion Models: The Impact of Replacement Purchases," *Journal of Forecasting*, 6, 1-19.

Katz, Michael L. and Carl Shapiro (1986), "Technology Adoption in the Presence of Network Externalities," *Journal of Political Economy*, 94:4, 822-841.

Kotler, Philip and Gary Armstrong (1994), *Principles of Marketing*, Englewood Cliffs, NJ: Prentice Hall.

Kuhl, Julius (1982), "Action vs. State Orientation as a Mediator between Motivation and Action," in *Cognitive and Motivational Aspects of Action*, W. Hacker et. al., eds., Amsterdam: North-Holland, 67-85.

Lackman, C.L. (1978), "Gompertz Curve Forecasting: A New Product Application," *Journal of the Market Research Society*, 20 (January), 45-47.

LaTour, Steven A. and Nancy C. Peat (1979), "Conceptual and Methodological Issues in Consumer Satisfaction Research," in *Advances in Consumer Research*, William L. Wilke, ed., Ann Arbor, MI: Association for Consumer Research, 431-437.

Lattin, James M. and John H. Roberts (1989), "Modeling the Role of Risk-Adjusted Utility in the Diffusion of Innovations," Working Paper 1019, Graduate School of Business, Stanford University.

Levinthal, Daniel A. and Devavrat Purohit (1989), "Durable Goods and Product Obsolescence," *Marketing Science*, 8:1 (Winter), 35-56.

Maddala, G.S. (1983), *Limited-Dependent and Qualitative Variables in Econometrics*, New York: Cambridge University Press.

Mahajan, Vijay and Eitan Muller (1979), "Innovation Diffusion and New Product Growth Models in Marketing," *Journal of Marketing*, 43 (Fall), 55-68.

_____, _____ and Frank M. Bass (1990), "New Product Diffusion Models in Marketing: A Review and Directions for Research," *Journal of Marketing*, 54 (January), 1-26.

_____, _____ and Roger A. Kerin (1984), "Introduction Strategy for New Products with Positive and Negative Word-of-Mouth," *Management Science*, 30:12 (December), 1389-1404.

_____, _____ and Subhash Sharma (1984), "An Empirical Comparison of Awareness Forecasting Models of New Product Acceptance," *Marketing Science*, 3 (Summer), 179-197.

_____ and Robert A. Peterson (1978), "Innovation Diffusion in a Dynamic Potential Adopter Population," *Management Science*, 24 (November), 1589-1597.

Mansfield, Edwin (1961), "Technical Change and the Rate of Imitation," *Econometrica*, 29:4 (October), 741-766.

_____ (1977), *The Production and Application of New Industrial Technology*, New York: Norton.

Meyer, Marc H. and James M. Utterback (1993), "The Product Family and the Dynamics of Core Capability," *Sloan Management Review*, (Spring), 29-47.

Midgley, David F. and Grahame R. Dowling (1978), "Innovativeness: The Concept and Its Measurement," *Journal of Consumer Research*, 4 (March), 229-242.

- Miniard, Paul W. and Joel B. Cohen (1983), "Modeling Personal and Normative Influences on Behavior," *Journal of Consumer Research*, 10 (September), 169-180.
- Moorthy, K. Sridhar and I.P.L. Png (1992), "Market Segmentation, Cannibalization, and the Timing of Product Introductions," *Management Science*, 38:3 (March), 345-359.
- Muth, John F. (1961), "Rational Expectations and the Theory of Price Movement," *Econometrica*, 29 (July), 315-335.
- Myers, Sumner and Donald G. Marquis (1969), *Successful Industrial Innovations*, Washington, DC: National Science Foundation.
- Norton, John A. and Frank M. Bass (1987), "A Diffusion Theory Model of Adoption and Substitution for Successive Generations of High-Technology Products," *Management Science*, 33:9 (September), 1069-1086.
- _____ and _____ (1992), "Evolution of Technological Generations: The Law of Capture," *Sloan Management Review*, (Winter), 66-77.
- Nunnally, Jum C. (1978), *Psychometric Theory*, Second Edition, New York: McGraw-Hill Book Company.
- Oliver, Richard L. (1981), "Measurement and Evaluation of Satisfaction Processes in Retail Settings," *Journal of Retailing*, 57:3 (Fall), 25-48.
- _____ Russell S. Winer (1987), "A Framework for the Formation and Structure of Consumer Expectations: Review and Propositions," *Journal of Economic Psychology*, 8, 469-499.
- Olshavsky, Richard W. (1980), "Time and the Rate of Adoption of Innovations," *Journal of Consumer Research*, 6 (March), 425-428.
- Olson, Jerry C. and Philip A. Dover (1979), "Disconfirmation of Consumer Expectations Through Product Trial," *Journal of Applied Psychology*, 64:2 (April), 179-189.
- Oren, Shmuel S. and Rick G. Schwartz (1988), "Diffusion of New Products in Risk-Sensitive Markets," *Journal of Forecasting*, 7 (October-December), 273-287.
- Ostlund, Lyman E. (1973), "Factor Analysis Applied to Predictors of Innovative Behavior," *Decision Sciences*, 4, 92-108.
- Perdue, Barbara C. and John O. Summers (1986), "Checking the Success of Manipulations in Marketing Experiments," *Journal of Marketing Research*, 23 (November), 317-326.

Petty, Richard E., Rao H. Unnava and Alan J. Strathman (1991), "Theories of Attitude Change," in *Handbook of Consumer Behavior*, Thomas S. Robertson and Harold H. Kassarian, eds., Englewood Cliffs, NJ: Prentice-Hall.

Ram, S. (1987), "A Model of Innovation Resistance," in *Advances in Consumer Research*, vol. 14, Melanie Wallendorf and Paul Anderson, eds., Provo, UT: Association for Consumer Research.

_____ (1989), "Successful Innovations Using Strategies to Reduce Consumer Resistance: An Empirical Test," *Journal of Product Innovation Management*, 6:20, 20-34.

Rogers, Everett M. (1962), *Diffusion of Innovations*, New York: The Free Press.

_____ (1983), *Diffusion of Innovations*, New York: The Free Press.

_____ and F. Floyd Shoemaker (1971), *Communication of Innovations*, New York: The Free Press.

Rosenberg, Nathan (1976), "On Technological Expectations," *Economic Journal*, 86 (September), 523-535.

_____ (1982), *Inside the Black Box: Technology and Economics*, Cambridge, MA: Cambridge University Press.

Sahal, Devendra (1981), *Patterns of Technological Innovation*, Reading, MA: Addison-Wesley Publishing Company, Inc.

Segars, Albert H. and Varun Grover (1993), "Re-Examining Perceived Ease of Use and Usefulness: A Confirmatory Factor Analysis," *MIS Quarterly*, (December), 517-525.

_____ and K. Ramanathan (1981), "Binomial Innovation Diffusion Models with Dynamic Potential Adopter Population," *Technological Forecasting and Social Change*, 20, 63-87.

Sheth, Jagdish N. (1981), "Psychology of Innovation Resistance: The Less Developed Concept (LDC) in Diffusion Research," *Research in Marketing*, 4, 273-282.

Simon, Herman and Karl-Heinz Sebastian (1987), "Diffusion and Advertising: The German Telephone Company," *Management Science*, 33 (April), 451-466.

Solomon, Michael R. (1983), "The Role of Products as Social Stimuli: A Symbolic Interactionism Perspective," *Journal of Consumer Research*, 10 (December), 319-329.

Spreng, Richard A. and Richard W. Olshavsky (1993), "A Desires Congruency Model of Consumer Satisfaction," *Journal of the Academy of Marketing Science*, 21:3 (Summer), 169-177.

_____, Scott B. MacKenzie and Richard W. Olshavsky (1996), "A Re-examination of the Determinants of Consumer Satisfaction," Working Paper, Michigan State University.

Tarde, Gabriel (1903), *The Laws of Imitation*, New York: Holt.

Tornatzky, L.G. and K.J. Klein (1982), "Innovation Characteristics and Innovation Adoption-Implementation: A Meta-Analysis of Findings," *IEEE Transactions on Engineering Management*, (February), 28-45.

Tushman, Michael L. and Philip Anderson (1986), "Technological Discontinuities and Organizational Environments," *Administrative Science Quarterly*, 31 (September), 439-465.

Tversky, Amos and Daniel Kahneman (1974), "Judgement Under Uncertainty: Heuristics and Biases," *Science*, 185, 1124-1131.

Utterback, James and William J. Abernathy (1975), "A Dynamic Model of Process and Product Innovation," *Omega*, 33, 639-656.

von Hippel, Eric (1988), *The Sources of Innovation*, New York: Oxford University Press.

Weiss, Allen M. and George John (1989), "Leapfrogging Behavior and the Purchase of Industrial Innovations: Theory and Evidence," Technical Working Paper No. 89-110, Marketing Science Institute, Cambridge, MA.

Wheelwright, S.C. and K.B. Clark (1992), *Revolutionizing Product Development*, New York: Free Press.

Winer, Russell S. (1985), "A Price Vector Model of Demand for Consumer Durables: Preliminary Developments," *Marketing Science*, 4:1 (Winter), 74-90.

Yi, Youjae (1989), "On the Evaluation of Main Effects in Multiplicative Regression Models," *Journal of the Market Research Society*, 31:1, 133-138.

Zaltman, Gerald, Robert Duncan and Jonny Holbek (1973), *Innovations and Organizations*, New York: John Wiley.

MICHIGAN STATE UNIV. LIBRARIES



31293010503260